I SEMESTER

21ZC01 LINEAR ALGEBRA AND STATISTICAL METHODS

3 1 0 4

VECTOR SPACES: Real vector spaces, subspaces, linear dependence, basis and dimension of a vector space – rank – change of basis, inner product space, norm, Gram-Schmidt process. Linear transformation. (11+3)

EIGENVALUES AND EIGENVECTORS: Eigenvalues and eigenvectors, diagonalization, eigenvectors and linear transformations , complex eigenvalues, discrete dynamical systems , iterative estimates for eigenvalues, singular value decomposition, QR decomposition. (11+4)

ESTIMATION AND TESTING OF HYPOTHESES: Estimation- Point estimation, Maximum Likelihood Estimation, Bayesian estimation of parameters, Interval estimates and Confidence interval. Sampling, sampling distribution. Testing of Statistical Hypothesis: Large sample tests- Inference concerning means, variances and proportions, Small sample tests - Inference concerning means and variances, goodness of fit and independence of attributes. (11+4)

MULTIVARIATE ANALYSIS: Random vectors and matrices – mean vectors and covariance matrices – multivariate normal distribution and its properties – principal components: population principal components – principal components from standardized variables. (12+4)

Total L: 45 +T: 15 = 60

REFERENCES:

1. David C Lay, “Linear Algebra and its Applications”, Pearson Education, New Delhi, 2017.
2. Douglas C Montgomery, and George C Runger, “Applied Statistics and Probability for Engineers”, Wiley, Sixth Edition, 2014.
3. Gilbert Strang, Linear Algebra and its Applications, Cengage, New Delhi, 2012.
4. Howard Anton and Chris Rorres, “Elementary Linear Algebra: Applications Version”, Wiley India, New Delhi, 2018.
5. Richar A Johnson,and Dean W Wichern, “Applied Multivariate Statistical Analysis”, Pearson Education, Sixth Edition, New Delhi, 2013.

21ZC02 / 21ZS02 DATA STRUCTURES AND ALGORITHMS

3 1 0 4

ALGORITHM ANALYSIS AND LINEAR DATA STRUCTURES: Analysis of iterative and recursive Algorithms – Asymptotic notations – Arrays – Linked Lists – Stacks – Queues-Applications (15 + 4)

TREES: Search Trees – Balanced Search Trees: AVL, RBT, Splay **Heaps**: Double ended heap – Leftist Heaps - Binomial Heaps – Fibonacci Heaps – Skew Heaps **Multi-dimensional data structure**: kd tree (10 + 5)

GRAPHS AND HASHING: Representation – Shortest path algorithms: Unweighted shortest path, Dijikstra’s algorithm, Graphs with negative edge costs, All pairs shortest path – Network Flow problems – Activity Networks – DFS applications: Biconnectivity, Euler Circuits . **HASHING**: Hashing: Static hashing – Dynamic hashing - Overflow handling (10 + 3)

ALGORITHM DESIGN TECHNIQUES : General Method - Dynamic Programming, Greedy Algorithms, Backtracking, Branch and Bound, Knapsack Problem– Applications of knapsack problem (10 + 3)

Total L: 45 + T: 15 = 60

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, 2019.
3. Mark Allen Weiss, “Data structures and Algorithm Analysis in C++”, Pearson Education, New Delhi, 2013.
4. Peter Brass, “Advanced Data Structures”, Cambridge University Press, New York, 2008.

21ZC03 / 21ZS03 DATABASE TECHNOLOGIES

3 0 0 3

RELATIONAL DATABASE: Relational database Design - ER and EER Diagrams, Reduction to relational schemas, Normalization- Functional Dependencies, Normal Forms, Overview of SQL, Relational Algebra. (12)

ORDBMS AND XML DATABASES: Database Design for ORDBMS – UDT and Complex structures, Nested Relations and Collections. XML Databases: XML Data Model – DTD – XML Schema – XML Querying: Xpath and Xquery – Web Databases – Open Database Connectivity. (10)

PARALLEL AND DISTRIBUTED DATABASES: Introduction - Architecture - Parallel Query Evaluation; Parallelizing Individual Operations, Sorting, Joins. Distributed Database Design: Concepts, Data Fragmentation, Replication and Allocation techniques– Distributed Query Processing– Commit Protocols – Concurrency Control. (12)

NOSQL DATABASES: 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 studies. (11)

Total L: 45

REFERENCES:

1. R. Elmasri, S.B. Navathe, “Fundamentals of Database Systems”, Seventh Edition, Pearson Education, 2017.
2. Raghu Ramakrishnan and Johannes Gehrke, “Database Management Systems”, Third Edition, McGraw Hill, New Delhi, 2014
3. Thomas Connolly and Carlolyn Begg, “Database Systems, A Practical Approach to Design, Implementation and Management”, Sixth Edition, Pearson Education 2015
4. NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Author: Sadalage, P. & Fowler, Publication: Pearson Education 2013.
5. Andreas Meier and Michael Edward Kaufmann, SQL & NoSQL Databases: Models, Languages, Consistency Options and Architectures for Big Data Management, Springer, 2019.

