# SEMESTER I

## 18ZC01 APPLIED MATHEMATICS FOR COMPUTER SCIENCE ENGINEERING

**2 2 0 3**

**NUMBER THEORY**: Divisibility: properties of divisibility, fundamental theorem of arithmetic, division algorithm, Euclidean algorithm,
extended Euclidean algorithm. Arithmetical functions - Möbius function, Euler totient function. Congruence - basic properties of congruence, residue classes and complete residue system, linear congruences, Euler-Fermat theorem, simultaneous linear congruences, Chinese remainder theorem. (8+7)
**APPLICATIONS OF NUMBER THEORY:** Pseudo random bit generators: linear congruential generator, Blum Blum-Shub generator.
Primality testing-Legendre and Jacobi symbols, the solovay -strassen algorithm, the Miller- Rabin algorithm. Classical cryptography
– the shift cipher, the substitution cipher, the affine cipher.Public key cryptography - RSA cryptosystem. (8+7)
**GRAPH THEORY:** Graphs - directed and undirected, subgraphs, graph models, degree of a vertex, degree sequence, hand-shaking lemma, walk, trail, path, connectedness, distance and diameter. Common classes of graphs – regular, complete Petersen,
cycle, path, tree, bipartite, hypercube, mesh - Isomorphic graphs. Representations of graphs – adjacency list, incidence list, adjacency matrix, incidence matrix, Eulerian graphs – Chinese postman problem and its solution – Hamiltonian graphs – travelling salesman problem – nearest neighbour algorithm. (8+7)
**STOCHASTIC PROCESSES:** Classification, Markov chain: transition probability matrices – Chapman Kolmogorov equations - classification of states, limiting probabilities, Poisson process - continuous time Markov chains: Kolmogorov equations, limiting probabilities, birth-death processes.

**Total L:32 +T: 28 = 60**

**REFERENCES:**

1. Douglas R Stinson, “Cryptography: Theory and Practice”, Chapman Hall”, New York, 2017.
2. Saeed Ghahramani, “Fundamentals of Probability with Stochastic Processes”, Pearson, New Delhi, 2016.
3. Trivedi K S, “Probability and Statistics with Reliability, Queueing and Computer Science Applications”, John Wiley & Sons, New Delhi, 2016.
4. Yellen J and Gross J, “Graph Theory and its Applications”, Chapman & Hall, New York, 2006.
5. Tom M Apostol, “Introduction to Analytic Number Theory”, Narosa Publishing House, New Delhi, 1998.


## 18ZC02/18ZS02 ADVANCED DATA STRUCTURES AND ALGORITHMS

**3 0 0 3**

**ALGORITHM ANALYSIS:** Analysis of iterative and recursive Algorithms – Asymptotic notations – Parallel Algorithms:Introduction-Scalar Product of two vectors- Matrix multiplication.
(10)

**TREES:** Search Trees – Balanced Search Trees: AVL, RBT, Splay-Heaps: Binary heap, leftist heap, binomial heap, Fibonacci heap, Multi-dimensional data structure: kd tree
(15)

**GRAPHS:** Representation – Shortest path algorithms: Unweighted shortest path, Dijkstra's algorithm, Graphs with negative edge costs, Acyclic graphs, All pairs shortest path – Network Flow problems – Activity Networks – DFS applications: Biconnectivity, Euler Circuits
(10)

**DISJOINT SETS AND HASHING:** Disjoint Sets: Representation – Union and find operations - Hashing: Static hashing – Dynamic hashing - Overflow handling - Bloom filters - Locality sensitive hashing
(10)

**Total L: 45**

**REFERENCES:**

1. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein, “Introduction to Algorithms”, PHI learning Pvt. Ltd., New Delhi, 2010
2. Venkatesan R and Lovelyn Rose S, “Data Structures”, Wiley India Pvt. Ltd., New Delhi, 2015.
3. Mark Allen Weiss, “Data structures and Algorithm Analysis in C++”, Pearson Education, New Delhi, 2013.
4. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, “Fundamentals of Data Structures in C”, Universities Press, Hyderabad, 2012.
5. Peter Brass, “Advanced Data Structures”, Cambridge University Press, New York, 2008.


## 18ZC03/18ZS03 DATABASE MANAGEMENT SYSTEMS

**3 2 0 4**

**RELATIONAL DATABASE:** Relational database Design – ER Diagram, Extended ER Diagram, Reduction to relational schemas, Normalization- Functional Dependencies, Normal Forms,SQL
(11+8)

**QUERY OPTIMIZATION**: Algorithms for Query Processing – external sorting, SELECT and JOIN operation, PROJECT and set operation, aggregate operation and OUTER JOINs, Heuristics of Query Optimization, Cost Based Query Optimization.
(11+7)

**TRANSACTION AND SECURITY:** Properties of Transaction, Serializability, Concurrency Control – locking, timestamp, validation based protocols, Deadlock – prevention, detection, recovery, Database security – issues, access control.
(12+7)

**TRENDS IN DATABASE:** Introduction to NoSQL databases - Key-Value Stores – Columnar Stores – Document Stores, Graph database - The Power of Graph Databases - Options for Storing Connected Data -Data Modeling with Graphs-Building a Graph Database Application - Case Study - Neo4J.
(11+8)

**Total L: 45 +T: 30=75**

**REFERENCES:**


1. Thomas Connolly and Carlolyn Begg, "Database Systems, A Practical Approach toDesign, Implementation and Management", Pearson Education,Harlow,2015.
2. Sadalage, P. & Fowler,"NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Pearson Education,USA,2013
3. R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", Pearson Education,USA,2016.
4. Redmond, E. &Wilson, "Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement",Pragmatic Programmers, LLC,USA,2012.
5. Ian Robinson, Jim Webber, Emil Eifrem, Graph Databases, , New Opportunities for Connected Data, O'Reilly Media,USA, 2015


## 18ZC04 ADVANCED COMPUTER ARCHITECTURE

**3 0 0 3**

**DESIGN AND ANALYSIS OF PROCESSOR AND MEMORY:** Instruction Set Principles - Review of Memory Hierarchy - Pipelining – Quantitative design and analysis of Processor - Memory Hierarchy Design
(12)

**INSTRUCTION LEVEL PARALLELISM:** Pipelining and Handling Hazards - Instruction Scheduling - Static and Dynamic Branch Prediction - Hardware Based Speculation - Limitations of ILP.
(11)

**DATA LEVEL PARALLELISM:** Vector Architecture - SIMD Instruction Set - GPU Architecture - Detecting and Enhancing Loop Level Parallelism.
(11)

**THREAD LEVEL PARALLELISM:** Symmetric and Distributed Shared Memory Architectures - Performance Issues - Synchronization - Models of Memory Consistency case studies of multi-core - Introduction to Domain Specific Architecture.
(11)

**Total L: 45**

**REFERENCES:**


1. John L Hennessy, John M Doe and David A Patterson, "Computer Architecture A Quantitative Approach", Morgan Kaufmann, USA, 2017.
2. Randal E. Bryant, Davie Richard O'Hallaron, "Computer Systems: A Programmer's Perspective" , Pearson, 2016.
3. David A. Patterson, John L. Hennessy, "Computer Organization and Design MIPS Edition: The Hardware/Software Interface", Morgan Kaufmann,2014.
4. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, "Operating System Concepts", Wiley Global Education, 2012.


