SEMESTER - 9

18XT91 INFORMATION RETRIEVAL

3 0 0 3

INTRODUCTION: Overview of IR Systems - Historical Perspectives - Goals of IR - The impact of the web on IR - The role of artificial intelligence (AI) in IR. (3)

TEXT REPRESENTATION: Statistical Characteristics of Text: Zipf's law; Porter stemmer; morphology; index term selection; using thesauri. **Basic Tokenizing, Indexing:** Simple tokenizing, stop-word removal, and stemming; inverted indices; Data Structure and File Organization for IR - efficient processing with sparse vectors. (6)

RETRIEVAL MODELS: Similarity Measures and Ranking - Boolean Matching – Extended Boolean models - Ranked retrieval - Vector Space Models -, text-similarity metrics - TF-IDF (term frequency/inverse document frequency) weighting - cosine similarity, Probabilistic Models, Evaluations on benchmark text collections. (8)

QUERY PROCESSING: **Query Operations and Languages**- Query expansion; Experimental Evaluation of IR: Performance metrics: recall, precision, and F-measure. (5)

TEXT CATEGORIZATION AND CLUSTERING: Categorization: Rocchio; Naive Bayes, kNN; Clustering: Agglomerative clustering; k-means; Expectation Maximization (EM); Dimension Reduction: LSI, PCA. (6)

INFORMATION FILTERING TECHNIQUES: introduction to Information Filtering, Relevance Feedback - Applications of Information Filtering: **RECOMMENDER SYSTEMS**: Collaborative filtering and Content-Based recommendation of documents and products. (6)

WEB SEARCH: IR Systems and the WWW - Search Engines: Spidering, Meta Crawlers; Link analysis: Hubs and Authorities, Google PageRank, Duplicate Detection. (5)

INFORMATION EXTRACTION AND INTEGRATION: Extracting data from text; Basic Techniques: Named Entity Recognition, Co-reference Resolution, Relation Extraction, Event Extraction; Extracting and Integrating specialized information on the Web, Web Mining and Its Applications. (6)

Total L: 45

TEXT BOOKS:

1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, “Introduction to Information Retrieval”, Cambridge University Press, 2012.
2. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, “Modern Information Retrieval”, Pearson Education, 2010.
3. B.Croft, D. Metzler, T. Strohman, Information Retrieval in Practice, Pearson Education, 2015. (Digitized)

REFERENCES:

1. Stephan Buttcher, Charles L.A. Clarke, and Gordon V. Gormack, “ Information Retrieval Implementing and Evaluating Search Engines”, MIT Press, 2010.
2. Francesco Ricci, Lior Rokach, Bracha Shapira, Paul B. Kantor, Recommender Systems – Handbook, Springer, 2011.
3. Anand Rajaraman and Jeffrey Ullman, “Mining Massive Data sets”, Cambridge University Press, 2014

18XT92 SOFTWARE PATTERNS

3 2 0 4

INTRODUCTION TO PATTERNS: Reusable object oriented software, Motivation, Best design practices of object oriented software, Coupling and Cohesion, Types of Cohesion and Coupling, Benefits of patterns, Definition of a Pattern, Types, Pattern description, Pattern Language, IDIOMS, Framework, Architecture. (6)

DESIGN PATTERNS: Creational patterns – Abstract factory, Builder, Factory method, Prototype, Singleton, Structural patterns – Adapter, Bridge, Composite, Decorator, Façade, Flyweight, Proxy, Behavioral patterns – Command, Interpreter, Iterator, Mediator, Memento, Observer, State, Strategy, Template method, Visitor, Chain of Responsibility, Case Studies. (15)

ARCHITECTURAL PATTERNS: From Mud to Structure – Layers, Pipes and Filters, Blackboard, Distributed systems – Broker, Interactive Systems – Model View Controller (MVC), Presentation Abstraction Control, Adaptable Systems – Reflection, Microkernel. Anti-Patterns. (13)

REFACTORING: What is refactoring, Principles in refactoring, Bad smells in code, Refactoring Techniques - Composing methods, Moving features between objects, Organizing data, Simplifying conditional expressions, Making method calls simpler, Dealing with generalization. Design Refactoring – Technical Debt, Design Smells, Abstraction Smells, Encapsulation Smells, Modularization Smells, Hierarchy Smells, Architectural Refactoring. Refactoring Tools. (11)

TUTORIAL PRACTICE:

1. ATM Simulation – Singleton pattern.
2. Image Viewer Application – Bridge pattern.
3. Address Book Maintenance – Prototype pattern.
4. US, Canada Tax and Freight charges – Factory Method pattern.
5. The Fast Food Franchise – Builder pattern.
6. Computer Models with different architectures – Abstract Factory pattern.
7. An Evaluation Application – Decorator pattern.
8. Refactoring Tool Usage.

Total L:45 + T:30 = 75

TEXT BOOKS:

1. Erich Gamma, Richard Helm, Ralph Johnsons and John Vlissides, “Design Patterns: Elements of Reusable Object-Oriented Software”, Pearson Education, 2004.
2. Frank Buschman, Regine Meunier, Hans Rohnert, Peter Sommerland and Michael Stal, “Pattern-Oriented Software Architecture: A System of Patterns”, John Wiley, 2011.
3. Martin Fowler, Kent Beck, William Opdyke and Don Roberts, “Refactoring: Improving the Design of Existing Code”, Addison-Wesley Longman, 2012.

REFERENCES:

1. Girish Suryanarayana, Ganesh Samarthyam, and Tushar Sharma, “Refactoring for Software Design Smells: Managing Technical Debt”, Morgan Kaufmann Publishers, 2014.
2. Len Bass, Paul Clements, and Rick Kazman, “Software Architecture in Practice”, Addison Wesley, 2013.

18XT93 DATA MINING

3 0 0 3

INTRODUCTION: Motivation for Data Mining – Importance – Definition – Kinds of data for Data Mining – Data Mining functionalities – Patterns – Classification of Data Mining Systems – Major issues in Data Mining-Overview of Data Mining Techniques. **DATA PREPROCESSING:** Types of data, Data cleaning-Smoothing, Handling missing values- Feature subset selection –Chi square and Information Gain- Sampling methods. (9)

DATA WAREHOUSE and OLAP TECHNOLOGY: Overview- Need for Data Warehouse- multidimensional data model-Data Warehouse architecture -Data warehousing Schemas - Data Warehousing to Data mining (5)

MINING FREQUENT PATTERNS, ASSOCIATIONS AND CORRELATIONS: Basic concepts – Efficient and Scalable Frequent Itemset Mining methods – Apriori, FP Tree. **CLASSIFICATION AND PREDICTION:** Overview of Classification techniques – Ensemble Learning-bagging, boosting, cascading, stacking (10)

INCREMENTAL & STREAM DATA MINING: Incremental Algorithms for Data Mining, Characteristics of Streaming Data, Issues and Challenges, Streaming Data Mining Algorithms, Any time stream Mining. (7)

SEQUENCE MINING: Characteristics of Sequence Data, Problem Modeling, Sequential Pattern Discovery, Timing Constraints, Applications in Bioinformatics. Multivariate Time Series (MVTS) Mining - Importance of MVTS data - Sources of MVTS data - Mining MVTS data . (8)

APPLICATIONS AND TRENDS IN DATA MINING: Spatial Data Mining –Graph Mining- Web Mining –Text Mining. (6)

Total L:45

TEXT BOOKS:

1. Jiawei Han and Micheline Kamber , “Data Mining – Concepts and Techniques”, Morgan Kaufmann Publishers, 2012.
2. Tan, Steinbach and Kumar, “Introduction to Data Mining”, Pearson Education, 2014.

REFERENCES:

1. Anand Rajaraman, Jeffrey Ullman, “Mining Massive Data sets”, Cambridge University Press, 2014.
2. Trevor Hastie, Robert Tibshirani and Jerome Freidman, ”The Elements of Statistical Learning: Data Mining, Inference, and Prediction”, Springer Series in Statistics, 2011.
3. Ian Witten, Frank Eibe and Mark A Hall, "Data Mining: Practical Machine Learning Tools and Techniques”, Elsevier, 2011.

18XT96 INFORMATION RETRIEVAL LAB

0 0 2 1

1. Different retrieval models namely Boolean, Vector space and Probability based retrieval.
2. Query refinement techniques
3. Evaluation of the retrieval algorithms.
4. Dimension Reduction techniques
5. Classification and Clustering techniques
6. Recommender systems- Collaborative and Content Based Filtering
7. Information Extraction techniques
8. Web based retrieval - Link based retrieval, combining content and link information

Total P:60

18XT97 RESEARCH SPECIALIZATION LAB - II

0 0 4 2

18XT98 DATA MINING LAB

0 0 4 2

1. Familiarize with tools like WEKA and statistical package like R
2. Getting to know your Data –Feature Selection
3. Ensemble Learning
4 Association Rules
5. Handling massive data using map reduce
6. Package using data mining techniques preferably research papers.

Total P:60

SEMESTER – 10

18XTP2 PROJECT WORK II – INDUSTRY / RESEARCH PROJECT

0 0 – 12

ELECTIVES

18XTE1 PRINCIPLES OF PROGRAMMING LANGUAGES

3 2 0 4

INTRODUCTION: The Role of Programming Languages: Toward Higher-level Languages, Problems of Scale, Programming Paradigms, Language Implementation Bridging the Gap - Language Description:- Syntactic Structure: Expression Notations, Abstract Syntax Trees, Lexical Syntax, Context -Free Grammars, Grammars for Expressions, Variants of Grammars (7)

IMPERATIVE PROGRAMMING: Statements: Structured Programming:- The Need for Structured Programming, Syntax-Directed Control Flow, Design Considerations: Syntax, Handling Special Cases in Loops, Programming with invariants, Proof Rules for Partial Correctness, Control flow in C - Types: Data Representation:- The Role of Types, Basic Types, Arrays Sequences of Elements, Records: Named Fields, Unions and variant Records, Sets, Pointers: Efficiency and Dynamic Allocation, Two String Tables, Types and Error Checking - Procedure Activations:- Introduction to Procedures, Parameter-passing Methods, Scope Rules for Names, Nested Scopes in the Source Text, Activation Records, Lexical Scope: Procedures as in C, Lexical Scope: Nested Procedures and Pascal. (10)

OBJECT ORIENTED PROGRAMMING : Groupings of Data and Operations:- Constructs fro Program Structuring, Information Hiding, Program Design with Modules, Modules and Defined Types, Class Declarations in C++, Dynamic Allocation I C++, Templates: Parameterized Types, Implementation of Objects in C++. - Object-Oriented Programming- Object-Oriented Thinking - Objects in Smalltalk. (9)

FUNCTIONAL PROGRAMMING: Elements of Functional Programming:- A little Language of expressions, Types : Values and Operations, Function declarations, Approaches to Expression Evaluation, Lexical Scope, Type Checking - Functional Programming in a Typed Languages:- Exploring a List, Function Declaration by Cases, Functions as First-Class Values, ML: Implicit Types, Data Types, Exception Handling in M, Little quit in Standard ML - Functional Programming with Lists:- Scheme, a Dialect of Lisp, The Structure of Lists, List Manipulation, A Motivating Example: Differentiation, Simplification of Expressions, Storage Allocation for Lists. (10)

OTHER PARADIGMS: Logic Programming:- Computing with Relations, Introduction to Prolog, Data Structures in Prolog, Programming techniques, Control in Prolog, Cuts - An Introduction to Concurrent Programming:- Parallelism in Hardware, Streams: Implicit Synchronization, Concurrency as interleaving, Liveness Properties, Safe Access to Shared Data, Concurrency in Ada, Synchronized Access to Shared variables. (9)

TUTORIAL PRACTICE:

1. Language tools like Lex and YACC.
2. Inter – Intra sequence control mechanism.
3. Parameter passing mechanism in C, C++.
4. Comparing Object oriented concepts in C++, Java.
5. List Operations in Prolog.
6. Fact finding & Theorem proving in Prolog.
7. Recursive functions in Functional programming language.
8. Expression evaluation in functional programming language.