21ZC04 / 21ZS04 ADVANCED SOFTWARE ENGINEERING

3 1 0 4

SOFTWARE ENGINEERING CONCEPTS: Software Characteristics –Software Myths – Software life cycle models – Prescriptive process models – Specialized process models –The Unified Process–Agile Methods - DevOps: Motivation- Operations- Deployment Pipeline: Overall Architecture - Requirement Analysis - Requirement Engineering Process (10+4)

SYSTEM ANALYSIS and UML MODELING: Analysis and Data Flow Oriented Modelling Approaches – Context diagram, Data flow diagrams–Use case Model – Class Based Modeling-Objects and Classes – Object Identification – Relationship among objects – classification–Behavioral Model- Interaction diagrams – Activity diagrams– State chart diagrams . (12+6)

SYSTEM DESIGN: Design Process – Design Concepts - Architectural Design and styles - Layered - Client-server - Tiered - Pipe and filter - Component level Design – Deployment Level Design - Design Patterns and Frameworks – Adapter – Proxy – Facade (13+2)

SOFTWARE TESTING AND PROJECT MANAGEMENT: Software Testing Strategies–Testing Conventional Applications– Testing Object OrientedApplications - Black box testing– White box testing –Debugging - Software configuration management- Software project management – Project planning – Cost Estimation Models– Scheduling – Risk management. (10+3)

Total L: 45 + T:15 = 60

REFERENCES:

1. Ian Sommerville, “Software Engineering”, Pearson Education, New Delhi, 2015.
2. Roger Pressman S, “Software Engineering: A Practitioners”, Tata McGraw Hill, New Delhi, 2014.
3. Len Bass, Ingo Weber and Liming Zhu, —DevOps: A Software Architect‘s Perspectivell,Pearson Education, 2016
4. 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.
5. Craig Larman, “Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development (3rd Edition)”, Pearson, 2015.
6. Craig Larman, “Large-scale scrum scaling agile for large & multisite development”, Addison-Wesley, 2014.

21ZC05 / 21ZS05 ADVANCED OPERATING SYSTEMS

3 1 0 4

PROCESS SCHEDULING & PROCESS SYNCHRONIZATION:- 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. (9 +3)

DISTRIBUTED OPERATING SYSTEM: 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. (12+4)

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.Case Study: HDFS and YARN (12+4)

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. (12+4)

Total L: 45 + T: 15 = 60

REFERENCES:

1. William Stallings, "Operating Systems – Operating System: Internals and Design Principles", Ninth Edition, Pearson, 2018.
2. Mukesh Singhal, Niranjan Shivaratri, "Advanced Concepts in Operating Systems", McGraw-Hill, 2017.
3. George Coulouris , Jean Dollimore, Tim Kindberg, Gordon Blair, "Distributed Systems – Concepts and Design", Fifth Edition, Pearson, 2017.
4. Rajib Mall, "Real-Time Systems: Theory and Practice", First Edition, Pearson, 2009.
5. Dawn Griffiths, David Griffiths , "Head First Android Development: A Brain-Friendly Guide", Second Edition, O'Reilly Media, 2017.
6. The Swift Programming Language (Swift 5.3), Apple Inc. 2020.

21ZC06 / 21ZS06 RESEARCH METHODOLOGY AND IPR

Vide Automotive Engineering 21AE06

21ZC72 AUDIT COURSE I

vide Automotive Engineering 21AE72

21ZC51 / 21ZS51 COMPUTATIONAL THINKING LABORATORY

0 0 4 2

List of Experiments:

- Learning the components of Computational Thinking (Decomposition, Pattern Recognition, Abstraction and Algorithm) and applying it on any real world application
- Solving problems by evaluating various algorithms and selecting appropriate algorithms
- Solving problems by evaluating various different data structures and selecting suitable ones.
- Solving Real World Application by selecting the optimized algorithms with appropriate data structures after applying Complexity Analysis

Total P: 60

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. Mark Allen Weiss, "Data structures and Algorithm Analysis in C++", Pearson Education, New Delhi, 2013.
3. R G Dromey, " How to solve it by Computer",Pearson Education, Jan 2006
4. Peter Denning, Matti Tedre,"Computational Thinking", MIT Press, 2019

21ZC52 / 21ZS52 DATABASE TECHNOLOGIES LABORATORY

0 0 4 2

List of Experiments:

- Relational database
  - SQL - Creation of Tables and Views.
  - Database Querying – Simple queries, Nested queries and Joins.
- Object Relational
  - UDT, Inheritance.
  - CRUD operation in Nested Tables..
- Distributed database
  - Transactions and Query Processing.
- XML Databases
  - Storage and Retrieval.
- No SQL Databases
  - Storage and Retrieval.
- SQL Data Profiler.
- Mini Project.

Total P: 60

REFERENCES:

1. Ivan Bayross, “SQL, PL/SQL the Programming Language of Oracle”, 4th Edition, BPB Publications, 2010.
2. Luc Perkins, Eric Redmond, Jim Wilson, “Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement Edition”, Second Edition, 2018.

II SEMESTER

21ZC07 EMBEDDED SYSTEMS DESIGN

3 0 0 3

INTRODUCTION TO EMBEDDED SYSTEM DESIGN AND ARM ARCHITECTURE: Introduction to Embedded Systems - Examples of Embedded Systems - Design Parameters of Embedded Systems - Challenges for Embedded Systems - **Embedded Design Life Cycle:** Selection Process - Hardware Software Partitioning - Development Environment - **Arm:** Introduction to Cortex-M Microcontroller - Microprocessor Architecture. (10)

INTERRUPTS, MEMORY AND COMMUNICATION INTERFACES: ARM based Nested Interrupt Vector Controller - Memory and Peripherals of Cortex M Microcontrollers/Microprocessors - Memory Interfacing - Cortext M Exceptions and Interrupts - Exception and Interrupt Priority - Interrupt Configuration - Handling of Exceptions or Interrupts - **Communication Interfaces:** UART Interface - I2C Interface - SPI Interface - CAN Interface. (12)