## 18ZC05/18ZS05 ANALYSIS AND DESIGN OF SOFTWARE SYSTEMS

**3 0 0 3**

**SOFTWARE ENGINEERING CONCEPTS:** Software Characteristics –Software Myths – Software life cycle models – The Linear Sequential Model - The Incremental Model - The RAD Model - Evolutionary Software Process Models - The Prototyping Model - Spiral Model –Agile Methods- Requirement Engineering - Requirement Engineering Tasks.
(12)

**SYSTEM ANALYSIS:** Requirement Analysis – Analysis Modelling Approaches – Data Flow Oriented Modelling – Context diagram, Data flow diagrams – Elements of Analysis Model - Data Modeling – Objects and Classes – Object Identification – Relationship among objects – classification .
(11)

**UML MODELING:** Unified Software Development Process – Scenario Based Modeling – Class Based Modeling – Behavioral Model – CASE tools.
(11)

**SYSTEM DESIGN:** Design Process – Design Concepts – Modularity – Functional Independence - Modular Design – Coupling – Cohesion – Refactoring – Design Model – Architectural Design - Component Level Design Element – Deployment Level Design – Architectural Styles and Patterns – IEEE Standard for Software Design Descriptions.
(11)

**Total L: 45**

**REFERENCES:**

1. Roger Pressman S, "Software Engineering: A Practitioners", Tata McGraw Hill, New Delhi, 2014
2. Booch G, Maksimchuk R A, Engel M W, Young B J, Conallen J, Houston K A, "Object Oriented Analysis and Design with Applications", Addison-Wesley, USA, 2007.
3. Booch G, Rumbaugh J and Jacobson I, "The Unified Modeling Language User Guide", Addison Wesley Professional,USA, 2005.
4. Ian Sommerville, "Software Engineering", Pearson Education, New Delhi, 2011.


## 18ZC51/18ZS51 ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY

**0 0 4 2**

The students will design, analyse and implement suitable data structures like Arrays, linked lists, stacks, queues,Search Trees,Heaps,kd Tree, Graph Algorithms, Sets,Hashing for real world problems.

**Total P: 60**

## 18ZC81 ENGLISH FOR RESEARCH PAPER WRITING

**0 0 4 0**

Planning and preparation, word order, breaking up of long sentences, structuring paragraphs and sentences, being concise and removing redundancy, avoiding ambiguity and vagueness, clarifying who did what, highlighting the findings, hedging and criticising, paraphrasing and plagiarism. (15)

Sections of a paper - Abstract, introduction, review of the literature, methods, results and discussions, conclusions, acknowledgements, references and the final check. (10)
Key skills needed to write title, abstract, introduction, review of the literature, methods, results and discussions, and conclusions of a research paper. (20)

Use of appropriate phrases to ensure the research paper is as good as it could possibly be the first- time submission. (15)

**Total P: 60**

**REFERENCES:**

1. Adrian Wallwork, "English for Writing Research Papers", Springer New York Dordrecht Heidelberg London, 2011.
2. Goldbort R., "Writing for Science", Yale University Press, 2006.
3. Day R., "How to Write and Publish a Scientific Paper", Cambridge University Press, 2006
4. Highman N., "Handbook of Writing for the Mathematical Sciences", SIAM, Highman's Book, 1998.


# SEMESTER II

## 18ZC06/18ZS06 DATA INTENSIVE COMPUTING SYSTEMS

**3 0 0 3**

**INFRASTRUCTURE:** Cloud, Data intensive systems and Industry 4.0 – Cloud Architecture – Virtualization – Data Virtualization – Storage Virtualization – Network Virtualization: SAS,SAN – File Systems – Big Data Characteristics – Use cases – Data Analytics Life cycle – Case study.
(12)

**STORAGE PLATFORMS:** NoSQL – Key-value store - Hadoop Architecture – Map Reduce programming – Examples - Spark; Column-oriented stores – HBase architecture, Hive; Document stores – MongoDB architecture – examples ; Graph stores – Neo4j architecture – examples; Realtime Processing – Storm
(11)

**THEORY AND METHODS-I:** Preprocessing – Statistical measures – Hypothesis testing – ANOVA - feature selection – PCA Regression – linear, logistic – LDA – Association Rule Mining – Text Analysis
(11)

**THEORY AND METHODS-II:** Clustering – partitioning and hierarchical approaches – Classification – KNN, Decision trees, Naive Bayes, SVM– Time Series Analysis – ACF, AR, MA, ARMA, ARIMA – Stream Analysis
(11)

**Total L: 45**

**REFERENCES:**

1. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data Big data science & analytics : a hands-on approach”, Wiley, 2015.
2. Jared Dean, “Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners”, Wiley, USA, 2014.
3. Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, “An Introduction to Statistical Learning with Applications in R”, Springer, USA, 2013.
4. Nathan Marz and James Warren, “Big Data - Principles and Best Practices of Scalable Realtime Data Systems”, MEAP Began, USA, 2012.
5. Venkata Josyula, Malcolm Orr & Greg Page, “Cloud Computing: Automating the Virtualized Data Center”, CISCO Press, USA, 2011.

## 18ZC07/18ZS24 ADVANCED OPERATING SYSTEMS 2 2 0 3

**PROCESS SCHEDULING & PROCESS SYNCHRONIZATION:** Overview, Process scheduling, Operations on process, Inter process communication, Process scheduling criteria, process scheduling algorithms. Process Synchronization: Background, Hardware Support to Process Synchronization, Semaphores, Monitors - Memory Management Techniques. Case study: process scheduling in Linux.
(8+7)

**DISTRIBUTED OPERATING SYSTEMS:** Issues in Distributed Operating System – Architecture – Communication Primitives – Lamport’s Logical clocks – Causal Ordering of Messages – Distributed Mutual Exclusion Algorithms – Centralized and Distributed Deadlock Detection Algorithms – Agreement Protocols - Case Study: Remote Procedure call in Distributed Computing Environment.
(7+7)

**DISTRIBUTED RESOURCE MANAGEMENT:** Distributed File Systems – Design Issues - Distributed Shared Memory – Algorithms for Implementing Distributed Shared memory–Issues in Load Distributing – Scheduling Algorithms – Synchronous and Asynchronous Checkpointing and Recovery – Fault Tolerance – Two-Phase Commit Protocol – Non blocking Commit Protocol – Security and Protection.
(7+8)

**REAL TIME AND MOBILE OPERATING SYSTEMS:** Basic Model of Real Time Systems – Characteristics - Applications of Real Time Systems – Real Time Task Scheduling - Handling Resource Sharing - Mobile Operating Systems –Microkernel Design - Client Server Resource Access – Processes and Threads - Memory Management - File system – case study - iOS and Android: Architecture and SDK Framework - Media Layer - Services Layer - Core OS Layer - File System.
(8+8)

**Total L:30 + T:30 = 60**

**REFERENCES:**

1. Mukesh Singhal, Niranjan Shivaratri, “Advanced Concepts in Operating Systems”, McGraw Hill,2011
2. William Stallings, “Operating Systems – Operating System: Internals and Design Principles”, Prentice Hall, 2014.
3. Nancy A Lynch, “Distributed Algorithms”, Morgan Kaufmann Series, Elsevier, 1996.
4. Hagit Attiya, Jennifer Welch, “Distributed Computing: Fundamentals, Simulations and Advanced Topics”, McGraw-Hill, 2004.

Rajib Mall, “Real-Time Systems: Theory and Practice”, Pearson, 2006.

## 18ZC08/18ZS35 ADVANCED COMPUTER NETWORKS 3 0 0 3

**INTERNET ROUTING, QOS ANALYSIS AND MULTICASTING:** Internet Architecture - IP service Model – Routing Domains and Autonomous Systems – Intra Domain Routing Algorithms - Inter Domain-Routing: BGP - BGP Traffic Engineering. Routing Convergence.Need for QoS - End to End QoS - QoS Levels - Performance Measures: Bandwidth - Delay and Jitter - Packet Loss - Throughput. Routing Overheads .Multicast: Address Assignments - Multicast Routing – DVMRP- Protocol Independent Multicasting.
(12)

**TCP PERFORMANCE MODELING:** TCP Segment format - TCP Sliding Windows - Congestion Control and Queuing - TCP Congestion Control - Analysis of TCP: Buffer Sizing - Throughput - Fairness - Random Early Detection Gateways for Congestion Avoidance. - Congestion Control for High Bandwidth - Delay Product Networks - Variations of TCP.
(11)

**HIGH SPEED NETWORKS:** Packet Switching Vs Cell Switching - ATM Networks: ATM Protocol Architecture - Logical Connections - ATM Cells - Service Categories - ATM Adaptation Layer - Traffic and Congestion Control In Frame Relay and ATM Networks. High-Speed LANS - Fast Ethernet - Gigabit Ethernet.
(11)

**WIRELESS NETWORKS:** Wireless Networks: Cellular Networks: GSM - UMTS - 3G and 4G Networks – IEEE E 802.11 - Bluetooth - WIMAX -.. WSN- Characteristics - Architecture – Applications- Network Virtualization and Software Defined Networking (11)

**Total L: 45**

**REFERENCES:**

1. James F Kurose, Keith W Ross, “Computer Networking - A Top-Down Approach Featuring the Internet”, Pearson Education, India, 2012.
2. Larry L Peterson and Bruce S Davie, “Computer Networks: A systems approach”, Morgan Kaufmann Publishers Burlington, USA, 2011.
3. Andrew S Tanenbaum, “Computer Networks”, Prentice Hall, USA, 2010.
4. William Stallings, “High-Speed Networks and Internets: Performance and Quality of Service”, Pearson Education, India, 2002.
5. Holger Karl , Andreas Willig, “Protocol and Architecture for Wireless Sensor Networks”, John Wiley Publication, 2002.