Total L: 45+T:30 = 75

TEXT BOOKS:

1. Terrence W. Pratt, Marvin V. Selkowitz and T.V. Gopal, “Programming Languages Design and Implementation”, Pearson Education, 2006.
2. Ravi Sethi, “Programming Languages Concepts and Constructs“, Pearson Education, 2007.

REFERENCES:

1. Robert W. Sebesta, “Concepts of Programming Languages”, Pearson Addison Wesley, 2008.
2. Robert Harper, “Programming in standard ML”, Carnegie Mellon University, 2011.
3. Larry C. Paulson, “ML for working Programmer”, Cambridge University Press, 2012.
4. Al Kelley and Ira Pohl, “A Book on C”, Pearson Education, 2005.
5. David A Waat, “Programming Language Design Concepts”, Wiley India, 2009

18XTE2 REINFORCEMENT LEARNING

3 2 0 4

REINFORCEMENT PROBLEM: Introduction - Elements of RL, History of RL- Evaluative feedback -Goals and rewards – Returns - Bandit learning: Upper-confidence - bound algorithms - Thompson sampling, online learning - Multi agent reinforcement learning (6)

MARKOV DECISION PROCESS (MDP) – Value functions - Optimality Criterion in MDPs.- Partially Observed Markov Decision Process (4)

DYNAMIC PROGRAMMING (DP): Policy Evaluation- Policy Improvement - Value Iteration, asynchronous DP- Efficiency of DP- Stochastic DP. (5)

MONTE CARLO METHODS: Policy Evaluation- Policy Improvement- On-policy and off- policy Monte Carlo controls-Incremental implementation. (8)

TEMPORAL DIFFERENCE LEARNING (TD): TD-prediction- Optimality of TD - Sarsa- Q-Learning – R- Learning-Actor-Critic Model-Unifying Monte Carlo and TD-Traces- Games. (8)

FUNCTION APPROXIMATION- Value prediction and control – Gradient Descent methods-Linear methods – Artificial Neural Network based approximation. (6)

PLANNING AND LEARNING: Model based learning and planning - prioritized sweeping-Heuristic search. (6)

Case Studies (2)

TUTORIAL PRACTICE:

1. Ranking of nodes of a graph using Q-Learning (PageRank, TrustRank, DistanceRank).
2. Implementing n-armed Bandit problem.
3. Finding shortest paths in graphs using RL.
4. Solving GridWorld problems.
5. RL for Stochastic grid word.
6. Automated Chess player.
7. Multi-agent system.
8. Distributed RL.
9. Policy search algorithm.

Total L: 45+T:30 = 75

TEXT BOOKS

1. Sutton R. S. and Barto A. G., "Reinforcement Learning: An Introduction", MIT Press, 2012.
2. Csaba Szepesvári, “Algorithms for Reinforcement Learning”, Morgan & Claypool, 2013.
3. Masashi Sugiyama, “Statistical Reinforcement Learning : Modern Machine Learning Approaches”, CRC Press, Taylor & Francis Group, 2015
4. Kevin Murphy , “Machine Learning - A Probabilistic Perspective” , MIT press, 2012.

REFERENCES

1. Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
2. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Prentice Hall, 2014.

18XTE3 NATURAL LANGUAGE PROCESSING

3 2 0 4

INTRODUCTION : Natural language processing techniques **-** The different analysis levels used for NLP: morpho - lexical - syntactic – semantic - pragmatic - markup (TEI, UNICODE) – Applications – open problems. (3)

WORDS : Regular expressions – Automata – Morphology – Finite state Transducers – Finite state morphological parsing – Combining FST lexicon and rules – Porter Stemmer Algorithm – Probabilistic models for Spelling – Bayes method, Minimum edit distance - N-Grams – Counting words in Corpora – Simple n-grams – Smoothing – Evaluating language models : Entropy, Perplexity- Part of Speech Tagging (POS) – Rule based tagging – Stochastic based tagging – Transformation based tagging - Context Free Grammars - Top down parser – Earley Algorithm – Bottom-up parsing – CYK parser – Probabilistic parsing. (15)

SEMANTICS : Meaning structure of a language – First order predicate calculus – Alternative approaches to meaning – Syntax driven sematic analysis – Attachments for a fragment of English – Word Sense Disambiguation – Machine learning approaches – Dictionary based approaches – Pragmatics : Discourse – Text coherence (10)

Natural Language Generation : Architecture of NLG Systems- Generation Tasks and Representations- Application of NLG. Machine Translation: Language similarities and differences – The transfer metaphor – Direct translation – Statistical translation - Translation involving Indian Languages. (12)

CASE STUDIES : Sentiment Analysis **-** Automatic summarization - Information retrieval and Question answering - Named entity recognition and relation extraction – Deep Learning for NLP (5)

TUTORIAL PRACTICE:

1. Implementing word similarity.
2. Implementing simple problems related to word disambiguation.
3. Simple demonstration of part of speech tagging.
4. Translation from one language into another language
5. Word sense disambiguation
6. Representations of Text, if, if-idf, WordZVec, Classifications Clustering of Text Data.

Total L:45+T:30 = 75

TEXT BOOKS:

1. Daniel Jurafsky and James H. Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition”, Prentice Hall, 2014.
2. Christopher Manning and Hinrich Schütze, “Foundations of Statistical Natural Language Processing”, MIT Press, 2003.

REFERENCES:

1. James Allen, “Natural Language Understanding”, Addison Wesley, 2008.

2. Steven Bird, Ewan Klein, and Edward Loper, “Natural Language Processing with Python - Analyzing Text with the Natural Language Toolkit”, O'Reilly Media, 2009.

18XTE4 DEEP LEARNING

3 2 0 4

INTRODUCTION: Neural networks - Deep Networks - Deep Feed forward Networks – Learning XOR, Gradient Based Learning – Hidden units , Design – Back propagation - Regularization of deep learning, (5)

OPTIMIZATION FOR TRAINING DEEP MODELS: Challenges in neural network optimization - Basic algorithms – Parameter initialization strategies – Algorithms with adaptive learning rates – Meta algorithms (10)

CONVOLUTIONAL NETWORKS: Convolution operation - Motivation – Pooling – Variants of convolution function (8)

RECURRENT NETWORKS: Unfolding computational graphs – Recurrent neural networks (RNN) – Bidirectional RNNs - Deep recurrent network – Methodology – Applications (10)

DEEP LEARNING RESEARCH : Linear Factor Models, Autoencoders, Representational Learning, Structured probabilistic models for deep learning, Monte Carlo Methods, Deep generative models (8)

APPLICATIONS: Natural language processing, Big Data, Brain Computer Interface, Visual Data, IoT (4)

TUTORIAL PRACTICE:

1. Collect data sets from the url : http://deeplearning.net/datasets/
2. Use TensorFlow library for visualization of data sets in different domains and analysis:
   a. Music
   b. Image processing
   c. Text analysis (Next word prediction,etc)
   d. Speech processing

Total L:45+T:30 =75

TEXT BOOKS:

1. Ian Goodfellow, YoshuaBengio, Aaron Courville , “Deep Learning”, The MIT Press, 2016.
2. Yoshua Bengio, “Learning Deep Architectures for AI”, Foundations & Trends in Machine Learning, 2009.

REFERENCES:

1. Adam Gibson, Josh Patterson "Deep Learning: A Practitioner's Approach ", OReilly, 2016.
2. Nicholas Locascio and Nikhil Buduma "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", OReilly, 2017

18XTE5 APPROXIMATION ALGORITHMS

3 2 0 4

INTRODUCTION: Definition-performance ratios, lower bounding OPT, vertex-cover problem- a greedy approach (4)

COMBINATORIAL ALGORITHMS: Set cover problem, Metric TSP, multiway cut problem, the minimum k-cut problem, FPTAS, PTAS, FPTAS for knapsack, greedy algorithms for Makespan-PTAS for minimum Makespan, Euclidean TSP (10)

LINEAR PROGRAMMING RELAXATIONS: LP-duality, min-max relations and LP-duality, rounding applied to vertex cover-simple rounding algorithm-randomized rounding, primal dual method and vertex cover. (9)

CUTS, METRICAL RELAXATIONS AND EMBEDDINGS: Multiway cut, sum multicommodity flow, some applications of multicut, rounding for Sparsest Cut via L1 Embeddings. (8)

SEMIDEFINITE PROGRAMMING: Strict quadratic programs and vector programs, properties of positive semidefinite matrices, the semidefinite programming problem, randomized rounding algorithm, improving the guarantee for MAX-2SAT. (7)

HARDNESS OF APPROXIMATION: reduction, graphs, and hardness factors, statement of the PCP theorem, hardness of MAX-3SAT.

(7)

TUTORIAL PRACTICE:

1. Problem related to vertex-cover algorithm.
2. Solving problem using Greedy algorithm for makespan.
3. Problems related to Euclidean TSP.
4. Problem using different algorithms with rounding.
5. Applications of multicut.

Total L:45+T:30 = 75

TEXT BOOKS:

1. David P. Williamson, David B. Shmoys, “The Design of Approximation Algorithms”, Cambridge University Press, 2011
2. Vijay V.Vazirani, “Approximation Algorithms”, Springer-Verlag, 2013.

REFERENCES:

1. Thomas H Cormen, Charles E Leiserson and Ronald L Rivest, “Introduction to Algorithms”, MIT Press, 2015.

18XTE6 NETWORK ALGORITHMICS

3 2 0 4

INTRODUCTION: Algorithms Vs Algorithmics – Network algorithmics – Network bottlenecks – Endnode bottlenecks – Router bottlenecks – characteristics of network algorithmics . (4)

NETWORK IMPLEMENTATION MODELS: Protocols - Hardware - Network device architectures – Operating System Implementation Principles – System Principles – Principles for modularity and efficiency – Principles for speeding up routines – Principles in action. (8)

ENDNODE ALGORITHMICS: Copying data – Transferring Control – Maintaining timers – Protocol Processing. (8)

ROUTER ALGORITHMICS: Exact match lookup – Prefix match look ups – Packet Classification – Switching – Scheduling packets – Computing traffic matrices. (15)

NETWORK SECURITY: Searching for multiple strings in packet payloads – IP trace back via probabilistic marking and logging – Detecting worms. (10)

TUTORIAL PRACTICE:

1. Implementation of CRC using a fast implementation technique.
2. Implementation of IP prefix lookup using lulea tries.
3. Implementation of binary search on prefixes.
4. Implementation of packet classification using linear search.
5. Implementation of packet classification using set pruning trees.
6. Implementation of decision trees approach for packet classification.
7. Implementation of packet scheduling algorithms.
8. Implementation of AhoCorasick algorithm.