ARM PROGRAMMING: Instruction Set - Data Processing Instruction - Memory Access Instruction: Load and Store Instruction - LDR with PC relative addressing mode - ADR instruction - Double and Multiple Word Memory Access - Stack Memory Access - Branch and Control Instruction: Branch Instructions - Conditional Branching Instructions - Looping Instructions - Recursive Functions - Special Instructions. (12)

VALIDATION, DEBUGGING TOOL SET ,TESTING AND CASE STUDY: Host and Target Machines - Validation Types and Methods - Host Testing - Host-Based Testing Setup - Target Testing - Host based Debugging - Remote Debuggers and Debug Kernels - ROM Emulator - Logic Analyzer - Background Debug Mode - ICE an integrated solution - **Case Study:** Case Studies on Embedded Systems and Real Time Embedded Systems. (11)

Total L: 45

REFERENCE BOOKS:

1. Berger, Arnold. Embedded Systems Design: An Introduction to Processes, Tools, and Techniques. United Kingdom, Taylor & Francis Group, 2017.
2. Javed, Kashif, and Tahir, Muhammad. ARM Microprocessor Systems: Cortex-M Architecture, Programming, and Interfacing. United States, CRC Press, 2020.
3. Prasad K V K K, “Embedded/Real-Time Systems: Concepts, Design and Programming - The Ultimate Reference”, Himal Impressions, New Delhi, 2003.
4. Wang, K.C.. Embedded and Real-Time Operating Systems. Germany, Springer International Publishing, 2018.

21ZC08 NETWORKING TECHNOLOGIES

3 1 0 4

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+4)

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+4)

CELLULAR AND WIRELESS NETWORKS: GSM – GPRS – UMTS – UTRAN - UMTS Security - IEEE802.16 and WiMAX – Security – Advanced 802.16 Functionalities – Mobile WiMAX - 802.16e – WLAN: Configuration and Security– IEEE 802.11e and WMM – Comparison of WLAN and UMTS – Bluetooth (11+4)

4G NETWORKS AND SOFTWARE DEFINED NETWORKS: LTE – Network Architecture and Interfaces – FDD Air Interface and Radio Networks - LTE Security Architecture – Interconnection with UMTS and GSM – Introduction 5G – Architecture – 4G Vs 5G – Software Defined Networks:Centralized and Distributed Control and Data Planes – Open Flow – SDN Controllers - Design of SDN Framework. (11+3)

Total L: 45 + T: 15 = 60

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. Martin Sauter, "From GSM to LTE, An Introduction to Mobile Networks and Mobile Broadband", Wiley, 2014.
5. Erik Dahlman, Stefan Parkvall, Johan Skold, —4G: LTE/LTE-Advanced for Mobile Broadbandll, Academic Press, 2013.
6. Paul Goransson, Chuck Black, —Software Defined Networks: A Comprehensive Approachll, Morgan Kauffman, 2014.

21ZC82 AUDIT COURSE II

vide Automotive Engineering 21AE82

21ZC61 EMBEDDED SYSTEMS LABORATORY

0 0 4 2

List of Experiments:

The students will be able to demonstrate the following:

- ARM Basics
  - Introduction to Development Tools and Environment for ARM Programming
  - Learn fundamentals in ARM Programming
  - Communication Interfaces
  - ARM programming for I/O Interfaces
  - ARM Programming for Interrupt handling
  - Interfacing Memory with ARM Microprocessors/Microcontrollers
  - ARM Programming for Communication Interface like UART, SPI and I2C
  - Real Time Operating System
  - Intro to RTOS development environment and tools for ARM Microprocessors/Microcontrollers
  - ARM Programming for RTOS - Creating Multiple Tasks and Scheduling the real time tasks
  - Apply Inter Task Communication techniques to communicate between tasks
  - RTOS - Task Synchronization
  - Debugging Techniques
  - Introduction to debugging tools of Embedded System
  - Learn debugging techniques of an Embedded System using various tools like probes, logical analyzer, debuggers, simulators

Total P: 60

REFERENCES:

1. Javed, Kashif, and Tahir, Muhammad. ARM Microprocessor Systems: Cortex-M Architecture, Programming, and Interfacing. United States, CRC Press, 2020.

2. Lewis, Daniel Wesley. Fundamentals of Embedded Software: With the ARM Cortex -M3. United Kingdom, Prentice Hall, 2012.
3. Siegesmund, Mark. Embedded C Programming: Techniques and Applications of C and PIC MCUS. Netherlands, Elsevier Science, 2014.
4. Wang, K.C.. Embedded and Real-Time Operating Systems. Germany, Springer International Publishing, 2018.