## 18ZC09 EMBEDDED SYSTEMS

**3 2 0 4**

**BASICS OF EMBEDDED SYSTEMS:** Introduction - Fundamental Components of Embedded Systems - Challenges for Embedded Systems - Architecture of Embedded Systems - Embedded Design Life Cycle - Selection Process - Hardware Software Partitioning decision - Programming Embedded Systems. Memory Management: Memory Access Procedure - Memory Interfacing -- Memory Management Methods - Interrupts - Interrupt Latency – Re-entrancy - Interrupt Priority - Programmable Interrupt Controllers - Interrupt Service Routines
(13+8)

**COMMUNICATION INTERFACES:** General Purpose Input Output(GPIO) interface - A/D and D/A converters - Serial Communication Interfaces - RS232/UART - RS422/RS485 – Modbus - CAN bus - Inter-Integrated Circuit (I2C) Interface - SPI Interface - USB - IrDA - Ethernet Interface – Wireless Communication - IEEE 802.11 – Bluetooth.
(11+7)

**REAL TIME OPERATING SYSTEMS:** Real-Time Concepts – Real-time Task Management – Real-time Task Scheduling - Clock Driven Scheduling - Event Driven Scheduling - Resource Sharing and dependencies – Priority Inversion - Priority Inheritance Protocol - Priority Ceiling Protocol – Task synchronization - Mutex - Semaphores - Inter Task Communication - Message Queues – Signals - Timers - Commercial RTOS
(11+7)

**VALIDATION AND DEBUGGING:** Host and Target Machines - Validation Types and Methods - Host Testing - Host-Based Testing Setup – Toolchain - Cross-compilers -Target Testing - Remote Debuggers and Debug Kernels - ROM Emulator - Logical Analyzer - Background Debug Mode – JTAG - In-Circuit Emulator

**CASE STUDY:** RFID Card Verification System - GPS Navigation System - Development of Protocol Converter
(10+8)

**Total L: 45 +T: 30 = 75**

**REFERENCES:**

1. Rajib Mall, ”Real-time systems: Theory and Practice”, Pearson Education India, 2009
2. Sriram V Iyer and Pankaj Gupta, “Embedded Real-time Systems Programming”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2006
3. Arnold S Berger, “Embedded Systems Design - An Introduction to Processes, Tools and Techniques”, CMP Books, USA, 2002.
4. Prasad K V K K, “Embedded/Real-Time Systems: Concepts, Design and Programming - The Ultimate Reference”, Himal Impressions, New Delhi, 2003.
5. Michael Barr, “Programming Embedded Systems in C and C++”, O'Reilly, 1999.

## 18ZC52/18ZS52 DATA INTENSIVE COMPUTING SYSTEMS LABORATORY

**0 0 4 2**

The students will learn to use data intensive computing platforms like Hadoop, Spark, Hbase, MongoDB, Neo4j and R for techniques like MapReduce, Machine Learning, Data Visualization, Regression, Clustering, Association Rule Mining, Classification, Time Series Analysis etc and are then applied to solve a data intensive problem.

**Total P: 60**

## 18ZC61/18ZS61 INDUSTRY VISIT & TECHNICAL SEMINAR

**0 0 4 2**

The student will make at least two technical presentations on current topics related to the programme. The same will be assessed by a committee appointed by the department. The students are expected to submit a report at the end of the semester covering the various aspects of his/her presentation together with the observation in industry visits.

**Total P: 60**

## 18AE82 RESEARCH METHODOLOGY AND IPR 0 0 6 0

Meaning of research problem, sources of research problem, criteria and characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem, approaches of investigation of solutions for research problem, data collection, analysis and interpretation.

(25)

Effective literature studies approaches, analysis of plagiarism, research ethics, effective technical writing, how to write report, developing a research proposal, format of research proposal, presentation of research proposal for assessment by a review committee.

(20)

Nature of intellectual property: Patents, designs, trade and copyright. Process of patenting and development: Technological research, innovation, patenting, development, international cooperation on intellectual property, procedure for grants of patents, patenting under PCT.

(20)

Patent rights: scope of patent rights, licensing and transfer of technology, patent information and databases, geographical indications. New developments in IPR: Administration of patent system, IPR of biological systems and computer software, traditional knowledge case studies on IPR.

(25)

**Total P: 90**

**REFERENCES:**


1. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
2. Ranjit Kumar, “Research Methodology: A Step by Step Guide for Beginners”, Sage Publication, 2nd Edition, 2010.
3. Ramappa T., “Intellectual Property Rights Under WTO”, S Chand Publication, 2008.
4. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.
5. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”, 2001.
6. Stuart Melville and Wayne Goddard, “Research Methodology: An Introduction for Science & Engineering Students”, 1996.
7. Mayall, “Industrial Design”, McGraw Hill, 1992.
8. Niebel, “Product Design”, McGraw Hill, 1974.


# SEMESTER III

## 18ZC53/18ZS53 SOFTWARE DEVELOPMENT LABORATORY

The student will demonstrate the ability to design research methodology that adequately addresses the following:

- Idea generation and Concept Selection
  - Identification of real time problem in the field of computers.
  - Comparing and contrasting different types of research methods.
  - Patent search for foolproof concept selection
  - Time line of activities
- Design
  - Conceptualizing a research design and propose an innovative solution for the problem identified.
- Development and Testing
  - Model/prototype development
  - Validation and testing

Report submission and presentation

**Total P: 60**

## 18ZC71/18ZS71 PROJECT WORK I

**0 0 6 3**

- Identification of a real world problem.
- Conduct literature survey
- Formulate a solution for the problem based on literature survey.
- Implementation of the modules

- Compare the results with existing solutions
- Write a technical report on the work done
- Publish the work in reputed national / international conferences

**Total P: 90**

## SEMESTER IV

### 18ZC72/18ZS72 PROJECT WORK II

**0 0 28 14**

- Problem Identification.
- Define the scope and objectives of the problem
- Develop a mathematical model with realistic assumptions.
- Propose a novel and original solution for the identified problem
- Implementation of the modules
- Interpretation and validation of results using formal research methods
- Comparison with existing solutions
- Publish the work in refereed national / international journals

**Total P: 420**

## ELECTIVE THEORY COURSES

### 18ZC21 CLOUD COMPUTING

**2 2 0 3**

**VIRTUALIZATION:** Introduction - Hypervisors – Challenges of X86 Architecture-Main Categories of Virtualization: Full, Para - Levels of virtualization: Hardware, Programming language, Application, Operating system, Storage, network, desktop, Application Server - Benefits of Virtualization - Cost of Virtualization - Virtualization Drawbacks – Xen-KVM.
(7+8)

**CLOUD TECHNOLOGIES :** infrastructure as a service: Amazon EC2 - Platform as Service: Google App Engine, Microsoft Azure Amazon AWS , Aneka – Software as a service : RESTFul Web Services – SLA- Cloud Storage: MapReduce, GFS, HDFS, Hadoop Framework-Cloud container: Docker.
(7+8)