Total L: 45+T:30 = 75

TEXT BOOKS:

1. George Varghese, “Network Algorithmics, An Interdisciplinary Approach to Designing Fast Networked Devices”, Morgan Kaufmann, 2006.
2. Michal Pioro and Deepankar Medhi, “Routing Flow and Capacity Design in Communication and Computer Networks”, Morgan Kaufmann, 2007.

REFERENCES:

1. James D McCabe, “Network Analysis, Architecture and Design”, Morgan Kaufmann, 2007.
2. Panos C Lekkas, “Network Processors, Architectures, Protocols and Platforms (Telecom Engineering)”, McGraw Hill, 2008.

18XTE7 SOCIAL NETWORK ANALYSIS

3 2 0 4

INTRODUCTION: Motivation - different sources of network data - types of networks - tools for visualizing network data - review of graph theory basics. (9)

GRAPH THEORETIC PROPERTIES OF SOCIAL NETWORKS: Notions of centrality - Strong and weak ties – Homophily - Structural Balance. (5)

DYNAMIC PROPERTIES OF NETWORKS: Information diffusion - networks effects on information diffusion - maximizing influence spread - power law and heavy tail - preferential attachment models - small world phenomenon - cascading behavior on networks - Epidemics. (11)

BEHAVIORAL PROPERTIES ON NETWORKS: Network economics - Bargaining and power in networks - Sponsored search markets (10)

MINING GRAPHS: Community and cluster detection: random walks - spectral methods - link analysis for web mining-overview of social tagging and applications. (10)

TUTORIAL PRACTICE:

1. Getting acquainted with UCINET and Netdraw.
2. Implementing graph-theoretic/social network metrics using UCINET.
3. Working with Visualization, Ego networks, Centrality, Community Detection etc.

Total L:45+T:30 = 75

TEXTBOOKS:

1. David Easley and Jon Kleinberg, “Networks, Crowds, and Markets: Reasoning About a Highly Connected World”, Cambridge University Press, 2010.

REFERENCES:

1. Peter R. Monge and Noshir S. Contractor, “Theories of Communication Networks”, Oxford University Press, 2003.
2. Duncan J Watts. “Six degrees: The Science of a Connected Age”, Norton, 2004.
3. Narahari Y, Garg D, Ramasuri N, and Prakash H, “Game Theoretic Problems in Network Economics and Mechanism Design Solutions”, Springer Verlag, 2008.
4. Charu C. Aggarwal,, ”Social Network Data Analytics”, Springer, 2015.

18XTE8 ADVANCED COMPUTER GRAPHICS

3 2 0 4

GEOMETRICAL TRANSFORMATIONS: Transformation as a change in coordinate system. Viewing in 3D: Projections – specifying arbitrary 3D viewing – The Mathematics of planar geometric projections – implementing planar geometric projections, Coordinate systems. (3)

OBJECT HIERARCHY: Geometric modeling- Characteristics of retained – mode graphics packages – Defining and displaying structure – Modeling transformations, Hierarchical structure networks. Input devices – interaction techniques And interaction task - USER INTERFACE SOFTWARE: Basic interaction – handling models - window management systems – User-interface management systems. (9)

REPRESENTING CURVES AND SURFACES: Polygon meshing – parametric cubic curves, Parametric bicubic surfaces, Quadric surfaces. SOLID MODELLING**:** Representing solids – Regularized Boolean set operations – Primitive instancing – Sweep representations – Boundary representations – Spatial – Partitioning representations – Constructive solid geometry – Comparison of representation – User interfaces for solid modeling. VISIBLE SURFACE DETERMINATION : Function of two variables – Techniques for efficient visible surface algorithms – Algorithms for visible line determination– Visible ray tracing. (12)

REALISM: Fundamental difficulties – Rendering techniques for line drawing, shaded images – Improved object models – Dynamics – stereopsis – Improved displays – Interacting with our other senses – *Aliasing and antialiasing.* ACHROMATIC AND COLORED LIGHT**:** Achromatic light – Chromatic color – Color Models for Raster Graphics – Reproducing Color – Using Color in Computer Graphics. illuminations and shading: Illumination models – Shading models for polygons – Surface detail – Shadows – Transparency – Inter object reflections – Physically based illumination models – Extended light sources – Spectral sampling – Improved camera model – Global Illumination algorithms – Recursive ray tracing – Radiosity methods – The rendering pipeline.(11)

IMAGE MANIPULATION AND SHADING: Filtering – Image Processing – Geometric transformations of Images – Multipass transformation – Image Composition – Mechanism for Image Storage – *Special Effects with images*. ANIMATION : Conventional and Computer assisted Animation – Animation languages – Methods of controlling animation - Basic rules of animation – Problems peculiar to animation. (10)

TUTORIAL PRACTICE:

Implement the following using OpenGL:

1. Using glRecti function, draw
   a) A flurry b) A checkerboard
2. Write the window to view port mapping functions, and use it to draw the since curve in real world coordinates.
3. Using user defined lineTo and moveTo functions, plot the Fibonacci series.
4. Write the Canvas class and it's supporting classes. Use the Canvas class to draw a simple meander.
5. Write functions to change the background and foreground colors.
6. Write a function to draw an n-sided polygon (using the basic Canvas class and line To and move To functions)
7. Write a program to draw the Sierpinski gasket.
8. Write a program to draw the graph of a given mathematical function f(x).
9. Write a program to read a data file that contains a collection of Polylines in the appropriate format and draw each polyline.
10. Write a parameterized function to display a house and call it a number of times by passing different values to form a village.
11. Write a program that displays a colored triangle and rectangle and rotates them at different angles along two axis.

Total L:45+T:30 = 75

TEXT BOOKS:

1. Foley James D, Vandam Andries and Hughes John F, "Computer Graphics: Principles and Practice", Addison-Wesley, 2013.
2. Donald Hearn, M. Pauline Baker and Warren Carithers, "Computer Graphics with OpenGL", Pearson Education, 2013.

REFERENCES:

1. Edward Angel and Dave Shreine, "Interactive Computer Graphics- A top down approach with OpenGL", Pearson Education, 2012.
2. Anil K Jain., "Fundamentals of Digital Image Processing", Pearson Education, 2007.
3. F S Hill, "Computer Graphics Using OpenGL", Prentice Hall, 2007.

18XTE9 COMPUTER VISION AND IMAGE ANALYSIS

3 2 0 4

OVERVIEW: Computer Imaging Systems: Image formation and Sensing, Color representation, Image Acquisition, Image digitization, Noise, Image Representation. (4)

DIGITAL IMAGE ANALYSIS: Preprocessing, Binary Image Analysis, Edge detection - First order derivative, Second order detection, Color edge detection, Pyramid edge detection, Edge linking and boundary detection, Segmentation - Region based segmentation, clustering techniques, boundary detection, thresholding. (8)

IMAGE ENHANCEMENT: Gray-Scale Modification, Image Sharpening, Image Smoothing - Image Restoration - Noise Models, Noise removal using spatial filters, frequency domain filters, Geometric transforms, Image Reconstruction. (6)

IMAGE TRANSFORMS: Overview of discrete transforms, Fourier Transform, Discrete Cosine transform, Discrete Haar transform, Principal components transform, Discrete Wavelet Transform, Filtering. (6)

IMAGE FEATURE ANALYSIS: Overview, Feature Extraction - Shape, histogram, color, spectral, textural features, feature Analysis. Image Compression - Overview, Lossless compression methods, lossy compression. (5)

MORPHOLOGICAL OPERATIONS - Binary Dilation, Erosion, Opening and Closing, Hit-or-Miss Transform, Basic Morphological Algorithms, Extension to Gray-Scale Images. (4)

IMAGE COMPRESSION - Basic requirements, Types of compression, Coding Algorithms. (4)

APPLICATIONS – CBIR, CBVR, Activity Recognition, computational photography, Biometrics, stitching and document processing; Modern trends - super-resolution; GPU, Augmented Reality; cognitive models, fusion and SR&CS. (8)

TUTORIAL PRACTICE:
1. Implementation of Image segmentation and edge detection.
2. Implementation of feature extraction.
3. Implementation of image classification and clustering.
4. Developing simple image analysis applications

Total L:45+T:30=75

TEXT BOOKS:

1. Umbaugh, S E.,"Digital Image Processing and Analysis: Human and Computer Vision Applications with CVIP Tools", CRC press, 2010.
2. Nagabhushana, S, "Computer vision and image processing", New Age International, 2005.

REFERENCES:

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer-Verlag London Limited 2011.
2. Richard Hartley and Andrew Zisserman, "Multiple View Geometry in Computer Vision", Cambridge University Press, 2004.
3. Gonzalez R C and Woods R E, "Digital Image Processing", AddisonWesley, 2008.

18XTEA DATA COMPRESSION

3 2 0 4

MINIMUM REDUNDANCY CODING: The Shannon - Fano Algorithm, The Huffman Algorithm - Into the Huffman Code: Counting the Symbols, Building the tree . (8)

ADAPTIVE HUFFMAN CODING: Adaptive Coding - Updating the Huffman Tree - Escape code. (7)

ARITHMETIC HUFFMAN CODING: Arithmetic Coding with floating point data type – Arithmetic coding with integral data type. (10)

STATISTICAL MODELING: Higher-order Modeling - Finite Context Modeling – Order one modeling – Order two Modeling. (10)

IMAGE COMPRESSION: Scalar Quantization - Vector Quantization – LBG Algorithm - JPEG Compression – Discrete Cosine Transform (12)

AUDIO COMPRESSION: Spectral Masking – Temporal Masking – Psychoacoustic Model – MPEG Audio Coding – MPEG Advanced Audio Coding (7)

VIDEO COMPRESSION: MPEG Compression – Motion Compensation – Model Based Coding (7)

DICTIONARY-BASED COMPRESSION: LZ77 Compression and Decompression - LZSS Compression and Decompression - LZ78 Compression and Decompression - LZW Compression and Decompression – LZMW Compression and Decompression - LZAP Compression and Decompression – LZY Compression and Decompression. (14)

TUTORIAL PRACTICE:
1. Implement Shannon Fano algorithm and Huffman algorithm.
2. Design compression and decompression program using adaptive Huffman coding.
3. Implement arithmetic coding algorithm.
4. Design compression program using statistical modeling upto 3 order.
5. Design compression and decompression program using LZ77 algorithm.