21ZC62 APPLICATION DEVELOPMENT LABORATORY

0 0 4 2

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 computer science or take requirements from a stakeholder
  - Comparing and contrasting the existing methods.
  - Produce a Functional specification document and get approval
  - The application should also meet non-functional requirements like performance, security needs etc.,

- Design
  - Conceptualizing a research design and propose an innovative solution for the problem identified.
  - Identify the suitable software methodology, design depending on the application needs and requirements.
  - Produce a architecture design,detail design and get approval
  - Choose available open source design tools based on the design methodologies chosen

- Development and Testing
  - Model/prototype development
  - Choose appropriate open source development and test tools
  - Develop detailed test plan and test cases
  - Validation testing, performance testing need to be done
  - Appropriate open source testing tools to be chosen

- Report submission and presentation
  - Test Report with appropriate result analysis to be prepared
  - Deployment, Stakeholder approvals to be included in presentation

Total P: 60

21ZC63 / 21ZS63 INDUSTRIAL VISIT AND TECHNICAL SEMINAR

Vide Automotive Engineering 21AE63

III SEMESTER

21ZC71 PROJECT WORK I

Vide Automotive Engineering 21AE71

IV SEMESTER

21ZC81 PROJECT WORK II

Vide Automotive Engineering 21AE81

PROFESSIONAL ELECTIVE THEORY COURSES (Four to be opted)

21ZC21 RANDOMIZED AND APPROXIMATION 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. Vijay V. Vazirani, "Approximation Algorithms", Springer Nature (SIE), San Francisco, USA, 2013.
5. James Aspnes, "Notes on Randomized Algorithms", http://www.cs.yale.edu/homes/aspnes/#classes, 2020.

21ZC22 / 21ZS22 AGILE SOFTWARE DEVELOPMENT

3 0 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. (11)

EXTREME PROGRAMMING: Life Cycnetle – User Stories – Architecture – Planning – Iteration – Testing – Release – XP Values – XP Practices – Planning – Coding – Pair Programming Model – Refactoring – Agile Modeling and XP – case study, (11)

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. (11)

OTHER METHODOLOGIES: FDD – Lean and Kanban Software development – Comparison of agile approaches - DevOps: Motivation -Operations- Overall Architecture - Building and Testing- Deployment. (12)

Total L: 45

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. Patrick Jeff, "Agile Software Development for Beginners and Dummies Extensive Guide To Agile Software Development", 2020.
4. Scott Ambler, “Agile Modeling: Effective Practices for eXtreme Programming and the Unified Process”, Wiley Computer Publishing, 2002.
5. Len Bass, Ingo Weber and Liming Zhu, “DevOps: A Software Architect‘s Perspective”, Pearson Education, 2016.

21ZC23 / 21ZS23 BLOCKCHAIN AND DISTRIBUTED LEDGER TECHNOLOGY

3 0 0 3

INTRODUCTION : Fundamental of Distributed Systems -distributed databases- transaction processing - Overview of Blockchain- Public Ledgers- Bitcoin- Smart Contracts- Block in a Blockchain- Transactions- Distributed Consensus- Public vs Private Blockchain- Understanding Cryptocurrency. (12)

DISTRIBUTED LEDGER TECHNOLOGY (DLT) : Working of DLT- Key Features of DLT- Relation between DLT and blockchain in digital currency- Open vs Permissioned Digital ledger- Advantages - Challenges and Risks related to DLT. (9)

BLOCKCHAIN PLATFORMS: Open Source Platforms : Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation, Writing smart contract (12)

BLOCKCHAIN APPLICATION DEVELOPMENT: Internet of Things, Medical Record Management System, Privacy & Security In Blockchain , Scalability issues (12)

Total L: 45

REFERENCES:

1. Imran Bashir,"Mastering Blockchain",Packt Publishing, March 2017
2. Rogen Wattenhofer , "Blockchain Science : Distributed Ledger Technologies", Inverted Forest Publishing, 2019
3. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press ,July 19, 2016.
4. Distributed Ledger Technology (DLT) and Blockchain, Fintech Note,2017
5. Melanie Swan ,"Blockchain: Blueprint for a New Economy", O'Reilly, 2015
6. Daniel Drescher, "Blockchain Basics",Apress; 1stedition, 2017

21ZC24 BRAIN COMPUTER INTERFACE

3 0 0 3

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OVERVIEW: Basic Neuroscience, working of the Brain, BCI components, Types of BCI – non-invasive, semi-invasive and invasive techniques, Recording techniques-EEG, MEG, fNIRS, fMRI, limitations of BCI. (10)

SIGNAL PROCESSING AND MACHINE LEARNING FOR BCI: Spike Sorting, Frequency Domain Analysis, wavelet Analysis, Time Domain Analysis, Spatial Filtering, Artifact Reduction Techniques, Classification and Regression (12)

EEG FEATURES FOR BCI: EEG Process, Temporal characteristics, Spatial Characteristics, Oscillatory EEG activity, event-related potentials (ERP), slow cortical potentials (SCP), and neuronal potentials. Motor Imagery BCI. (11)

APPLICATIONS OF BCI: BCI that stimulate, bidirectional BCI, Medical applications**:** Sensory Restoration, Motor Restoration, Cognitive Restoration, Restoring Communication with Menus, Cursors, and Spellers, Brain-Controlled Wheelchairs, Non-medical applications: Web Browsing, lie detection, gaming, education and learning, Toolboxes for BCI. (12)

Total L: 45

REFERENCES:

1. Rajesh P N Rao ," Brain-Computer Interfacing: An Introduction. Cambridge: Cambridge University Press" ,2013
2. Jonathan Wolpaw and Elizabeth Winter Wolpaw , "Brain–Computer Interfaces: Principles and Practice", , OUP 2012.
3. Chang S. Nam, Anton Nijholt, Fabien Lotte Brain–Computer Interfaces Handbook: Technological and Theoretical Advances, 2018. CRC Press
4. Dipali Bansal and Rashima Mahajan. EEG-Based Brain-Computer Interfaces - Cognitive Analysis and Control Applications, Elsevier, 2019
5. Dornhege, G," Toward brain-computer interfacing", MIT press, 2007.
6. Siuly, Siuly, Li, Yan, Zhang, Yanchun , EEG Signal Analysis and Classification - Techniques and Applications, 2017, Springer