**CLOUD SECURITY** Infrastructure Security: Network level, Host level and Application level –Data Security- Identity and access Management: Architecture and Practices - Security Management in the Cloud – Availability management- access Control

(8+7)

**Total L: 30 + T: 30=60**

**REFERENCES:**


1. Rajkumar Buyya, Christian Vecchiola and Thamarai SelviS, “Mastering Cloud Computing”, Tata McGraw Hill Education Private Limited,New Delhi,2013.
2. Diane Barrett and Gregory Kipper, “Virtualization and Forensics: A Digital Forensic Investigators Guide to Virtual Environment”, Elsevier, USA,2010.
3. David S Linthicium, “Cloud computing and SOA convergence in your enterprise”, Pearson, USA,2010.
4. Tim Mather, Subra Kumaraswamy and Shahed Latif,“Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance”,O'Reilly, USA,2011.
5. Dimitris N. Chorafas, “Cloud Computing Strategies”, CRC Press,2010
6. Sébastien Goasguen , “Docker in the Cloud -Recipes for AWS, Azure, Google, and More”, O’Reilly Media ,2016.


### 18ZC22 XML AND WEB SERVICES

**2 2 0 3**

**XML TECHNOLOGY:** Benefits – XML Documents - Well-Formed XML – Validation - DTD – XML Schemas - Relax NG – Schematron
(8+8)

**XMLPROCESSING:** Parsing XML – Updating XML – Extracting Data from XML – XPATH – Xquery – XSLT.
(7+7)

**WEB SERVICES AND IMPLEMENTATION:** Architecture – Messaging – Service Description – Service Discovery – Service Transport Security – SOAP Protocol – WSDL – UDDI – Web Service Clients and Service Invocation – WS -* Standards.
(8+8)

**REST BASED WEB SERVICES:** Principles - Comparison with SOAP-XML Based Web Services – Design and Implementation of REST Services – Resource Oriented Architecture – best practices.
(7+7)

**Total L: 30 + T: 30 = 60**

**REFERENCES:**

1. Kalin M, "Java Web Services: Up and Running", O'Reilly Media, USA, 2013.
2. Fawcett J, Ayers D, Liam and REQ, "Beginning XML", Wrox, 2012.
3. Richardson L and Ruby S, "Restful Web Services", O'Reilly, USA, 2008.
4. Hansen MD, "SOA Using Java Web Services", Prentice Hall, USA, 2007


## 18ZC23 SEMANTIC WEB TECHNOLOGY

**2 2 0 3**

.
**SEMANTIC WEB VISION:** Introduction to syntactic web and semantic web-Evolution of web - Semantic Web Technologies - Recommended Layered Architectures. Structured web documents - The XML Language: Structuring - Namespaces - Addressing and Querying XML Documents - Processing.
(8+8)

**RESOURCE DESCRIPTION:** RDF- RDF Schema: Axiomatic Semantics for RDF and RDF Schema - Direct Inference System for RDF and RDFS, Querying in SPARQL.
(7+7)

**ONTOLOGY ENGINEERING AND WEB ONTOLOGY LANGUAGE:** OWL Language - Ontology Examples - OWL in OWL - Future Extensions to OWL - Ontology engineering: Constructing Ontologies Manually - Reusing Existing Ontologies - Using Semiautomatic Methods - On-To-Knowledge Semantic Web Architecture.
(8+8)

**INFERENCE RULES, TOOLS AND APPLICATIONS:** Rules - Monotonic Rules: Syntax - Semantics - Representing Family Relationships. Non monotonic Rules: Syntax - Brokered Trade as an Example - Monotonic and Non monotonic Rule Markup. Development tools for semantic web - Jena Framework - Semantic Wikis-Semantic web service, Horizontal Information Products at Elsevier - Data Integration at Audi - Skill Finding at Swiss Life.
(7+7)

**Total L: 30 + T: 30 = 60**

**REFERENCES:**

1. Ducharme B, "Learning SPARQL", O'Reilly Media, USA, 2018.
2. John Hebeler, Matthew Fisher, Ryan Blace and Andrew Perez-Lopez "Semantic web programming", Wiley, 2009.
3. Antoniou Gand Van Harmelen F, "Semantic Web Primer", MIT press, USA, 2008.
4. Davies J, Studer R and Warren P, "Semantic Web Technologies: Trends and Research in Ontology-based Systems", Wiley, USA, 2006.
5. Daconta, MC, J Obrst L and Smit KT,"The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management", Wiley, USA, 2003.


## 18ZC24/18ZS22 AGILE SOFTWARE DEVELOPMENT

**2 2 0 3**

**AGILE PRINCIPLES AND MODELING:** Introduction - Traditional, IID and Agile Methodologies – Comparison - Need - Manifesto – Values and Practices – Agile Modeling Values, principles and practices – Agile modeling with RUP
(8+8)

**EXTREME PROGRAMMING:** Life Cycle – User Stories – Architecture – Planning – Iteration – Testing – Release – XP Values – XP Practices – Planning – Coding – Pair Programming Model – Refactoring – Agile Modeling and XP – case study
(7+7)

**SCRUM:** Introduction – Practices - Applying Scrum – Need – Scrum Values - Practices- Tools in Agile Software Development – Case Study – Applying Scrum for IoT projects, Applying Scrum for Big Data Projects
(7+7)

**OTHER AGILE DEVELOPMENT METHODOLOGIES:** FDD – DSDM - Lean and Kanban Software development – Comparison of agile approaches - Case Studies - Defining Data Warehousing Projects for Iterative Development – User stories – agile estimation - Adapting Iterative Development for Data warehousing Projects**.**
(8+8)

**Total L: 30 + T: 30 = 60**

**REFERENCES:**


1. Robert Martin, “Agile Software Development: Principles, Patterns, and Practices”, Pearson Education Ltd., 2014.
2. Jim Highsmith, “Agile Data Warehousing Project Management”, Morgan Kaufmann, 2012.
3. Alistair Cockburn, “Agile Software Development: The Cooperative Game”, Pearson Education, USA, 2006.
4. Scott Ambler, “Agile Modeling: Effective Practices for eXtreme Programming and the Unified Process”, Wiley Computer Publishing, 2002.
5. Ken Schwaber and Mike Beedle, “Agile Software Development with Scrum”, Prentice Hall, USA, 2001.


## 18ZC25/18ZS23 INTERNET OF THINGS

**2 2 0 3**

**IOT ARCHITECTURE:** Introduction o IoT - M2M Architecture - Design Principles for Connected Devices - Definitions and Functional Requirements – Sensors and Actuators IOT Architecture - IETF Architecture for IoT - OGC Architecture - Communication Model
(8+6)

**COMMUNICATION PROTOCOLS:** Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNET Protocol – MODBUS – Zigbee Architecture – 6LOWPAN – LoRA-COAP - MQTT
(8+6)

**ELECTRONIC PROTOTYPING:** Prototypes and Production - Open Source versus Closed Source - Prototyping Embedded Devices - Prototyping IoT Projects with Arduino - Prototyping IOT Projects with Raspberry PI
(7+9)

**CASE STUDIES AND IOT DATA ANALYTICS:** Real world design constraints - Applications - Asset management, Industry 4.0, Smart grid, Commercial building automation, Smart cities Data Analytics for IoT – Edge analytics - sensor data fusion techniques - Cloud Storage Models & Communication APIs - Cloud for IoT - Predictive analytics
(7+9)

**Total L: 30 + T: 30 = 60**

**REFERENCES:**


1. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley & Sons Ltd., UK, 2014.
2. Dieter Uckelmann, Mark Harrison and Florian Michahelles, “Architecting the Internet of Things”, Springer, 2011.
3. Olivier Hersent, David Boswarthick and Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, Wiley & Sons Ltd., UK, 2012.
4. David Boswarthick, Omar Elloumi and OlivierHersent, “M2M Communications: A Systems Approach”, John Sons Ltd, UK, 2012.