Total: L: 45+T: 30 = 75

TEXT BOOK:

1. Khalid Sayood, "Introduction to Data Compression", Morgan Kaufmann, 2013.
2. David Salomon, "Data Compression: The Complete Reference", Springer, 2014

REFERENCES:

1. Charles K. Chui, Qingtang Jiang, "Applied Mathematics: Data Compression, Spectral Methods, Fourier Analysis, Wavelets and Applications", Atlantic Press, 2013

18XTEB RANDOMIZED ALGORITHMS

3 2 0 4

INTRODUCTION: Randomized algorithms, generation of random numbers, randomized quick sort, Karger's min-cut algorithm Las Vegas and Monte Carlo algorithms, computational models and complexity classes. (5)

PROBABILISTIC INEQUALITIES: Union bound, Markov and Chebyshev inequalities-Applications- Occupancy problem**,** randomized selection- coupon collector's problem, the Chernoff bound- routing in a parallel computer- a wiring problem. (6)

PROBABILISTIC METHOD: Overview of the method-maximum satisfiability – finding a large cut , Independent Sets (4)

MARKOV CHAINS AND RANDOM WALKS: Markov chains, Random walk on graphs – connectivity in undirected graphs – Expanders and rapidly mixing random walks, Probability amplification fo random walks on expanders (7)

DATA STRUCTURES AND GRAPH ALGORITHMS: Random Treaps, hashing – hash tables – perfect hashing, skip lists **–** Fast min-cut. (6)
ONLINE ALGORITHMS: Paging problem-adversary models- paging against an oblivious adversary-relating the adversaries-the adaptive online adversary, k-server problem. (4)
PARALLEL AND DISTRIBUTED ALGORITHMS: Sorting on a PRAM – Maximal Independent sets-parallel matching (5)

NUMBER THEORETIC ALGORITHMS:, Polynomial roots and factoring, primality testing. (4)

DERANDOMIZATION: The method of Conditional Probabilities – Derandomizing max-cut algorithm, Constructing pairwise independent values modulo a prime – large cut. (4)

TUTORIAL PRACTICE:
1. Find solution for s-t min-cut problem adapting min cut algorithm.
2. Problems using treap data structure.
3. Problems using randomized hash table.
4. Comparison of performance analysis of Karger's min cut with fast min-cut algorithms.
5. Randomized primality testing.
6. Problem using K-server on-line algorithms.
7. Real time application of parallel algorithms for maximum independent set.

Total L:45+TP:30 = 75

TEXT BOOKS:
1. Motwani R and Raghavan P, "Randomized Algorithms", Cambridge University Press, 2014.
2. Michael Mitzenmacher and Eli Upfal, "Probability & Computing: Randomized Algorithms and Probabilistic Analysis", Cambridge University Press, 2017.

REFERENCES:
1. Thomas H Cormen, Charles E Leiserson and Ronald L Rivest, "Introduction to Algorithms", MIT Press, 2015
2. Notes on Randomized algorithms, James Aspens, Yale University, 2013,

18XTEC CLOUD COMPUTING

3 2 0 4

INTRODUCTION TO PARALLEL AND DISTRIBUTED COMPUTING: Introduction, Architecture and Distributed computing models and technologies SOA, Web Services. (5)

GRID, CLUSTER AND UTILITY COMPUTING: Introduction, Architecture, Pros & Cons, Real time applications. (4)

INTRODUCTION TO CLOUD COMPUTING: Definition, History, Comparison of Cloud Computing with Grid, Cluster and Utility Computing, Deployment models – Private, Public, Hybrid and Community - Pros and Cons of Cloud Computing . SaaS, PaaS, IaaS etc. (8)

VIRUTUALIZATION : Types of Virtualization, Tools for Virtualization, Architecture of VMM, Virtualization for Cloud. (4)

ADVANCED WEB TECHNOLOGIES: AJAX and Mashup – Programing examples using applications. (4)

MAP REDUCE PARADIGMS: Introduction, GFS Architecture, HDFS Architecture, Hbase, Google big Table, Amazon's (key value) pair storage and Microsoft's Azure infrastructure, Map reduce programming examples. (6)

CLOUD COMPUTING FRAMEWORK: Amazon EC3, S3 storage revises, Aneka frame work, IBM blue Cloud. (7)

APPLICATIONS: Distributed search engine and distributed data mining in the cloud. (7)

TUTORIAL PRACTICE:
1. Parallel programming using pvm on Linux platform.
2. Develop web services using Eclipse or similar tools.
3. Virtualization (VM Ware, VCloud, Hyper V)
4. Develop a Mashup website based on 2 or more existing websites.
5. Build Private cloud compatible with AWS API using Eucalyptus
6. Build Cloud platform using Openstack
7. Package development using tools supported by cloud providers as a free service.

Total L:45+T:30 = 75

TEXT BOOK
1. Anthony T. Velte, Toby J. Velte and Robert Elsenpeter "Cloud Computing : A Practical Approach" McGraw Hill, 2010.

REFERENCES:
1. Liu M L, "Distributed Computing Principles and Applications", Pearson Education, 2005.
2. Joel M.Crichlow," Distributed And Parallel Computing" , Prentice Hall, 2007.
3. Donald Miner and Adam Shook, "Mapreduce design pattern", O'Reilly, 2012.

18XTED PERVASIVE COMPUTING

3 2 0 4

INTRODUCTION: Pervasive computing, m-Business, challenges and future of pervasive computing - modelling key for pervasive computing - pervasive system environment interaction - IOT - architectural design - application examples: Healthcare, Tracking, emergency information systems, home networking appliances and entertainment. (5)

DEVICE TECHNOLOGY FOR PERVASIVE COMPUTING: Hardware computing devices - pervasive information access devices- smart identification, smart card, labels, tokens - embedded controls, smart sensors, actuators -Human-machine interfaces, Biometrics - Various operating systems for pervasive devices. (4)

COMMUNICATION TECHNOLOGIES FOR PERVASIVE COMPUTING: Connecting the world – WWAN, SRWC, DECT, Bluetooth, IrDA – mobile internet – internet protocols. Audio networks - wireless data networks - pervasive networks - service oriented networks - network design issues - Managing smart devices in virtual environments, user-centered and physical environments - pervasive computing issues. (7)

APPROACHES FOR DEVELOPING PERVASIVE APPLICATIONS: Categorization - smart services for pervasive application development - developing mobile applications – presentation transcoding – device independent view component – heterogeneity of device platforms - Context Awareness and Mobility to build pervasive applications. (8)

CONTEXT AWARE SYSTEMS: Modelling - mobility awareness - spatial awareness - temporal awareness - ICT system awareness - Intelligent Systems - basic concepts- autonomous systems - reflective and self-aware systems - self management and autonomic computing - complex systems. (8)

LOCATION AWARE SYSTEMS: Basic concepts - DNS Server, server process, client process – location modelling –- location update- location inquiry - location management – cost- network topology – mobility pattern, memory less movement model, Markovian Model, Shortest distance model, Gauss-Markov model, Activity Based Model, Mobility Trace, Fluid-flow Model, Gravity Model. (7)

LOCATION DEPENDENT QUERY MODELS: Location dependent information system - location dependent data – location aware queries – location dependent queries – moving object database queries - query transition steps in LDQ processing. (6)

TUTORIAL PRACTICE:

1. Create application with onClick, onKeyDown, onFocusChanged Event Handlers.
2. Create application with Toast Notifications.
3. Create application with Android's Advanced User Interface Functions.
4. Create Android Audio/Video Application.
5. Create application to Create, Modify and Query an SQLite Database.
6. Create application that Works with an Android Content Provider.
7. Create application that performs Data Storage and Retrieval from Android External Storage.
8. Create Location-Aware application that uses Proximity Alerts and Google Maps API.
9. Implementation of small packages to demonstrate all APIs.

Note: Implementations in android platform.

Total L:45+T:30=75

TEXT BOOKS:

1. Stefan Poslad, “Ubiquitous Computing - Smart Devices, Environment and Interactions”, John Wiley, 2011.
2. Adelstein F and Gupta S K S, “Fundamentals of Mobile and Pervasive Computing”, Tata McGraw Hill, 2008.

REFERENCES:

1. Syed Ijlal Ali Shah, Mohammad Ilyas, Hussein T. Mouftah, “Pervasive Communications Handbook”, CRC Press, 2015.
2. Guruduth Banavar, Norman Cohen, Chandra Narayanaswami, “Pervasive Computing: An Application-Based Approach”, Wiley Inter Science, 2012.
3. Mohammed Ilyas and Imad Mahgoub, “Mobile Computing Handbook”, Auerbach Publications, 2009.
4. Burkhardt, Henn, Hepper and Rintdorff, Schaeck. “Pervasive Computing”, Pearson Education, 2009.
5. Ashoke Talukdar and Roopa Yavagal, “Mobile Computing”, Tata McGraw Hill, 2010.
6. A. Genco, S. Sorce: Pervasive Systems and Ubiquitous Computing, WIT Press, 2012.

18XTEE BIG DATA AND MODERN DATABASE SYSTEMS

3 2 0 4

OBJECT AND SPATIAL DATABASES: Object Oriented Databases - Complex data types - Structured types and Inheritance - Query Processing in Object databases - Spatial Databases : Geometric Information System - Spatial Data Types – Spatial Queries - Spatial indexing techniques (6)

PARALLEL AND DISTRIBUTED DATABASES: Architecture of parallel databases – Parallel query evaluation, Parallel query optimization – Distributed DBMS Architecture, Distributed Database Design, Distributed Query Processing (6)

DATA MODELING FOR BIG DATA: Big Data and Challenges, Big Data models, NoSQL data models, Basic principles of NoSQL models, SQL databases Vs NoSQL databases - **MAP-REDUCE** : Apache Hadoop and HDFS, Big data Applications (8)

NOSQL DATABASES (PART 1): Key - Value Stores: Oracle Coherence – Amazon DynamoDB, Key -Value Stores (in-memory) : Redis , Column Oriented Store: Google BigTable , Apache Cassandra - Hbase. (10)

NOSQL DATABASES (PART 2): Document Oriented Stores – MongoDB - Apache CouchDB - Graph databases: Neo4J - OrientDB (10)

DATABASE INTEGRATION: Data warehousing, Schema directed data integration - Schema mapping and information preservation – Information Preserving XML Schema Embedding. (5)

TUTORIAL PRACTICE:

1. Implementing of object databases
2. Implementing of spatial databases and spatial queries
3. Distribution using Map-Reduce on Big Data (Hadoop).
4. Data Integration from heterogeneous Databases.
5. Implementation of No-SQL databases- DynamoDB, MongoDB, Google"s BigTable, DBo4, Neo4J.

Total L:45+T:30=75

TEXT BOOKS

1. M.Tamer Ozsu, Patrick Valduriez, "Principles of Distributed Database Systems", 2011.
2. Pramod J. Sadalage and Martin Fowler, "NoSQL Distilled - Brief Guide to the Emerging World of Polyglot Persistence", Pearson Education, 2013.
3. Guy Harrison, "Next generation Databases: NoSQL and BigData", Apress, 2015.
4. Shashank Tiwari, "Professional NoSQL", John Wiley & Sons, 2011.
5. Anhai Doan, Alon Halevy, Zachary Ives, "Principles of data integration", Morgan Kaufmann, 2012.