21ZC25 CLOUD COMPUTING

3 0 0 3

INTRODUCTION TO CLOUD COMPUTING: The Vision of Cloud Computing - Defining a Cloud- A Cloud Computing Reference Model –Cloud Deployment Models: Public, Private, Community, Hybrid Clouds - Cloud Delivery Models: IaaS, PaaS, SaaS Characteristics and Benefits - Challenges Ahead - Historical Developments - Computing Platforms and Technologies. (10)

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 - Cloud container: Docker. (12)

CLOUD ARCHITECTURE AND 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- Resource Management - Scheduling. (12)

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 - Federation in Cloud - Cloud Storage - Edge Computing. (11)

Total L: 45

REFERENCES:

1. Rajkumar Buyya, Christian Vecchiola and Thamarai SelviS, “Mastering Cloud Computing”, Tata McGraw Hill Education Private Limited,New Delhi,2013.
2. Chen, Lei, Le-Khac, Nhien-An, Takabi, Hassan , “Security, privacy and digital forensics in the cloud”, John Wiley & Sons, 2019.
3. Sébastien Goasguen , “Docker in the Cloud -Recipes for AWS, Azure, Google, and More”, O’Reilly Media ,2016.
4. Tim Mather, Subra Kumarasamy and Shahed Latif,“Cloud Security and Privacy: An Enterprise Perspective on Risks and Complainace”,O'Reilly, USA,2011.
5. Raj Samani; Jim Reavis; Brian Honan, “ CSA Guide to Cloud Computing : Implementing Cloud Privacy and Security”, Syngress, 2014.
6. Jim Smith, Ravi Nair, “Virtual Machines: Versatile Platforms for Systems and Processes”, Morgan Kaufmann Publisher, 2005.

21ZC26 COMPUTER VISION

3 0 0 3

IMAGE PROCESSING TECHNIQUES: Introduction to Computer Vision - Challenges - Process of recognition - Images and Imaging processing operations - classical Image Filtering operations - Thresholding techniques - Region Growing methods - Edge detection techniques - Corner and Interest point detection (11)

SHAPES AND REGIONS: Binary shape analysis - Object labeling and counting – Size filtering – distance Functions – Skeletons and thinning – deformable shape analysis - Boundary Pattern analysis – active contours – shape models and shape recognition - centroidal profiles – handling occlusion – boundary length measures – boundary descriptors (11)

HOUGH TRANSFORM AND ITS APPLICATIONS: Hough Transform (HT) for line detection – Line localization – line fitting – RANSAC for straight line detection - HT based Circular Object Detection - Ellipse detection – Case study: Human Iris location – hole detection - Generalized Hough Transform (GHT) – Spatial matched filtering – GHT for ellipse detection – object location - GHT for feature collation (12)

3D VISION AND MOTION TECHNIQUES: 3D Vision - Methods for 3D vision - projection schemes - 3D object recognition - 3D reconstruction - 3D motion - Triangulation - bundle adjustment – translational alignment - Parametric motion – spline-based motion – optical flow – layered motion - Real time pattern recognition applications - Image acquisition- Real time hardware and systems design considerations (11)

Total L: 45

REFERENCES:

1. E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 2012
2. R. Szeliski, Computer Vision: Algorithms and Applications, Springer 2011
3. Sandipan Dey, Python Image Processing cookbook, Packt Publishers, 2020
4. D. L. Baggio et al, Mastering OpenCV with Practical Computer Vision projects, Packt Publishing, 2012
5. 3. D.Forysth et al, Computer Vision - A Modern Approach, Second Edition, Prentice Hall,2012

21ZC27 CRYPTOGRAPHY AND NETWORK SECURITY

3 0 0 3

SECURITY CONCEPTS & SYMMETRIC CIPHER: 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- MD5- HMAC- Digital Signatures - Digital Signature Standard (DSS). Blockchain: The growth of blockchain technology - Types, Consensus, and Mining Task - Platforms. (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", 7 th Edition, Prentice Hall of India, Pearson Education, New Delhi, 2017.
2. AtulKahate, "Cryptography and Network Security", Tata McGraw Hill Ltd., New Delhi, 2013.
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21ZC28 DEEP LEARNING

3 0 0 3

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DEEP LEARNING FOUNDATIONS: AI, Machine learning, Representation learning and Deep learning – ML Algorithms - Challenges and Motivation for Deep learning – Deep feedforward networks - Cost functions - Output units - Hidden units – Architecture design – Regularization for Deep learning – Optimization for training deep models. (12)

CONVOLUTIONAL NEURAL NETWORKS: Convolution operation – Motivation – Pooling – Convolution variants – Down sampling, stride and padding –Local, convolution, tiled and full connections– CNN training – Structured outputs – Data types – Efficient convolution algorithms – Random or unsupervised features – Neuro scientific basis of CNN. (11)

RECURRENT NEURAL NETWORKS: Recurrent networks – Unfolding computational graphs – RNN design patterns - Backpropagation through time - Teacher forcing - Gradient computation - RNN as directed graphical models - Modeling sequences conditioned on context – Bidirectional RNN – Encoder Decoder Sequence-to-Sequence Architectures – Deep recurrent networks – Recursive neural networks - Challenge of long-term dependencies – Strategies for multiple time scales – LSTM and GRU – Optimization for long-term dependencies – Explicit memory. (11)