## 18ZC26 COMPILER DESIGN

**2 2 0 3**

**LEXICALANALYSIS:** Introduction to Compilers - Analysis of the Source Program, The Phases of a Compiler, The Grouping of Phases, Compiler Construction Tools, a Simple One-Pass Compiler, Language Design. The Role of the Lexical Analyzer - Input Buffering, Specification of Tokens, Recognition of Tokens, Regular Expressions - Finite Automata- Deterministic Finite Automata - Converting RE to Non Deterministic Finite Automata - Converting NFA to DFA. LEX Specification – Design of Lexical Analyzer for a Sample language.
(7+7)

**SYNTAX ANALYSIS:** The Role of the Parser - Context Free Grammars - Top Down Parsing - Bottom Up Parsing - Recursive Descent Parser - Predictive Parser - Shift Reduce Parser - SLR Parser - LR Parser - LALR Parser - Error Handling and Recovery in Syntax Analyzer - YACC Specification – Design of a Syntax Analyzer for a Sample Language.
(8+8)

**SYNTAX DIRECTED DEFINITIONS AND INTERMEDIATE CODE GENERATION:** Syntax Directed Definitions: Inherited and Synthesized Attributes - Construction of Syntax Trees - Bottom-Up Evaluation of S-Attributed and L-Attributed Definitions - INTERMEDIATE CODE GENERATION: Intermediate Languages- Declarations, Assignment Statements, Boolean Expressions, Case Statements, Back Patching. Storage Management - Runtime Storage Management, Activation Record, Symbol Table - Organization.
(8+8)

**CODE OPTIMIZATION AND CODE GENERATION:** Principal Sources of Optimization - Basic Blocks and Flow Graphs - DAG Representation - Optimization of Basic Blocks - Introduction to Global Data Flow Analysis - Peephole Optimization - Issues in the Design of Code Generator - A Simple Code Generator.
(7+7)

**Total L: 30 + T: 30 = 60**

**REFERENCES:**

1. Alfred V Aho, Monica S Lam, Ravi Sethi and Jeffrey D Ullman, “Compilers - Principles, Techniques and Tools”, Pearson Education, New Delhi, 2008.
2. Sudha Sadasivam G, “Compiler Design”, Scitech Publications, Chennai, 2008.
3. Dhamdhere D M, “Compiler Construction Principles & Practice”, Macmillan India Ltd., New Delhi, 2001.
4. Jean Paul Tremblay and Paul G Sorenson, “The Theory & Practice of Compiler Writing”, McGraw Hill, New Delhi, 2001
5. Dick Grone, Henri E Bal, Ceriel J H Jacobs and Koen G Langendoen, “Modern Compiler Design” , John Wiley & Sons, New Delhi, 2000.

## 18ZC27/18ZS33 EVOLUTIONARY COMPUTING TECHNIQUES

**3 0 0 3**

**HEURISTIC AND METAHEURISTIC APPROACHES:** Challenges in Solving Complex Problems - Evolutionary algorithms: Principles, Historical development, Features, Classification and Components, Advantages, Applications. Heuristic Search: Problem representation as search - Generate and Test - Breadth First Search - Depth First Search - Hill Climbing: Principles, Local and Global maxima, Ridges, Plateau - Steepest Ascent - Simulated annealing: Annealing schedule, Parameter Selection (12)

**GENETIC ALGORITHM:** Biological Background - Simple Genetic Algorithm (SGA) - Representation types - Recombination Types - Mutation types - GA Algorithm - Schema Theorem - Variations of GA: Adaptive GA, Real Coded GA - Differential Evolution: Principles, Mutation, Crossover, Selection (11)

**SWARM INTELLIGENCE:** Particle Swarm Optimization: Swarms, Operating principles, PSO Algorithm, Neighborhood Topologies - Variations of PSO: Binary, weighted - Ant Colony Optimization: Ant foraging behavior, Theoretical Considerations, ACO Algorithm, Variations of ACO: Elitist Ant System (EAS), MinMax Ant System (MMAS) and Rank Based Ant Colony System (RANKAS). (11)

**MULTI-OBJECTIVE OPTIMIZATION: Principles** - Classical Methods - Challenges - Evolutionary algorithms for multi-objective optimization - Multimodal function optimization - Non-Dominated Sorting Genetic Algorithm (NSGA): Non-elitist, elitist - Controlled elitism in NSGA
(11)

**Total L: 45**

**REFERENCES:**

1. Eiben AE and Smith JE, “Introduction to Evolutionary Computing”, Springer, Heidelberg, 2015.
2. Rich E and Knight K, “Artificial Intelligence”, Tata McGraw Hill Education Private Limited, India, 2011.
3. Deb K, “Multi-Objective Optimization Using Evolutionary Algorithms”, Wiley-Blackwell, USA, 2008.
4. Dorigo M and Stutzle T, “Ant Colony optimization”, Prentice Hall of India, New Delhi, 2005.
5. Kennedy J and Eberhart RC, “Swarm Intelligence”, Morgan Kaufmann Publishers, USA, 2001.

## 18ZC28 INFORMATION RETRIEVAL

**3 0 0 3**

**INTRODUCTION:** The notion of Relevance, The IR problems, Conceptual Models of IR systems, Characteristics of text collections, Term and Language properties for IR collections, Data and File Structures for Information Retrieval, Boolean Retrieval, Evaluation in information retrieval (12)

**INDEXING:** Automatic Indexing, Indexing goals, Lexical Analysis, Stemming algorithms, Part-of-speech tagging and Parsing, Phrase recognition, Thesaurus Construction, Indexing and storage issues, Dictionaries and Tolerant Retrieval, Index Compression (11)

**RETRIEVAL MODELS AND SCORING:** Vector Space Model: Term frequency and weighting, Probabilistic information retrieval: The Binary Independence Model, Language models for information retrieval, Computing Scores: Efficient scoring and ranking, Search Relevance and Query Understanding
(11)

**TEXT CLASSIFICATION and WEB SEARCH:** Issues in the classification of text documents, Naive Bayes, Support vector machines, Web Search: Web characteristics, Advertising as the economic model, Web crawling and indexes, Link analysis, Personalization.
(11)

**Total L: 45**

**REFERENCES:**

1. David A. Grossman and Ophir Frieder,” Information Retrieval: Algorithms and Heuristics”, Dordrecht, The Netherlands: Springer, 2014.

2. Bruce Croft W, Metzler D, and Strohman T, “Search Engines: Information Retrieval in Practice”, Addison Wesley, USA, 2013.
3. Gerald K, “Information Retrieval Architecture and Algorithms”, Springer, Heidelberg, 2013.
4. Manning C, Raghavan P, and Schutze H, “Introduction to Information Retrieval”, Cambridge University Press, New Delhi, 2012.
5. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, “Modern Information Retrieval: The Concepts and Technology behind Search”, Addison Wesley, USA, 2012.

## 18ZC29 NATURAL LANGUAGE PROCESSING

**3 0 0 3**

**WORDS:** Introduction - Mathematical Foundations – Linguistic Essentials - Regular Expressions, Text Normalization, Edit Distance - Finite State Transducers - Language Modeling with N-grams - Naive Bayes Classification and Sentiment - Neural Nets and Neural Language Models - Hidden Markov Models - Neural Sequence Modeling: RNNs and LSTMs - Part-of-Speech Tagging
(12)

**SYNTAX:** Formal Grammars of English - Syntactic Parsing – Ambiguity – Cocke Kasami Younger (CKY) algorithm - Partial Parsing - Statistical Parsing
(11)

**SEMANTICS:** Vector Semantics - Semantics with Dense Vectors - Computing with Word Senses: WSD and WordNet - Lexicons for Sentiment and Affect Extraction - The Representation of Sentence Meaning - Computational Semantics - Information Extraction - Semantic Role Labeling and Argument Structure - Coreference Resolution and Entity Linking
(11)

**PRAGMATICS AND APPLICATIONS:** Discourse Coherence – Sequence To Sequence Models and Machine Translation - Summarization - Question Answering
(11)

**Total L: 45**

**REFERENCES:**

1. Daniel Jurafsky and James H. Martin, “Speech and Language Processing”, Prentice-Hall, Inc., 2017.
2. Christopher D. Manning, Hinrich Schütze, “Foundations of Statistical Natural Language Processing”, The MIT Press, 2018.
3. Nitin Indurkhya, Fred J. Damerau, “Handbook of Natural Language Processing Machine Learning & Pattern Recognition Series, Chapman & Hall/CRC, Taylor and Francis Group, 2010.
4. Yoav Goldberg, “Neural Network Methods for Natural Language Processing”, Synthesis Lectures on Human Language Technologies, April 2017.
5. Steven Bird, Ewan Klein, and Edward Loper, “Natural Language Processing with Python - Analyzing Text with the Natural Language Toolkit”, O,Reilly.