REFERENCES/LINKS

1. Ramez Elmasri and Shamkrant Navathe, "Fundamentals of Database Systems", Addison Wesley, 2013.
2. Kristina Chodorow, "MongoDB: The Definitive Guide", O'Reilly Media, 2012

18XTEF PRINCIPLES OF COMPILER DESIGN

3 2 0 4

SYSTEMS PROGRAMMING : Language Processors – Data Structures for Language Processing – Introduction to Assemblers, Macro processors, Interpreters - Compilers - Linkers and Loaders - its need and working. (5)

COMPILERS: Introduction – phases of compiler – Compiler writing tools – FLEX - BISON – JavaCC – PLY – ANTLR. (3)

LEXICAL ANALYSIS: Role of a Lexical Analyzer – tokens – patterns – lexemes – lexical error - buffer pair - sentinels – Implementation of a lexical analyzer (6)

PARSING TECHNIQUES: Context free grammars – Ambiguity – Capabilities of context free grammars. Top down and bottom up parsing – Handles – Shift reduce parsing – Operator precedence parsing – Recursive descent parsing -Predictive parsing. (9)

AUTOMATIC PARSING TECHNIQUES: LR parsers – Canonical collection of LR(0) items – Construction of SLR parsing tables – LR(1) sets of items construction – CLR parser – LALR parser (6)

SYNTAX DIRECTED TRANSLATION AND INTERMEDIATE CODE: Semantic actions – Implementations of syntax directed translators – Postfix notation, Quadruples, triples , indirect triples –Methods of translation of assignment statements, Boolean expression and control statements - Representing information in a symbol table. (9)

CODE OPTIMIZATION: machine independent code optimization – common subexpression - copy propagation – dead code elimination – code motion – data flow analysis - basic blocks – DAG representation – error detection and recovery - code generation. LLVM – Compiler framework. (7)

TUTORIAL PRACTICE:

1. Development of a Lexical Analyzer.
2. Design and implementation of a Symbol Table Manager.
3. Implementation of the following Parsing algorithms.
   a. Recursive descent Parser b.Shift reduce Parser
4. Implementation of a Syntax Directed Translation Engine to
   a. Simulation of a Desk Calculator b. Generation of Postfix code.
5. Implementation of Lexical Analyzer using FLEX.
6. Implementation of Syntax Analyzer using BISON.
7. Implementation of Syntax Analyzer using ANTLR.
8. Implementation of Lexical Analyzer and Syntax Analyzer using JavaCC.
9. Implementation of Lexical Analyzer and Syntax Analyzer using PLY.

Total L:45+T:30=75

TEXT BOOKS:

1. John J. Donovan, "Systems Programming", McGraw Hill , 2017.
2. Aho A.V, Monica S Lam, Ravi Sethi and Ullman J.D., "Compilers : Principles, Techniques and Tools", Pearson Addison Wesley, 2013.

REFERENCES:

1. Keith Cooper, Linda Torczon, "Engineering a Compiler", Morgan Kaufman Publishers, 2012.

18XTEG NETWORK SCIENCE

3 2 0 4

INTRODUCTION: Basics of networks and graphs, random network model - degree distribution, evolution, small world property, six degrees of separation, Watts-Strogatz model, local clustering coefficient, random networks and network science. (5)

BARABÁSI-ALBERT MODEL: Growth and preferential attachment, Barabási-Albert model, degree dynamics, degree distribution, diameter and the clustering coefficient, preferential attachment - absence of growth, measure, non-linearity, the origins. (8)

SCALE-FREE PROPERTY: Power laws and scale-free networks, Hubs, Universality, Ultra-small property, role of the degree exponent, Generating networks with a pre-defined degree distribution. (8)

EVOLVING NETWORKS: Bianconi-Barabási model, measuring fitness, Bose-Einstein condensation, evolving networks. (8)

DEGREE CORRELATIONS: Assortativity and disassortativity, Measuring degree correlations, Structural cutoffs, Degree correlations in real networks, Generating correlated networks, impact of degree correlations. (8)

NETWORK ROBUSTNESS: Percolation theory, robustness of scale-free networks, attack tolerance, cascading failures, modeling cascading failures, building robustness. (8)

TUTORIAL PRACTICE:
1. Implementation of Barabási-Albert model.
2. Implementation of Watts-Strogatz model.
3. Implementation of Bianconi-Barabási model.
4. Obtaining Degree correlations in real networks.
5. Case studies of the theory concepts on real networks

Total L: 45+T:30 = 75

TEXT BOOK:
1. Laszlo Barabasi**,** Network Science, Cambridge University Press, 2016.

REFERENCES:
1. Estrada, E., Fox, M., Higham, D.J. and Oppo, G.L., "Network Science - Complexity in Nature and Technology", Springer, 2010.
2. Ted G. Lewis, "Network Science: Theory and Practice", Wiley, 2013.

18XTEH SECURITY MODELLING AND ANALYSIS

3 2 0 4

INTRODUCTION: Computer security, Cryptographic protocols, Security analysis, Needham-Schroeder example, Model checker-Murphi. (5)

KEY EXCHANGE AND CONTRACT-SIGNING PROTOCOLS: Key management, Kerberos, Public-Key infrastructure, Security properties and attacks on them, Diffie-Hellman key exchange, IPSEC, IKE. Contract-Signing and Fair-Exchange, Trusted third party, Optimistic Contract-Signing, Asokan-Shoup-Waidner protocol, Desirable properties –fairness- timeliness- accountability, Abuse-Free Contract-Signing. (10)

MODELING SECURITY PROTOCOLS IN CSP: Data types for protocol models- Modeling intruder, Expressing protocol goals, Overview of FDR and Casper, Protocol specifications, Case study: Wide-Mouthed-Frog protocol. (10)

PROTOCOL COMPOSITION LOGIC: Proving protocols secure, Symbolic model, Challenge Response example, Informal 'hand' proof, Formalization: protocol specification language, syntax, semantics, proof system, Protocol composition, Complexity theoretic semantics. (10)

FORMAL PROOF OF COMPUTER SECURITY PROTOCOLS: Protocol Verification by BAN logic and Inductive Method: BAN logic- syntax and semantics, Inductive Method: Analysis by theorem proving, Inductive proofs, Protocol traces, Dolev-Yao attacker model. (10)

TUTORIAL PRACTICE:
1. Modeling Needham-Schroeder protocol
2. Analyzing Needham-Schroeder protocol in BAN logic
3. Modeling Asokan-Shoup-Waidner protocol
4. Modeling an intruder in CSP, FDR and Casper
5. Modeling Wide-Mouthed-Frog protocol
6. Analyzing Wide-Mouthed-Frog protocol in BAN logic

Total: L:45+P:30 = 75

TEXT BOOKS:
1. Peter Ryan, Steve Schneider, 'Modeling and analyzing security protocols: the CSP approach'. Addison-Weasley, 2001
2. Colin Boyd, Anish Mathuria, 'Protocols for Authentication and Key Establishment'. Springer, 2010.

REFERENCES:
1. Tobias Nipkow, Lawrence C. Paulson, Markus Wenzel, 'A Proof Assistant for Higher-Order Logic', Springer, 2010.
2. C. A. R. Hoare, 'Communicating Sequential Processes', Prentice Hall, 2004.
3. Bella, Giampaolo, " Formal Correctness of Security Protocols", Springer, 2007.

18XTEI INTERNET OF THINGS

3 2 0 4

INTRODUCTION TO IoT: Introduction to Internet of Things (IoT) – Machine to Machine (M2M) –- Features and Definition of IoT– Recent Trends in the Adoption of IoT – Societal Benefits. (2)

IoTARCHITECTURE: Functional Requirements - IoT Enabling Technologies – IPv6 - Basic Architecture - Componentsof IoT: Embedded Computation Units, Microcontrollers, System on Chip (SoCs) - Sensors – Actuators – Communication Interfaces. (7)

RF COMMUNICATION TECHNOLOGIES INIoT: Wireless Sensor Networks (WSN): Overview, Fault Tolerance - RFID – NFC - Low Power Personal Area networks (LowPAN): Overview, 6LowPAN,IEEE 802.15.4, BLE, Zigbee, Zwave, and Thread - Wi-Fi -Low Power Wide Area Networks (LPWAN): Concepts and features, SigFox, LoraWAN, LPWAN-3GPP,Comparing different LPWAN technologies. (7)

APPLICATIONLAYER PROTOCOLS IN IoT: Rest Architecture - HTTP – CoAP:Architecture, Features,Applications-MQTT: Architecture, Feature, Applications -Comparing different IoT Application Layer Protocols. (7)

MODERN NETWORKING:Cloud Computing: Introduction to the Cloud Computing, Cloud service options, Cloud Deployment models, Load balancing, Hypervisors, Comparison of Cloud providers - Introduction to SDN: Data Plane, Control Plane, Application Plane - OpenFlow Protocol – Relevance of SDN to IoT (8)

SECURITY IN IoT: IEEE 802.11 Wireless Networks Attacks: Basic Types, WEP Key Recovery Attacks, KeystreamRecovery Attacks against WEP – RFID Security – Security Issues in ZigBEE: Eavesdropping Attacks, Encryption Attacks – Bluetooth Security: Threats to Bluetooth Devices and Networks – Blockchain in IoT security. (10)

PROTOTYPING: Prototyping embedded devices- Open Source versus Closed Source-Embedded Computing Basics-Arduino-Raspberry Pi- Implementation. (2)

APPLICATIONS INIoT: Smart homes – Energy – Health Care – Smart Transportation – Smart Living – Smart Cities- Smart Grid – Smart Agriculture. (2)

TUTORIAL PRACTICE:

1. Simulating Wireless Sensor Networks
2. Connected Vehicle applications
3. Traffic Signal Monitoring & Control System
4. Smart home automation
5. IOT Based Person/Wheelchair Fall Detection
6. Gas Pipe Leakage Detector using Robot
7. Smart Energy Meter Monitoring
8. IOT Based Fire Department Alerting System

Total L:45+P:30=75

TEXT BOOKS:

1. Dieter Uckelmann, Mark Harrison, Florian Michahelles, “Architecting the Internet of Things”, Springer, 2011
2. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley, 2014.
3. Thomas Erl, Dr. Zaigham Mahmood, Professor Ricardo Puttini,"Cloud Computing: Concepts, Technology & Architecture",PHI, 2013
4. Brian Russell, Drew Van Duren, "Practical Internet of Things Security", Packt Publishing, 2016.

REFERENCES:

1. Olivier Hersent, David Boswarthick and Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, John Wiley, 2012.
2. Kai Hwang, GeofferyC.Fox, Jack J.Dongarra, “Distributed and Cloud Computing”, Elsevier, 2012.
3. William Stallings,“Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud” Addison-Wesley, 2015
4. Jim Doherty, “SDN and NFV Simplified: A Visual Guide to Understanding Software Defined Networks and Network Function Virtualization”, Addison-Wesley, 2016
5. Johnny Cache, Joshua Wright and Vincent Liu, “Hacking Exposed Wireless: Wireless Security Secrets and Solutions”, Tata McGraw Hill, 2010.