AUTOENCODERS, GENERATIVE MODELS AND APPLICATIONS: Autoencoders (AE) – AE variants - Undercomplete AE - Regularized AE – Overcomplete AE - Sparse AE – Denoising AE – Learning Manifolds with Autoencoders - Contractive AE – Variational AE - Representation Learning – Greedy pre-training – Transfer learning and domain adaptation – Restricted Boltzmann Machine – Generative Adversarial Networks - Practical methodology - Monte Carlo methods – Gibbs sampling – Deep learning applications. (11)

Total L: 45

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21ZC29 / 21ZS26 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 AND MEMETIC ALGORITHMS: Multi-Objective 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 - Memetic Algorithms: Need - Template - Design Issues - Considerations for Discrete and Combinatorial Optimization problems (11)

Total L: 45

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21ZC30 GPU COMPUTING

3 0 0 3

GPU ARCHITECTURE -Evolution of GPU architectures - Understanding Parallelism with GPU –Typical GPU Architecture - CUDA Hardware Overview - Threads, Blocks, Grids, Warps, Scheduling - Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory. (11)

CUDA PROGRAMMING: Using CUDA - Multi GPU - Multi GPU Solutions - Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions (12)

OPENCL BASICS: OpenCL Standard – Kernels – Host Device Interaction – Execution Environment – Memory Model – Basic OpenCL Examples - Demonstration (11)

APPLICATIONS: Video and Image Processing - Experiences on Image and Video Processing with CUDA and OpenCL, Signal and Audio Processing -Efficient Automatic Speech Recognition on the GPU -Emerging Data-Intensive Applications - Large-Scale Machine Learning (11)

Total L: 45

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21ZC31 INFORMATION RETRIEVAL

3 0 0 3

IR SYSTEM DESIGN: Boolean retrieval –inverted index – Processing Boolean queries – Tokenization – Stop words – Normalization – Stemming – Lemmatization – Search structures for dictionaries – Wild card queries – Spelling correction – Index construction - Index Compression. (11)

SCORING AND EVALUATION: Parametric and zone indexes – Weighted zone scoring – Learning weights – Term frequency and weighting – Inverse document frequency – TF-IDF – Vector space mode for scoring – Efficient scoring and ranking – Components of an IR system – IR system evaluation – Evaluation of unranked retrieval sets - Evaluation of ranked retrieval results - Assessing relevance – Kappa statistic – Relevance feedback – Query expansion. (12)

IR MODELS: Probabilistic information retrieval - The Probability Ranking Principle - The Binary Independence Model - Language Models - Query likelihood language models - Query generation probability (11)

TEXT CLASSIFICATION AND WEB SEARCH: Text classification - Naive Bayes - Bernoulli model - Multinomial model - Text classification evaluation – Web search – Web graph - Components of a web search engine – Web crawling – Crawler architecture – Distributed crawler – URL frontier – Link analysis – PageRank – Topic specific PageRank – Hubs and authorities. (11)

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2. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, “Modern Information Retrieval: The Concepts and Technology behind Search”, Addison Wesley, USA, 2012.
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21ZC32 INTERNET OF THINGS

3 0 0 3

IOT ARCHITECTURE: Introduction To IoT- M2M Architecture- - Design Principles For Connected Devices: Scalability and Security Issues - Definitions And Functional Requirements – IOT Architecture-**Moving Intelligence to the Edge** - the Need for Edge Analytics- Challenges in Centralized IoT – Edge Analytics Architecture- the Capabilities needed at Edge Devices- Running Data Analytics at Edge Device (12)

INDUSTRIAL IOT PROTOCOLS: SCADA – BACNET Protocol – MODBUS-**Open Source Networking Protocols for IoT:** IEEE 802.15.4 – Zigbee Architecture – 6LOWPAN – LoRA-COAP – MQTT (11)

ELECTRONIC PROTOTYPING: Sensors and Actuators- Prototypes and Production- Open Source versus Closed Source - Prototyping Embedded Devices- - Prototyping IoT Projects With Arduino- Prototyping IOT Projects With Raspberry PI (11)

CASE STUDIES AND IOT DATA ANALYTICS : Real world design constraints - Large Scale Use Cases of IoT- Open Research Challenges - Asset management, Food supply chain management, - Smart grid, Connected Health Care, Smart City Applications- Role of AI & Big data analytics in Industry 4.0 (11)

Total L: 45

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1. Dieter Uckelmann, Mark Harrison and Florian Michahelles, “Architecting the Internet of Things “, Springer, 2011
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4. Arshdeep Bagha, Vijay Madisetti, Internet of Things: A Hands- on Approach, Universities Press, 2015
5. L.S.Jayashree, Selvakumar, Getting Started with Enterprise IoT - Design Approaches, Software Architecture Models and Use Cases, Springer, USA, 2020
6. Honbo Zhou, “The Internet of Thingsin the Cloud: A Middleware Perspective”, CRC Press, 2012.

21ZC33 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 - Word Senses: WSD and WordNet - Lexicons for Sentiment and Affect Extraction - 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 - Topic Modelling - Question Answering (11)

Total L: 45

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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.
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6. Li Deng and Yang Liu, "Deep Learning in Natural Language Processing", Springer, Germany. 2018.