## 18ZC30 VIRTUALIZATION

**3 0 0 3**

**ARCHITECTURE AND EMULATION:** Computer architecture - Virtual Machine (VM): Basics and types – Taxonomy-Interpretation - Different types - Interpreting Complex Instruction Set - Binary Translation - Code Discovery and Dynamic Translation - Control Transfer Optimizations - Instruction Set Issues - Dynamic Program Behavior - Profiling - Optimization: Translation Blocks, Framework, Code Reordering and Optimization.
(12)

**VM TYPES:** Process VM: Issues, Emulation Types, Code Cache Management, System Environment - High Level Language (HLL) VM: Object Oriented HLL VMs, Java Virtual Machine (JVM), Common Language Infrastructure, Implementation and Issues, High Performance Emulation - Code Signed VM: Mapping, Code Issues and Caching, Traps, I/O.
(11)

**SYSTEM VIRTUAL MACHINES:** Key Concepts - Resource Virtualization: Processors, Memory, I/O - Performance Enhancement.
(11)

**MULTIPROCESSOR VIRTUALIZATION AND CASE STUDY:** Partitioning of Multiprocessor Systems - Partitioning: Physical, Logical - Different Host and Guest Instruction Set Architectures - Security - Migration of Computing Environments - Case Study: Virtual Box
(11)

**Total L: 45**

**REFERENCES:**
1. Portnoy M, “Virtualization Essentials”, Sybex, USA, 2012.
2. Ruest N and Ruest D, “Virtualization, A Beginner's Guide”, McGraw-Hill Osborne Media, USA, 2009.
3. Craig ID, “Virtual Machines”, Springer Verlag, Heidelberg, 2006.
4. Smith J E and Nair R, “Virtual Machines: Versatile Platforms for Systems and Processes”, Elsevier, India, 2005.
5. Wolf C and Halter EM, “Virtualization: From the Desktop to the Enterprise”, Apress, USA, 2005.

## 18ZC31 PROGRAMMING PARADIGMS

**3 0 0 3**

**BASICS OF PROGRAMMING:** Role of Programming Languages - Programming Paradigms - Syntactic Structure - Expression Notations - Abstract Syntax Trees - Lexical Syntax - Context Free Grammars - Grammars for Expressions. Semantic Methods: Synthesized Attributes, Attribute Grammars, Natural Semantics, Denotational Semantics
(11)

**IMPERATIVE AND OBJECT ORIENTED PROGRAMMING:** Structured Programming - Syntax-Directed Control Flow - Design Considerations - Programming with Invariants - Data Representation - Data Types - Error Checking - Procedure Activations - Parameter Passing - Scope and Scope Rules - Activation Records - Object Oriented Constructs - Information Hiding - Design With Modules - Defined Types - Declarations - Inheritance - Polymorphism - Dynamic Allocation – Templates.
(11)

**FUNCTIONAL PROGRAMMING:** Static Types and Lambda Calculus: Equality, Substitution, Pure Lambda Terms, Programming Constructs as Lambda Terms, Typed Lambda Calculus, Polymorphic Types. Types, Values and Operations - Expression Evaluation - Lexical Scope - Type Checking - Lists - Function Declaration by Cases - Functions as First-Class Values - ML: Implicit Types - Data Types - Exception Handling In ML - Scheme: Structure of Lists, List Manipulation, Simplification of Expressions. (12)

**LOGIC AND CONCURRENT PROGRAMMING:** Computing with Relations - Prolog: Data Structures, Programming Techniques, Control, Cuts - Concurrent Programming: Parallelism in Hardware, Streams and Implicit Synchronization, Concurrency as Interleaving, Liveness Properties - Safe Access to Shared Data.
(11)

**Total L: 45**

**REFERENCES:**
1. Sebesta R W, “Concepts of Programming Languages”, Addison-Wesley, USA, 2012.
2. Harper R, “Practical Foundations for Programming Languages”, Cambridge University Press, USA, 2012.
3. Michael L. Scott, "Programming Language Pragmatics”, Morgan Kaufmann Publishers Inc, USA, 2009.
4. Sethi R, “Programming Languages: Concepts and Constructs”, Addison-Wesley, USA, 2002.

## 18ZC32 CRYPTOGRAPHY AND NETWORK SECURITY

**3 0 0 3**

**SECURITY CONCEPTS & SYMMETRIC CIPHERS:** The OSI Security Architecture - Security Attacks, Security Services - Security Mechanisms - A Model for Network Security - Classical Encryption Techniques: Symmetric Cipher model, substitution techniques, Transposition techniques, Steganography. Block Ciphers and Data Encryption Standard: Block Cipher Principles, DES. (10)

**PUBLIC-KEY CRYPTOGRAPHY:** Number Theory: Prime Numbers, Fermat’s and Euler’s Theorems - Principles of Public-Key Cryptosystems - The RSA Algorithm - Diffie - Hellman Key Exchange - Elliptic Curve Cryptography
(10)

**CRYPTOGRAPHIC HASH FUNCTIONS:** Applications of Cryptographic Hash Functions - Secure Hash Algorithm (SHA) Message Authentication Codes - Message Authentication Requirements - Message Authentication Functions- Digital Signatures - Digital Signature Standard (DSS).
(10)

**MUTUAL TRUST, NETWORK & INTERNET SECURITY:** Key Management and Distribution: Symmetric Key Distribution Using Symmetric Encryption, Asymmetric Encryption - Distribution of Public Keys - X.509 Certificates - Public Key Infrastructure – Transport Level Security - Basic Concepts, Secure Sockets Layer (SSL) - Transport-Level Security, Transport Layer Security (TLS) - HTTPS - Secure Shell (SSH) - Introduction to quantum cryptography - Ethical hacking
(15)

**Total L: 45**

**REFERENCES:**

1. William Stallings, “Cryptography and Network Security: Principles and Practice”, Prentice Hall of India Pearson Education, New Delhi, 2013.
2. Atul Kahate, “Cryptography and Network Security”, Tata McGraw Hill Ltd., New Delhi, 2013.
3. Bernard Menezes, “Cryptography and Network Security”, Cengage Learning India, New Delhi, 2010.
4. Behrouz A and Forouzan, “Cryptography and Network Security”, Tata McGraw Hill Ltd., New Delhi, 2008.

## 18ZC33 CELLULAR NETWORK ENGINEERING

**3 0 0 3**

**CELLULAR NETWORK and MAC LAYER:** Introduction – Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation, IPV6-Network layer in the internet-Routing, Destination Sequence distance vector – Cellular Network applications - Important Issues and the Need for Medium Access Control (MAC) Protocols - Classification of MAC Protocols - Multiple-Channel MAC Protocols.
(12)

**CELLULAR TRANSPORT LAYER:** TCP enhancements for wireless protocols – Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility – Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, Transaction oriented TCP – TCP over 3G wireless networks.
(11)

**CELLULAR WIDE AREA NETWORK:** Overview of UMTS Terrestrial Radio access network - UMTS Core network Architecture: 3G-MSC, 3G-SGSN, 3G-GGSN, Firewall, DNS/DHCP - High speed Downlink packet access (HSDPA) - LTE network architecture and protocol.