18XTEJ EPIDEMIC MODELS

3 2 0 4

INTRODUCTION: The epidemic in a closed population – Initial growth-the final size. Heterogeneity: Differences in infectivity, differences in infectivity and susceptibility . (9)

STRUCTURED POPULATIONS: The concept of state - i-states, p-states, recapitulation and problem formulation. (7)

THE BASIC REPRODUCTION RATIO: The definition of R_0, general h-state, on conditions that simplify the computation of R_0, sub models for the kernel, extended example, pair formulation models. Partially vaccinated populations, the intrinsic growth rate r, some generalities, separable mixing. (15)

MACROPARASITES: Introduction, counting parasite load, the calculation of R_0 for life cycles, seasonality and R_0, a pathological model. (8)

CONTACT: Introduction, Contact duration, consistency conditions, effects of subdivision, network models. (6)

TUTORIAL PRACTICE:

Case studies.

Total L:45+P:30=75

REFERENCES

1. O.Diekmann, J.A.P. Heesterbeek, “Mathematical Epidemiology of Infectious Diseases: Model building, Analysis and Interpretation”, John Wiley , 2000.
2. Roy M. Anderson and Robert M. May, “Infectious diseases of humans; dynamic and control” Oxford university press, 1992.
3. Diekmann O., Heesterbeek, J.A.P. and Britton, T. Mathematical tools for understanding infectious disease dynamics. Princeton, (2012).

18XTEK STATISTICAL LEARNING

3 2 0 4

THEORETICAL FOUNDATIONS : Function Spaces:Banach Spaces, Cauchy Sequences, Holder spaces, Sobolev spaces, reproducing kernel Hilbert spaces (RKHS),Concentration of Measure. (10)

LINEAR REGRESSION: Low Dimensional Linear Regression**,** Ridge Regression, Lasso Regression (8)

NONPARAMETRIC REGRESSION : Kernel Estimators, Polynomial Estimators, Linear Smoothers, Cross Validation, Data Splitting, Additive Models, SpAM algorithm (7)

LINEAR CLASSIFICATION: Review of Classification Models, Newton's Method for Logistic Regression, Comparison of Logistic Regression with Linear Discriminant Analysis, Regularized Logistic Regression, SVM. (7)

NON-PARAMTERIC CLASSIFICATION: Plugin methods, k-NN, Boosting. (6)

MINIMAX RISK: Bounds of minimax risk, Le Cam's method, Fano's method, Tsybakov's method, Hypercubes. (7)

TUTORIAL PRACTICE:
Solve the following problems using R
1. Auto Regression, Ridge Regression and Lasso Regression for predictions.
2. Kernel PCA for non-linear datasets
3. Non linear SVM using different kernel functions
4. Classification using LDA and boosting

Total L: 45+P: 30 = 75

TEXT BOOKS:

1. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibeshirani, "An introduction to Statistical learning", Springer 2013.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "Elements of Statistical Learning: Data Mining, Inference and Prediction", Springer 2013.

REFERENCES :

1. Vladimir N Vapnik, "Statistical learning theory", Wiley, 1998.
2. Robert Schapire, Yoav Freund, "Boosting : Foundations and Algorithms", The MIT Press, 2012.

OPEN ELECTIVES

18XTO1 COMPUTATIONAL FINANCE

3 2 0 4

MATHEMATICAL PRELIMINARIES: Conditional expectation – Sigma Algebra – Filtrations, Stochastic Calculus - Random walk – Brownian motion – Martingales – Ito's Lemma. (5)
FINANCIAL DERIVATIVES: Law of one price – Risk neutral pricing – Arbitrage and Hedging – Financial Products and capital markets – Futures, Forwards and options – Options pricing problem. Risk free assets – risky assets. (8)

BASIC OPTIONS THEORY: Definitions – Pay off diagrams – Single period binomial options theory – Multi period binomial options theory – Real options – American options, Simulation methods for options pricing – Random variable generation – simulation of stochastic processes. Black Schole's formula. (11)

PORTFOLIO THEORY: Introduction - Portfolio theory with matrix algebra - Review of constrained optimization methods, Markowitz algorithm, Markowitz Algorithm using the solver and matrix algebra – Portfolio choice and linear pricing – Statistical analysis of efficient portfolios. Sharpe's single index model. (11)

THE CAPITAL ASSET PRICING (CAP) AND RISK BUDGETING: Mean variance portfolio theory – Asset returns – Variance as a risk measure - The one and two fund theorems, The capital market line – CAP as a pricing formula – Systematic and unsystematic risk – Euler's theorem – Asset contributions to volatility – beta as a measure of portfolio risk , Limitations of mathematical models in finance. (10)

TUTORIAL PRACTICE:
1. Problems using Capital Asset Pricing model.
2. Plot time series data and find outliers
3. Monte Carlo Simulation of options pricing
4. Sharpe's single index model
5. Black Schole's model
6. CAP model

Total L: 45+T:30 = 75

REFERENCES:

1. Marek Capinski, Tomasz Zastawniak, "Mathematics for Finance: A Introduction to Financial engineering", Springer, 2011.
2. David Ruppert, "Statistics and Data Analysis for Financial Engineering", Springer-Verlag, 2011.
3. Edwin J. Elton, Martin J. Gruber, Stephen J. Brown and William N. Goetzmann "Modern Portfolio Theory and Investment Analysis", Wiley, 2014.
4. Simon Benninga, "Financial Modeling", MIT Press, 2014.
5. Steven E Shreve, "Stochastic Calculus for Finance – I" , Springer, 2012
6. Glasserman Paul, "Monte Carlo Methods in financial Engineering", Springer Science and Business media, 2013.

18XTO2 COMPUTATIONAL GEOMETRY

3 2 0 4

MATHEMATICAL & GEOMETRICAL REVIEW: Algorithm analysis – sorting, binary search, balanced binary search, divide and conquer, plane sweep, Kd-trees, Dijkstra's algorithm, points, lines and planes, basic geometric objects – polygons, polytopes, convexity, graphs - vertex coloring, planar, Euler's formula. (2)

CONVEX HULLS: Definition, lower bounds, algorithms - Graham's scan, divide and conquer, Jarvis march, 3D hulls. (5)

LINE SEGMENT INTERSECTION: Plane sweep algorithm, Doubly-connected edge list, computing overlay of two subdivisions, Map overlay algorithm, half-plane intersection, arrangements of lines. (8)

POLYGON TRIANGULATION: Art gallery problem – introduction, triangulation, bounds, partition into monotone pieces, triangulating monotone polygon, placement of guards. (8)

ORTHOGONAL RANGE SEARCHING: 1-D and 2-D range searching, range trees. (4)

VORONOI DIAGRAMS: Properties, beach line, computing Voronoi diagram, Delaunay triangulations, computing Delaunay triangulations. (8)

ROBOT MOTION PLANNING: Work space and configuration space, point robot, free space, Minkowski sums for convex and nonconvex polygons, translational motion planning, motion planning with rotations, Point location and trapezoidal maps. Visibility graphs - Shortest paths for a point robot, computing visibility graph, shortest paths for a translating polygonal robot. (10)

TUTORIAL PRACTICE:

Implementation of algorithms for the following problems.

1. Convex hull problems.
2. Line and half plane intersections.
3. Map overlay problems using Doubly-connected edge list.
4. Triangulation and Art gallery problem.
5. Orthogonal range searching (1D and 2D) using Kd-trees.
6. Construct Voronoi diagrams.
7. Translational algorithms for robot motion planning.

Total L:45+T:30 = 75

TEXT BOOKS:

1. Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars, "Computational Geometry - Algorithms and Applications", Springer Verlag, 2011.
2. Joseph O'Rourke, "Computational Geometry in C", Cambridge University Press, 2001.

REFERENCES:

1. Franco P. Preparata and Michael Ian Shamos, "Computational Geometry - An Introduction", Springer-Verlag, (Digitized) 2011 .
2. Goodman J E and O'Rourke, "Handbook of Discrete and Computational Geometry", CRC Press, 2004.
3. Subir Kumar Ghosh, "Visibility Algorithms in the Plane", Cambridge University Press, 2007.

18XTO3 DATA SCIENCE

3 2 0 4

INTRODUCTION TO DATA SCIENCE: Data wrangling, cleaning, and sampling to get a suitable data set - Mathematics for understanding the data – Descriptive statistics : Visualizing Data - Central Tendency –Variability –Standardizing -Normal Distribution -Sampling Distributions. (8)

DATA MANIPULATION AT SCALE: Parallel databases, parallel query processing, in-database analytics, MapReduce, Hadoop, Key-value stores and NoSQL; tradeoffs of SQL and NoSQL. (8)

DATA ANALYTICS USING STATISTICAL TECHNIQUES: Review of univariate regression, multiple regression - Linear regression and related methods - splines and regularization - Kernel methods - Generalized additive models - Kernel smoothing - Gaussian mixtures and EM algorithm - Geometry, subspaces, orthogonality, projections, normal equations, rank deficiency, estimable functions and Gauss-Markov theorem - Computation via QR decomposition, Gramm-Schmidt orthogonalization and the SVD - Multivariate normal distribution. (15)

COMMUNICATING RESULTS : Visualization - descriptive statistics and visualisations, privacy, ethics – multivariate visualization. (5)

SPECIAL TOPICS : Graph Analytics: structure, traversals, analytics, PageRank, community detection, recursive queries, Semantic web. (5)

CASE STUDY : Community Detection – Collaborative Network – Opinion mining – Co-citation network . (4)

TUTORIAL PRACTICE:

1. Introduction to R and problems using R.
2. Collect datasets from Kaggle and Data Analysis.
3. Implementation of various predictive models.
4. Generate the results using Confidence levels.
5. Implementation of SVD.

Total L: 45+T:30 = 75

TEXT BOOKS:
1. Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2011.
2. Ravi Kannan and John Hopcroft, “Foundations of Data Science”, 2013.

REFERENCES:
1. Johannes Ledolter, ‘Data Mining and Business Analytics with R’, John Wiley, 2013
2. Gareth James and Daniel Witten, Trevor Hastie, Robert Tibshirani, “An Introduction to Statistical Learning with Applications in R”, Springer, 2013.
3. Michael T. Longnecker, R. Lyman Ott,” An Introduction to Statistical Methods and Data Analysis”, Cengage Learning 2008.
4. T. Hastie, R. Tibshirani, and J. Friedman, “The elements of statistical learning: data mining, inference, and prediction”, Springer, 2009.
5. Matthew A. Russell,”Mining the Social Web: Analyzing Data from Facebook, Twitter, LinkedIn, and Other Social Media Sites”, O'Reilly Media, 2013.
6. Philipp K. Janert, “Data Analysis with Open Source Tools”, O'Reilly Media, 2010.