21ZC34 / 21ZS27 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 basis function models - Maximum Likelihood Estimation - Least Squares - Bias-Variance Decomposition - Bayesian Linear Regression - Limitations of fixed basis functions - Linear Models for Classification – Linear Discriminant Analysis - Probabilistic Generative Models – Maximum Likelihood solution - Probabilistic Discriminative Models – Logistic regression. (11)

NEURAL NETWORKS AND MIXTURE MODELS: Neural Networks - Feed-forward Networks - Network Training - Delta Rule-Gradient Descent - Error Backpropagation - Regularization in Neural Networks - Mixture Models – Expectation Maximization - Combining models - Committees - Boosting - Tree-based models (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 – Conditional Independence - Markov Random Fields - Inference in Graphical Models. (11)

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1. Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer-Verlag New York, 2013.
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21ZC35 REAL TIME SYSTEMS

3 0 0 3

INTRODUCTION TO REAL-TIME COMPUTING: Structure of a real-time system - Characterization of real-time systems and tasks - Hard and Soft timing constraints - Design Challenges - Performance measures - Programming Languages for Real-Time Systems (10)

REAL TIME OS: Real Time Tasks and Characteristics - Task Assignment and Scheduling- Task allocation algorithms - Single-processor and Multiprocessor task scheduling - Task assignment - Fault tolerant scheduling - Case Study: VxWorks. (12)

REAL-TIME COMMUNICATION & CLOCK SYNCHRONISATION: Network topologies and architecture issues - Protocols - Contention-based, token-based, polled bus - Fault tolerant routing - Clock Synchronisation (11)

FAULT TOLERANCE & RELIABILITY EVALUATION TECHNIQUES - Fault Types - Fault Detection - Fault and Error Containment - Hardware, Software, Time, and Information Redundancy - Byzantine Failures - Reliability Evaluation Techniques - Parameter values - Reliability models for hardware redundancy - Software Error Models (12)

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21ZC36 SOFTWARE DEFINED NETWORKS

3 0 0 3

HISTORY AND EVOLUTION OF SOFTWARE DEFINED NETWORKING (SDN): Separation of Control Plane and Data Plane, IETF Forces, Active Networking**Network Function Virtualization:** Concepts, Applications, Existing Network Virtualization Framework (VMWare and others), Mininet based examples. (11)

CONTROL AND DATA PLANE SEPARATION: Concepts, Advantages and Disadvantages, the OpenFlow protocol. **Control Plane:** Overview, Existing SDN Controllers including Floodlight and OpenDaylight projects**- Data Plane:** Software-based and Hardware-based; Programmable Network Hardware**. Programming SDNs:** Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs. (12)

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

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4. Fei Hu ,"Network Innovation through OpenFlow and SDN: Principles and Design", CRC Press, ISBN-10: 1466572094, 2014.
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6. Jason Edleman, Scott S. Lowe ,"Network Programmability and Automation: Skills for the Next-Generation Network Engineer" , O'Reilly Publishers, 2018

21ZC37 QUANTUM COMPUTING

3 0 0 3

FOUNDATIONS: Quantum bits – Multiple qubits – Quantum computation: single qubit gates, multiple qubits gates – Quantum circuits – Qubit copying circuit – Bell state – Quantum teleportation – State space – State evolution – Quantum measurement – Distinguishing quantum states – Projective measurements - Positive Operator-Valued Measure (POVM) – Phase - Density operator - Ensembles of quantum states - Reduced density operators. (11)

QUANTUM COMPUTATION: Quantum circuits – Quantum algorithms – Single qubit operations – Controlled operations – Measurements – Universal quantum gates – Simulation of quantum systems – Quantum Fourier transform – Phase estimation – Order finding - Factoring – Shor's algorithm for integer factorization – Period finding – Discrete logarithms – Hidden subgroup problem (11)

QUANTUM ALGORITHMS: Quantum algorithms - Classical computations - Quantum parallelism - Deutsch's algorithm – Deutsch-Jozsa algorithm - Grover's algorithm - Quantum search as quantum simulation - Quantum counting - Speeding up NP complete problems - Searching unstructured database - Optimality of search - Black box algorithm limits. (11)

QUANTUM INFORMATION AND ERROR CORRECTION: Quantum noise - Quantum operations - Environments - Operator-sum representation - Axiomatic approach - Trace and partial trace - Geometric interpretation - Bit flip and phase flip channels - Depolarizing channel - Amplitude damping - Phase damping - Distance measures - Information preservation - Quantum error correction - Three qubit bit flip code - Three qubit phase blip code – Shor's code - CSS codes - Stabilizer formalism and examples - Fault-tolerant quantum logic - Fault-tolerant measurement (12)

Total L: 45

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21ZC38 DATA INTENSIVE COMPUTING SYSTEMS

3 0 0 3

BIG DATA AND INFRASTRUCTURE: Big Data Overview – Characteristics – Role of Data Scientist – Big Data in Industry Verticals – Infrastructure- Cloud Computing – Data Centre Architecture – Compute, Network, Storage and Desktop Virtualization – Storage Devices. (11)

DATA ANALYTICS AND MAP REDUCE: Data Analytics Lifecycle – Discovery, Data Preparation, Model Planning, Model Building, Communicating Results, Operationalizing – Hadoop Distributed File System- MapReduce Architecture – Sample Case Studies. (11)

STORAGE PLATFORMS: SPARK - NoSQL Stores – Key-Value Stores – Columnar Stores – Document Stores - Graph Databases – Case Studies –, HBase, MongoDB, Neo4j. (11)

THEORY AND METHODS I: K Means Clustering,Hierarchical Clustering, Naïve Bayesian Classifier, Decision Tree Classifier, Association Rule Mining, Linear Regression, Logistic Regression, SVM, Time Series Analysis, Text Analysis- Rtool FeaturesStream Analysis - Concepts - Stream Data Model and SPARK Architecture – RDD – Transformations (12)

Total: 45

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2. Jared Dean, "Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners", Wiley, USA, 2014.