(11)

**4G NETWORKS:** Introduction – 4G vision – 4G features and challenges – Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna techniques, OFDM-MIMO systems, Adaptive Modulation and coding with time slot scheduler, Cognitive Radio.
(11)

**Total L: 45**

**REFERENCES:**

1. D.P. Agrawal and Qing-An Zeng, “Introduction to Wireless and Mobile Systems”, CL Engineering, 2010.
2. Subir Kumar Sarkar, T.G. Basavaraju, C. Puttamadappa, “Ad Hoc Mobile Wireless Networks: Principles, Protocols and Applications”, Auerbach Publications, 2013.
3. Jonathan Loo, Jaime Lloret Mauri, Jesús Hamilton Ortiz, “Mobile Ad Hoc Networks: Current Status and Future Trends”, CRC Press, 2012.
4. Radhika Ranjan Roy, “Handbook of Mobile Ad Hoc Networks for Mobility Models”, Springer Science+Business Media, LLC 2011.
5. Joh R. Vacca, “Wireless Broadband Networks Handbook 3G, LMDS and Wireless Internet”, Tata McGraw Hill, 2001.

## 18ZC34 ADHOC AND SENSOR NETWORKS

**3 0 0 3**

**AD HOC NETWORKS MAC:** Introduction – Self Organizing behavior – Issues and classification of MAC protocol - MACA - MACAW – DBTMA.
(12)

**AD HOC NETWORKS: ROUTING AND TRANSPORT LAYER:** Routing challenges in Ad hoc Network- Classification- Proactive, reactive, and hybrid routing protocols -DSDV, AODV, DSR, OLSR, CBRP, FSR. Issues of TCP in Ad hoc Networks - TCP Over Ad Hoc Networks
(11)

**SENSOR NETWORK:** Challenges for Wireless Sensor Networks - Single Node Architecture - Hardware Components - Energy Consumption of Sensor Nodes – Single hop versus Multi hop Networks - Sensor Network Applications. Coverage problem in Sensor Network - Types of coverage - OGDC coverage algorithm
(11)

**SENSOR NETWORK: MAC AND ROUTING:** Classification of MAC protocols - MAC related properties - MAC performance issues -MAC protocols for sensor networks - Issues with the adoption of ad hoc routing protocols - Data-centric routing - Position-based routing - Data aggregation - Clustering-based routing algorithm
(11)

**Total L: 45**

**REFERENCES:**


1. C Siva Ram Murty & BS Manoj, "Ad HOC Wireless Networks: Architectures & Protocols", Pearson Education,2004.
2. Mohamed Ilyas , "Handbook of Ad Hoc Wireless Network", CRC Press,2002.
3. Ibrahiem M. M. El Emary, S. Ramakrishnan, "Wireless Sensor Networks: From Theory to Applications", CRC Press, 2013.
4. Ian Akyildiz, Mehmet Can Vuran, "Wireless Sensor Networks" John Wiley & Sons USA 2010.
5. Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks Technology, Protocols and Applications", John Wiley & Sons, Online.


## 18ZC35 MEMETIC ALGORITHM

**3 0 0 3**

**INTRODUCTION:** Optimization - Evolutionary Algorithms: Components, Operation, variants, design and Tuning – Local Search: Basic concepts, Neighborhoods and Local optima, Classifications, Local search in combinatorial and continuous domains (12)

**MEMETIC ALGORITHM (MA) DESIGN ISSUES:** Need for MA - MA template - Design issues - Balancing Global and Local search - Time complexity of Local search - Diversity management (11)

**SELF-ADAPTATIVE AND COEVOLVING MA:** Self-adaption and co-evolution - framework, Self adaptation of fixed and varying sized rules - Population size Variation - Handling Uncertainties (11)

**MULTI-OBJECTIVE MEMETIC ALGORITHMS (MOMA):** Basic Concepts, Adaption of Memetic algorithms for multi-objective optimization, Examples of MOMA, Implementation of MOMA - Applications (11)

**Total L: 45**

**REFERENCES:**


1. Ferrante Neri, Carlos Cotta, and Pablo Moscato, "Handbook of Memetic Algorithms", Studies in Computational Intelligence, Springer-Verlag Berlin Heidelberg, 2012.
2. Chi-Keong Goh, Yew Soon Ong , Kay Chen Tan, "Multi-Objective Memetic Algorithms", Studies in Computational Intelligence, Springer-Verlag Berlin Heidelberg, 2009.
3. William E. Hart, Dr. J. E. Smith, N. Krasnogor, "Recent Advances in Memetic Algorithms", Studies in Fuzziness and Soft Computing, Springer-Verlag Berlin Heidelberg, 2005.


## 18ZC36 COMPUTER VISION

**3 0 0 3**

**INTRODUCTION:** Motivation, Difficulty, Image analysis tasks, Image representations, Image digitization, Image properties,
Color images, Cameras

(11)

**DATA STRUCTURES AND TEXTURE:** Levels of image data representation - Traditional image data structures - Hierarchical
data structures - Statistical texture description, Syntactic texture description methods, Hybrid texture description methods,
Texture recognition method applications

(11)

**OBJECT RECOGNITION AND 3D VISION:** Knowledge representation, Statistical pattern recognition, Neural nets, Syntactic
pattern recognition, Recognition as graph matching, Optimization techniques in recognition, Fuzzy systems-3D vision:
Tasks - Basics of projective geometry - Scene construction from multiple views, Uses: Shape from X - Full 3D objects - 3D
model based vision - 2D view based 3D representation.

(12)

**MOTION ANALYSIS:** Differential motion analysis methods, Optical flow, Analysis based on interest points, Detection of
specific motion patterns, Video Tracking, Motion models to aid tracking.

(11)

**Total L: 45**

**REFERENCES:**


1. Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image Processing, Analysis and Machine Vision", Cengage Learning, New Delhi, 2014.
2. Wesley E. Synder and Hairong Qi, "Machine Vision", Cambridge University Press, USA, 2010.

3. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer-Verlag, London, 2011.
4. Rafael C Gonzalez, Richard E Woods, Steven L Eddins, “Digital Image Processing”, Pearson Education, New Delhi, 2009.

## 18ZC37 COGNITIVE COMPUTING

**3 0 0 3**

**INTRODUCTION TO COGNITIVE SCIENCE AND COGNITIVE COMPUTING WITH AI:** Cognitive Computing - Cognitive Psychology - The Architecture of the Mind - The Nature of Cognitive Psychology – Cognitive architecture – Cognitive processes – The Cognitive Modeling Paradigms - Declarative / Logic based Computational cognitive modeling – connectionist models – Bayesian models. Introduction to Knowledge-Based AI – Human Cognition on AI – Cognitive Architectures
(12)

**COGNITIVE COMPUTING WITH INFERENCE AND DECISION SUPPORT SYSTEMS:** Intelligent Decision making - Fuzzy Cognitive Maps – Learning algorithms: Non linear Hebbian Learning – Data driven NHL - Hybrid learning – Fuzzy Grey cognitive maps – Dynamic Random fuzzy cognitive Maps
(11)

**COGNITIVE COMPUTING WITH MACHINE LEARNING:** Machine learning Techniques for cognitive decision making – Hypothesis Generation and Scoring - Natural Language Processing - Representing Knowledge - Taxonomies and Ontologies - Deep Learning
(11)

**CASE STUDIES:** Cognitive Systems in health care – Cognitive Assistant for visually impaired – AI for cancer detection, Predictive Analytics - Text Analytics - Image Analytics -Speech Analytics – IBM Watson - Introduction to IBM’s PowerAI Platform - Introduction to Google’s TensorFlow Development Environment
(11)

**Total L: 45**

**REFERENCES:**

1. Hurwitz, Kaufman, and Bowles, “Cognitive Computing and Big Data Analytics”, Wiley, Indianapolis, 2005.
2. Jerome R. Busemeyer, Peter D. Bruza, “Quantum Models of Cognition and Decision”, Cambridge University Press, 2014.
3. Emmanuel M. Pothos, Andy J. Wills, “Formal Approaches in Categorization”, Cambridge University Press, 2011.
4. Nils J. Nilsson, “The Quest for Artificial Intelligence”, Cambridge University Press, 2009.
5. Neil Stillings, Steven E. Weisler, Christopher H. Chase and Mark H. Feinstein, “Cognitive Science: An Introduction”, MIT Press, 1995.