18XTO4 DATA VISUALIZATION

3 2 0 4

INTRODUCTION: Information visualization – Theoretical foundations – Information visualization types – Design principles - A framework for producing data visualization (8)

STATIC DATA VISUALIZATION : Tools – working with various data formats (4)

DYNAMIC DATA DISPLAYS : Introduction to web based visual displays – deep visualization – collecting sensor data – visualization – D3 framework - Introduction to Many eyes and bubble charts (10)

MAPS – Introduction to building choropleth maps (3)

TREES – Network visualizations – Displaying behavior through network graphs (10)

BIG DATA VISUALIZATION – Visualizations to present and explore big data – visualization of text data and Protein sequences (10)

TUTORIAL PRACTICE:
Note : Explore softwares like R, Python, Google Vision, Google Refine, and ManyEyes ; Data sets are available on Gap minder, Flowing data

1. Visualization of static data.
2. Visualization of web data.
3. Visualization of sensor data.
4. Visualization of protein data.

Total L: 45 + T: 30 = 75

TEXT BOOK:
1. Ware C and Kaufman M ”Visual thinking for design”, Morgan Kaufmann Publishers, 2010.

REFERENCES:
1. Fry ,”Visualizing data”, Sebastopo”, O’Reily, 2007.

18XTO5 PRINCIPLES OF MANAGEMENT AND BEHAVIOURAL SCIENCES

3 2 0 4

PRINCIPLES OF MANAGEMENT: Meaning, Definition and Significance of Management, Basic Functions of Management – Planning, Organizing, Staffing, Directing and Controlling. Organizational Environment – Social, Economic, Technological and Political. Corporate Social Responsibility - Case discussion. (5)
INDUSTRIAL AND BUSINESS ORGANIZATION: Growth of Industries (Small Scale, Medium Scale and Large Scale Industries). Forms of Business Organizations. Resource Management – Internal and External Sources (8)

ORGANIZATIONAL BEHAVIOUR: Significance of OB, Impact of culture on organization. Role of leadership and leadership styles. Personality and Motivational Theories. Attitudes, Values and Perceptions at work - Case discussion (8)

GROUP BEHAVIOUR: Group dynamics, Group formation and development, group structure and group cohesiveness. Informal organization – Sociometry – Interaction analysis – Exercises (8)

GLOBALISATION: Issues for global competitiveness, proactive and reactive forces of globalization. Cross cultural management – Management of work force diversity. (8)

HUMAN RESOURCE MANAGEMENT: Objectives and Functions, Selection and Placement, Training and Development – Conflict management – Stress management - Human resource management in global environment - Human resource information system(HRIS) - Case discussion. (8)

TUTORIAL PRACTICE:
1. Case study on human resource information system.
2. Case study on organizational behavior.
3. Case study on human resource information system.
4. Case study on organizational behavior.

Total L: 45 + T: 30 = 75

TEXT BOOKS:
1. Harold Koontz, Heinz Weihrich and Ramachandra Aryasri, “Principles of Management”, Tata McGraw Hill, 2004.
2. Mamoria C B, “Personnel Management”, Sultan Chand, 2005.

REFERENCES:
1. John W Newstrom and Keith Davis, “Organizational Behavior”, Tata McGraw Hill, 2002.
2. Stephen P Robbins, ”Organisational behavior”, Prentice Hall, 2010.
3. Khanna O P, “Industrial Engineering & Management”, Dhanpat Rai Publications, 2010.

18XTO6 ENTREPRENEURSHIP

3 2 0 4

INTRODUCTION TO ENTREPRENEURSHIP: Definition – Characteristics and Functions of an Entrepreneur – Common myths about entrepreneurs – Importance of Entrepreneurship. Creativity and Innovation**:** The role of creativity – The innovation Process – Sources of New Ideas – Methods of Generating Ideas – Creative Problem Solving – Entrepreneurial Process. (11)

FORMS OF BUSINESS ORGANIZATION: Sole Proprietorship – Partnership – Limited liability partnership - Joint Stock Companies and Cooperatives. Developing an Effective Business Model: The Importance of a Business Model – Starting a small scale industry - Components of an Effective Business Model. (9)

APPRAISAL OF PROJECTS: Importance of Evaluating Various options and future investments- Entrepreneurship incentives and subsidies – Appraisal Techniques. (8)

FINANCING THE NEW VENTURE: Determining Financial Needs – Sources of Financing – Equity and Debt Funding – Case studies in Evaluating Financial Performance. (8)

THE MARKETING FUNCTION: Industry Analysis – Competitor Analysis – Marketing Research for the New Venture – Defining the Purpose or Objectives – Gathering Data from Secondary Sources – Gathering Information from Primary Sources – Analyzing and Interpreting the Results – The Marketing Process**.** Intellectual Property Protection and Ethics**:** Patents – Copyright - Trademark- Geographical indications – Ethical and social responsibility and challenges. (9)

TUTORIAL PRACTICE: Case Studies

Total L: 45 + T: 30 = 75

TEXT BOOKS:
1. Donald F.Kuratko and Richard M. Hodgetts, “Entrepreneurship”, South-Western, 2003.
2. Vasant Desai, “The Dynamics of Entrepreneurial Development and Management”, Himalaya Publishing House, 2010.

REFERENCES:
1. Gupta S.L., Arun Mittal, “Entrepreneurship Development”, International Book House, 2012.
2. Sudha G. S., “Management and Entrepreneurship Development”, Indus Valley Publication, 2009.
3. Badi V., Badi N. V., “Business Ethics”, R. Vrinda Publication (P) Ltd., 2012.
4. Prasanna Chandra, “Projects- Planning, Analysis, Financing, Implementation and review”, TATA McGraw Hill, 2012.

18XTO7 COMPUTATIONAL COMPLEXITY THEORY

3 2 0 4

INTRODUCTION: The computational model - Modeling computation and efficiency - Review of Turing machines – Universal Turing machines – Uncomputable functions – Deterministic time and the class P (5)

COMPLEXITY CLASSES: P, NP, NP Complete , NP-Hard - P vs NP – NP completeness – Relation between NP and NP completeness – The cook Levin theorem – The web of reductions – Decision vs Search – coNP, EXP and NEXP (8)

DIAGONALIZATION: Time hierarchy theorem – Space hierarchy theore – non deterministic time hierarchy theorem – Oracle machines - Space complexity – Configuration graphs – Some space complexity classes – PSPACE completeness – NL Completeness. (8)

POLYNOMIAL HIERARCHY AND ALTERNATIONS: The classes $\sum_i^p$ and π_i^p – The polynomial hierarchy – Alternating turing Machines – Time versus alternations – Defining the hierarchy via oracle machines (8)

CIRCUITS – Boolean circuits – Karp Lipton theorem – Circuit lower bounds (2)

RANDOMIZED COMPUTATION: Probabilistic Turing Machines (PTM) –Examples - RP(Randomized Polynomial) , BPP (Bounded Error probabilistic polynomial) ,Complement Randomized Polynomial (Co-RP) – Probabilistic Polynomial (PP) – Randomized logarithmic space polynomial time (RL) – Related problems. (5)

COUNTING PROBLEMS: Counting classes – Complexity of counting problems – An approximate comparison procedure - Constructing A-Comp - Non-Uniform Classes– Oracles – Relativization. (6)

APPLICATIONS - Randomized decision tree – Pseudo random number generators (3)

TUTORIAL PRACTICE:
1. Implementation of finding a solution to different classes of problems
2. Implementation of randomized decision tree

Total L: 45 + T: 30 = 75

TEXT BOOKS:
1. Sanjeev Arora, Boaz Barak, “Computational Complexity : A modern approach”, Cambridge University Press, 2012.
2. Goldreich, “Computational Complexity: A Conceptual Perspective”, CUP 2010.

REFERENCES:
1. Michael Sipser, “Introduction to the Theory of Computation”,Cengage learning, 2012.
2. Luca Trevisan, “Lecture Notes on Computational Complexity”, 2004.

18XTO8 WIRELESS NETWORKS

3 2 0 4

WIRELESS FUNDAMENTALS: Introduction to cellular networks,-wireless local area networks- Spectrum allocations – Radio propagation models-Narrowband digital modulation and wireless fading environments. – Modern Communications Systems – MAC – SDMA – TDMA – FDMA - CDMA - Cellular and Ad-hoc-Concepts. (7)

WLAN TECHNOLOGIES: wireless network architectures – 802.11 PHYs - 1 MAC – WPA and WEP- 802.11i: Security – 802.11e: MAC Enhancements for Quality of Service – Related Wireless Standards (Hyperlan, HomeRF, Bluetooth, Zigbee, Wireless USB)- WiFi and Wi MAX Standards. (8)

AD HOC AND SENSOR NETWORKS: Ad hoc Network- Characteristics- Table-driven and Source-initiated On Demand routing protocols, Hybrid protocols - Routing in intermittently connected mobile networks. Wireless Sensor networks- Classification, MAC and Routing Protocols. (8)

MOBILE NETWORK AND TRANSPORT LAYERS: Mobile IP – Dynamic Host Configuration Protocol-Mobile Ad Hoc Routing Protocols–Multicast routing-TCP over Wireless Networks – Indirect TCP – Snooping TCP – MobileTCP – Fast Retransmit / Fast Recovery – Transmission/Timeout Freezing-Selective Retransmission – Transaction Oriented TCP- TCP over 2.5 / 3G wireless Networks . (8)

WIRELESS PANs MANs – Physical and MAC layer details, Wireless PANs – Architecture of Bluetooth Systems, Physical and MAC layer details, Standards-WLAN deployment issues- Interference – Resource Allocation (6)

FUTURE TRENDS: Emerging WLAN Related Technologies – 802.11 Trends – Cellular – 802.16 – 802.20 – 802.22 – UWB, Cognitive Radios, RFID – 4G and Data Communications Convergence. (8)

TUTORIAL PRACTICE:
1. Study of OMNET++/NS-2 simulator.
2. Simulation of a IEEE 802.11 LAN under various conditions using chosen simulator.
3. Simulation of a priority MAC protocol using chosen simulator.
4. Simulation of different routing protocols using simulators.
5. Simulation of TCP over error-prone wireless network using simulator.
6. Development of Mobile application using blue tooth.

Total L:45+T:30 = 75

TEXT BOOKS:
1. Gary. S. Rogers and John Edwards, “An Introduction to Wireless Technology”, Pearson Education, 2012.
2. Siva Ram Murthy C and B.S Manoj, “Ad hoc Wireless Networks Architecture and Protocols”, Pearson Education, 2005.
3. Kaveh Pahlavan, Prashant K. Krishnamurthy, “Principles of Wireless Networks : A Unified Approach”, John Wiley, 2011.
4. William Stallings, “Wireless Communication and Networks”, Pearson Education, 2009.

REFERENCES:
1. Dharma Prakash Agrawal and Qing-An Zeng, “Introduction to Wireless and Mobile Systems”, Thomson Press, 2007.
2. Feng Zhao and Leonidas Guibas, “Wireless Sensor Networks-An Information Processing Approach”, Elsevier, 2004.
3. Clint Smith, P.E. and Daniel Collins, “3G Wireless Networks”, Tata McGraw Hill, 2007.
4. Ivan Stojmenovic, “Handbook of Wireless Networks and Mobile Computing”, John wiley, 2006.
5. SavoGlisic, “Advanced Wireless Communications 4G Technologies”, Wiley Publications, 2006.

18XTO9 ADVANCED OPERATING SYSTEMS

3 2 0 4

LINUX SYSTEM: Design Principles – Kernel Modules – Process Management Scheduling – Memory Management – Input-Output Management – File System –Interprocess Communication. iOS and Android: Architecture and SDK Framework – Media Layer – Services Layer – Core OS Layer. (6)

OVERVIEW OF SYSTEM CALLS: anatomy of a system call and x86 mechanisms for system call implementation - MMU/memory translation, segmentation, and hardware traps interact - create kernel-user context separation – virtualization. (6)

THE KERNEL EXECUTION AND PROGRAMMING CONTEXT: Live debugging and tracing– Hardware and software support for debugging –Dtrace: programming, implementation/design, internals–Kprobes and SysTrace: Linux catching up. (7)

Linking and loading– Executable and Linkable Format (ELF)– Internals of linking and dynamic linking –Internals of effective spinlock implementations on x86. (4)

Process and thread kernel data structures– process table traversal – lookup, allocation and management of new structures- /proc internals– optimizations. (4)

Virtual File System and the layering of a file system call from API to driver– Object-orientation patterns inkernel code– a review of OO implementation generics (C++ vtables, etc). (8)

Kmem and Vmem allocators. OO approach to memory allocation–Challenges of multiple CPUs and memory hierarchy–Overview of the kernel network stack implementation– Path of a packet through a kernel– Berkeley Packet Filter architecture– Linux Netfilter architecture. (10)

TUTORIAL PRACTICE:

1. Implementation of Process and Memory System call
2. Writing Kernel Module
3. Accessing Kernel data structure
4. Using Dtrace and strace
5. Implementing kernel network stack

Total L:45+T:30 = 75

TEXT BOOKS:

1. Robert Love, Linux System Programming, O'Reilly, 2013
2. Yang Lixiang, Liang Wenfeng, The Art of Kernel Linux design, CRC Press, 2016
3. Rami Rosen, Linux Kernel Networking : Implementation and Theory, Apress, 2014.

18XTOA MOBILE COMPUTING

3 2 0 4

INTRODUCTION: Introduction to mobile and wireless devices - wireless networking, Advantages and disadvantages of wireless networking, Evolution of mobile communication generations- Challenges in mobile computing – Vertical and horizontal mobile applications - Wireless LAN and Wireless WAN. (5)

CELLULAR CONCEPT: Wireless transmission - Frequencies for radio transmission - Regulations - Signals , Antennas , Signal propagation ,Path loss of radio signals , Additional signal propagation effects - Multi-path propagation - Multiplexing - Space division multiplexing - Frequency division multiplexing -Time division multiplexing - Code division multiplexing - Spread spectrum - Direct sequence spread spectrum - Frequency hopping spread spectrum. (10)

CELLULAR NETWORK : Cellular Concepts – Factors determining cell size and shape - GSM-Mobile services - System architecture -- Handover – GPRS – Mobile services – System architecture – Location Management strategies – Eager caching Vs lazy caching - LTE Network architecture and interfaces (10)

MOBILE APPLICATIONS ARCHITECTURE: Smart Client – Smart Client Architecture – Messaging Architecture – The Model-View-Controller Model- Delegate Pattern- Building Smart Client Applications-Design, Development, implementation, testing and deployment phase- MVVM mobile architecture design. (6)

MOBILE APPLICATION DEVELOPMENT: Introduction to Android Platform – Android architecture overview - Application life cycle - UI design for Android - Different types of layouts – Widgets – List view and Adapters - Dialogs and Toasts – Intent filters - Files and database – SQLite on Android - Security model – Comparison with IOS application development -Building cross-platform applications using React Native. (14)

TUTORIAL PRACTICE:

1. Android SDK installation and study
2. Defining Layouts
3. Single Activity Application, Application with multiple activities, using intents To Launch Activities
4. Application using GUI Widgets
5. Application with Notifications
6. Creating and Saving Shared Preferences and Retrieving Shared Preferences
7. Usage of SQLite Databases for storage
8. Working with Retrofit library in Android Applications
9 Android Automated Testing Frameworks
10. Case Study: Dagger Framework for Android

Total L: 45 + T: 30 = 75

TEXT BOOKS:

1. Jochen Schiller, "Mobile Communications", Pearson Education, 2012.
2. Martyn Mallick, "Mobile and Wireless Design Essentials", Wiley, 2003
3. John Horton, "Android Programming for Beginners", Packt Publishing, 2017.

REFERENCES:

1. Andreas F.Mohisch, "Wireless Communications", Wiley, 2010.
2. David Taniar, "Mobile computing concepts, methodologies, tools and applications", IGI Global, 2009.
3. Ronan Schwarz, Phil Dutson, James Steele and Nelson To, "The Android Developer's Cookbook -Building Applications with the Android SDK", Addison Wesley, 2013.

18XTOB COMPUTATIONAL FOUNDATIONS FOR ROBOTICS

3 2 0 4

INTRODUCTION: Robots and their applications in industry, mobile and service applications, Configurations of industrial and mobile robots. Robot controllers, drives, actuators and sensors, Spatial descriptions and Transformations: Positions, orientations and frames, Mappings, translations, rotations and transformations, transformation arithmetic, Transform equations, representation of orientation, free vector transformation, Introduction to ROS. (12)

FORWARD AND INVERSE KINEMATICS: Link co-ordinates, D-H Representation, Arm equation -Two axis and three axis, robots, Inverse kinematics of two axis and three axis robots, Maneuverability – Workspace – Control. (15)

LOCALIZATION AND MAPPING: Challenges in mobile robots, Introduction - Bayes filter – Kalman Filter - Extended Kalman Filter - Information Filter - Histogram Filter - Particle Filter –Localization- Map Representation- Probabilistic Map based Localization-Monte carlo localization- Landmark based navigation-Globally unique localization- Positioning beacon systems- Route based localization – Mapping – Metrical maps - Grid maps - Sector maps – Hybrid Maps – SLAM (18)

DECISION MAKING: Discrete planning and dynamic programming principles, Configuration space abstraction, Sampling-based planners for mobile robots, Feedback-based planning for mobile robots- Feedback in discrete spaces, wave-front functions, Potential and navigation functions for mobile robots. (15)

PLANNING AND NAVIGATION: Overview of the three computational components and their interaction, sensing, planning, and control - Global path planning – A* Algorithm - local path planning - Road map path planning- Cell decomposition path planning- Potential field path planning-Obstacle avoidance – Path control. Markov Decision Process (MDP) in discrete spaces, optimal control and steering methods- Nonlinear optimization and gradient methods. (15)

TUTORIAL PRACTICE:
1. Robot Operation System (ROS) basics
2. Localization
3. Path planning and navigation
4. Multi-robot coordination

Total L:45 + T: 30 = 75

TEXT BOOKS:

1. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson Education Company, 2008
2. Steven M. LaValle, Planning Algorithms, Cambridge University Press, 2006
3. Howie Choset, Kevin M. Lynch, Seth Hutchinson, George A. Kantor, Wolfram Burgard, Lydia E. Kavraki, Sebastian Thrun, Principles of Robot Motion Theory, Algorithms, and Implementations (PRMTAI), MIT Press, 2005.

REFERENCES:

Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, “Robot Modeling and Control”, Wiley, 2006.
1. Kevin M. Lynch and Frank C. Park, “Modern Robotics: Mechanics, Planning, and Control”, Cambridge University Press, 2017.
2. Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, MIT Press, 2004.

18XTOC ENVIRONMENTAL SCIENCE AND GREEN COMPUTING

3 2 0 4

NATURAL RESOURCES, ECOSYSTEMS AND BIODIVERSITY: Environment, Definition, Scope and importance, Forest resources, Use and overexploitation, Water resources: Use and over utilization. Eco system ; Structure and functions of an eco system, energy flow in the eco system. Bio Diversity; values of biodiversity, biodiversity at global, national and local levels – threats to bio diversity. Conservation of bio diversity – In-situ & Ex-situ conservation. (9)

ENERGY SOURCES: Growing energy needs, Renewable and non renewable energy sources, Hydro power, Solar Power: Photovoltaic Energy – Motivation for going Solar – Solar Electricity – PV cells. Wind Power: – Using the Wind: Generating Power at Remote Sites,– Measuring the Wind – Estimating the output. Use of alternate energy sources. (9)

SOCIAL ISSUES AND THE ENVIRONMENT: From unsustainable to sustainable development, Urban problems related to energy, Water conservation, Rain water harvesting, Watershed management, Environment and human health, Role of information technology in environment and human health. Environment Protection Act: Air (Prevention and Control of Pollution) Act – Water Act, Forest Conservation Act, Wildlife Protection Act, Introduction to EIA and ISO 14000. (9)

ENVIRONMENTAL POLLUTION AND DISASTER MANAGEMENT: Definition – causes, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, thermal pollution and nuclear hazards. Disaster management - floods, earthquake, cyclone and landslides. Solid waste management - causes, effects and control measures of municipal solid wastes (Biomedical wastes, hazardous wastes). Role of an individual in prevention of pollution. (9)

GLOBAL ATMOSPHERIC CHANGE & GREEN FUNDAMENTALS: The Atmosphere of Earth – Global Temperature – Global Energy Balance, The Greenhouse Effect - Environmental Issues and Green Computing, Electronic waste management: Introduction;- Environment and society, producer responsibility legislation – the Waste Electrical and Electronic Equipment (WEEE) directive, Materials Composition of WEEE: Mobile Phones – Television – Washing Machines, - Current and new electronic waste recycling technology- Future perspectives of electronic scrap. (9)

TUTORIAL PRACTICE:
Case studies.

Total L:45+P:30=75

TEXT BOOKS:

1. Mackenzie L. Davis, and David A. Cornwell, “Introduction to Environmental Engineering”, Tata McGraw Hill, New Delhi, 2010
2. Chetan Singh Solanki, “Solar Photovoltaics”, PHI, 2011.
3. Siraj Ahmed, “Wind Energy : Theory and Practice”, PHI, 2011.
4. Mahajan S. P. Pollution Control in Process Industries, Tata McGraw Hill, 1985.
5. R. E. Hester and R. M. Harrison, “Electronic Waste Management”, Royal Society of Chemistry, 2009.

REFERENCES

1. William W. Nazarodd and Lisa Alvarez-Cohen, “Environmental Engineering Science”, Wiley-India, 2010
2. Anubha Kaushik and Kaushik C P, “Environmental Science and Engineering”, New Age International, 2005.

3. Martha Maeda, “How to Solar Power your Home”, Atlantic Publishing Group, 2011.
4. Paul Gipe, “Wind Power – Renewable Energy for Home, Farm and Business”, Sterling Hill Publications, 2008.
5. Klaus Hieronymi, Ramzy Kahhat, Eric Williams, “E-Waste Management : From Waste to resource”, Routledge – Taylor and Fransis, 2012.
6. Diane Gow Mcdilda, “The Everything Green Living Book”, Adams Media, 2007.