## 18ZC38 THEORETICAL COMPUTER SCIENCE

**3 0 0 3**

**REGULAR LANGUAGES AND FINITE AUTOMATA:** Basics of Automata Theory - Chomsky Hierarchy of Grammars and the Corresponding Acceptors. Regular Expression - Deterministic FA - Non deterministic FA - Minimization of DFA - Pumping Lemma of Regular Languages - Decision Problems. Context Free Grammars - Non Deterministic PDA
(11)

**DECISION PROBLEM:** Decision properties Turing Machines - Variants of TMs - Programming Techniques for TMs - Non Deterministic TMs - TMs and Computers - Recursive and Recursively Enumerable Languages.
(11)

**COMPUTABILITY THEORY:** Hilbert's Problem - Computable Functions – The Recursion Theorem - Decidable Language - Universal Turing Machines - Undecidable - Halting Problem - Rice Theorem - Post Correspondence Problem - Church Turing thesis.
(11)

**TIME AND SPACE COMPLEXITY THEORY:** Tractable and Intractable Problems - Time of Tractable Problems – P, NP, NP-Complete Classes - Boolean Satisfiability Problem - Polynomial Time Reductions - Proof of NP-completeness : Vertex Cover Problem - Clique Problem - Hamiltonian Circuit problem - TSP - NP hard, Cook Levin Theorem. Space Complexity of tractable problems – Savitch’s theorem – Class PSPACE – PSPACE Completeness – Class L and NL – NL Completeness – coNL.
(12)

**Total L: 45**

**REFERENCES:**

1. Michael Sipser, “Introduction to the Theory of Computation”, Thomson course Technology, USA, 2012.
2. John C Martin, “Introduction to Languages and the Theory of Computation”, Tata McGraw Hill Publishing Company, New Delhi, 2007.
3. John E Hopcroft and Rajeev Motwani and Jeffrey D Ullman, “Introduction to Automata Theory, Languages and Computation”, Pearson Education Asia, New Delhi, 2006.
4. Peter Linz, “An Introduction to Formal Language and Automata”, Narosa Publishers, New Delhi, 2006.
5. Harry R Lewis, Christos H Papadimitriou, “Elements of the Theory of Computation”, Prentice Hall of India/Pearson Education, New Delhi, 2003.
6. Christos H Papadimitriou, “Computational Complexity”, Addison-Wesley, New York, 1994.

## 18ZC39 ADVANCED ALGORITHMS

**3 0 0 3**

**ADVANCED RANDOMIZATION AND HARDNESS OF APPROXIMATION:** Algorithm for Bipartite Matching - Constructing Perfect Matching - Randomized Markov Chains - Ergodicity - Time Reversal. Hardness of Approximation: Reductions from NP-Complete Problems Reductions that Preserve Approximation.
(12)

**MULTITHREADED ALGORITHMS:** Dynamic Multithreaded Algorithms - Performance Measures and Scheduling – Analyzing Multithreaded Algorithms - Parallel Loops and Race Conditions - Multithreaded Matrix Multiplication – Merge Sort.
(11)

**ONLINE ALGORITHMS:** Investment Problem- Ski Rental Problem – Randomized On-Line Algorithms - Analysis of Marking Algorithm and Finding Lower Bound - The K-Server Problem
(11)

**STRING MATCHING:** Notations - Naive String Matching Algorithm - Rabin-Karp Algorithm - String Matching with Finite Automata -Knuth-Morris - Pratt Algorithm.
(11)

**Total L: 45**

**REFERENCES:**

1. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein, “Introduction to Algorithms” ”, PHI learning Pvt. Ltd., New Delhi, 2010.
2. David P. Williamson and David B. Shmoys, ”The Design of Approximation Algorithms”, Cambridge University Press, 2010
3. Allan Borodin and Ran El-Yaniv, “Online Computation and Competitive Analysis”, Cambridge-UK, Cambridge University Press, 1998.
4. Michel Goemans, “Lecture Notes on Advanced Algorithms”, MIT,1996.


## 18ZC40 SOFTWARE DEFINED NETWORKS

**3 0 0 3**

**NETWORK FUNCTION VIRTUALIZATION:** History and Evolution of Software Defined Networking (SDN): IETF Forces, Active Networking. Control and Data Plane Separation: Concepts, Advantages and Disadvantages, the OpenFlow protocol - Network Function Virtualization: Concepts, Applications, Existing Network Virtualization Framework (VMWare and others), Mininet based examples.
(12)

**CONTROL AND DATA PLANE SEPARATION:** Control Plane: Overview, Existing SDN Controllers including Floodlight and OpenDaylight projects - Customization of Control Plane: Switching and Firewall Implementation using SDN Concepts. Data Plane: Software-based and Hardware-based; Programmable Network Hardware. Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs.
(11)

**SOFTWARE DEFINED NETWORKS FOR THE INTERNET-OF-THINGS:** Challenges - Understanding the nature of IoT traffic flows in different use cases-A software defined end-to-end IoT Infrastructure - Effective resource provisioning in the IoT Multinetwork environments - Addressing scalability and security issues- Adding SDN automation and verification in IoT infrastructure. (11)

**USE CASES OF SDNS:** Data Centers, Internet Exchange Points, Backbone Networks, Home automation Systems, Industrial automation Systems and Smart grids.
(11)

**Total L: 45**

**REFERENCES:**

1. Thomas D. Nadeau, Ken Gray, “SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies”, O'Reilly Media, 2013.
2. Paul Goransson and Chuck Black, “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann, 2014.
3. Vivek Tiwari, “SDN and OpenFlow for Beginners”, Amazon Digital Services, Inc., 2013.
4. Fei Hu, “Network Innovation through OpenFlow and SDN: Principles and Design”, CRC Press, 2014.


## 18ZC41/18ZS37 MACHINE LEARNING

**3 0 0 3**

**COMPUTATIONAL LEARNING THEORY BASICS:** Introduction: Types of Learning - Designing a learning system – concept learning - Find-s – Candidate Elimination - PAC Learnability- Sample complexity for finite and Infinite hypothesis spaces-VC Dimension - Evaluating Hypothesis - Estimating Hypothesis Accuracy - Error Estimation - Bias-Variance - Confidence Interval - Central Limit Theorem
(12)

**LINEAR MODELS:** Linear Models For Regression – Linear Regression Models, Maximum Likelihood Estimation - Least Squares, The Bias-Variance Decomposition, Bayesian Linear Regression, Linear Models for Classification, Probabilistic Generative Models, Probabilistic Discriminative Models, Linear Discriminant Analysis.
(11)

**NEURAL NETWORKS:** Neural Networks - Feed-forward Networks - Network Training - Delta Rule- Gradient Descent - Error Backpropagation - Regularization in Neural Networks.
(11)

**KERNEL AND GRAPHICAL METHODS:** Kernel Methods - Constructing Kernels- Radial Basis Function Networks - Gaussian Processes - Maximum Margin Classifiers – SVM - Graphical Methods – Bayes Theorem - Bayesian Networks - Markov Random Fields - Inference in Graphical Models - Mixture Models – Expectation Maximization.
(11)

**Total L: 45**

**REFERENCES:**


1. Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer-Verlag New York, 2013.
2. Tom M. Mitchell, “Machine Learning”, McGraw Hill, 1997.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, “The Elements of Statistical Learning - Data Mining, Inference, and Prediction”, Second Edition, Springer Series in Statistics, Springer-Verlag New York, 2013.
4. Yaser S. Abu Mostafa, Malik Magdon Ismail, Hsuan Tien Lin, “Learning From Data A Short Course”, Amlbook.Com, 2012.