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21ZC39 OPEN SOURCE SYSTEMS

3 0 0 3

PRINCIPLES OF OPEN SOURCE SOFTWARE : Introduction to Open Source - The Philosophy of OSS - The Cathedral and Bazaar Model - Commercial Software and OSS - Free Software and Freeware - Open Source Licenses - Copyrights and Copyleft – Patents - Economics of FOSS: Zero Marginal Cost - Income – Generation Opportunities - Problems with Traditional Commercial Software -Internationalization. (9)

OPEN SOURCE DATABASE AND PROGRAMMING LANGUAGE: Introduction to open source databases Case study: Mysql - Postgresql - Introduction to open source programming languages: Case Study: Python - Practicing exercises on - Strings and Numeric Data Types - Simple Input and Output. Control Flow and Syntax - Indenting - Operators – Loop constructs - Lists – Tuples - Sets - Dictionaries. (12)

OPEN SOURCE SCRIPTING LANGUAGES: Introduction to Open Source Scripting Language – Case study: PHP, R, Bash - Practicing exercises on - data types – arrays – array functions - Control structures – String manipulation – anonymous function - File Handling and Data Storage - Working with Forms – development of applications using PHP with MySQL. (12)

OPEN SOURCE WEB SERVERS, TOOLS AND TECHNOLOGIES: Web Server - Feature – Architectures - Case Study: Apache Web Server. Open source tools and technologies: Integrated Development Environment for Development and Testing - Types – Case Study: Android, Apache Net Beans, Eric – Software testing tools – case study: selenium, Bugzilla, JMeter - Text Processing Tools – Case study: Open office – Apache open NLP – Google Cloud Natural Language - E-Learning Tools – Case study: Moodle, Course Lab - Content Management Tools – case study: Mind maps, Timelines, Video/ Audio editing - Version Control tools - Parallel and System Programming Tools – Case study: CUDA - Virtualization and Cloud Computing. (12)

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1. Sandeep Koranne , "Handbook of Open Source Tools", Springer Science & Business Media, Heidelberg, 2010.
2. Christopher Negus, Christine Bresnahan , "Linux Bible", Wiley, USA, 2015.
3. Tony Gaddis, “Starting Out with Python”, Pearson, 4th Edition, 2018.
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21ZC40 SOFTWARE ENGINEERING MANAGEMENT

3 0 0 3

INTRODUCTION:
Software Project Life Cycle andManagement: Software process and Process Models – Choice of Process models - Agile methods – Extreme Programming- Scrum - Managing interactive processes. Process - Process Maturity - Capability Maturity Model and its variants - CMMI .**People Management**: Basic organization structures - Decision making - Issues in people management. Effective Team building - Organizational Behavior - Managing people in software environments - Working in teams. Case Study: Introduction to agile tools: JIRA, Kanban. (12)

POJECT EVALUATION AND SOFTWARE ESTIMATION:
Project Evaluation: Strategic Assessment – Technical Assessment – Cost benefit Analysis - Discounted cash flow - Return on investment. **Software Estimation**: Components of Software Estimation - Problems associated with estimation - Estimation Techniques: Decomposition Techniques - LOC Estimation – FP Estimation - Empirical Estimation Models: COCOMO II – Other Specialized Estimation Techniques. Case Study: Software Tools for Estimation. (11)

PROJECT SCHEDULING AND RISK MANAGEMENT:
Project Scheduling: Principles of project scheduling - Critical Path - Tracking methods - Timeline chart - Earned Value Analysis. **Risk Management**: Nature of Risk - Type of Software Risks - Risk identification - Risk exposure - Risk prioritization - Risk Mitigation, Monitoring and Management Plan. Software Project Management Tools: CASE Tools, Planning and Scheduling Tools. (11)

SOFTWARE CONFIGURATION MANAGEMENT AND SOFTWARE MAINTENANCE:
Software Configuration Management: Need for Configuration Management - check in check out process - Versions and Variations – Baselines - Software Configuration Audit **Software Maintenance**: Software Maintenance Process, Activities and Categories – Maintenance Measurement – Service Measurement and Benchmarking. Case study: CVS and Subversion Tools. (11)

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2. Roger S Pressman , "Software Engineering - A Practitioner_s Approach", McGraw Hill International Edition, Singapore, 2015.
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OPEN ELECTIVE THEORY COURSES (One to be opted)

21ZC91 GAME THEORY

3 0 0 3

GAMES: Games – Utility Theory – Preference Relations – Characterization Theorem –Extensive-Form Games – Graphs and Trees – Game Trees – Games with Chance – Games with Imperfect Information - Strategic Form Games - Relation with Extensive Form Games – Solution Concepts – Notation – Domination – Second-Price Auctions – Order of Elimination of Domination – Nash Equilibrium – Maxmin Concept – Elimination of Dominated Strategies – Two-Player Zero-Sum Games – Games with Perfect Information – Games on Unit Square (12)

STRATEGIES: Mixed Extension of Strategic Form Game – Computing Equlibria in Mixed Strategies – Generalizing Nash Theorem – Utility Theory and Mixed Strategies – Maxmin and Minmax in N-Player Game – Imperfect Information – Value of Information – Evolutionary Stable Strategies – Behaviour Strategies – Kuhn’s Theorem – Equilibria in Behaviour Strategies – Kuhn’s Theorem for Infinite Games (11)

EQUILIBRIUM, GAMES WITH INCOMPLETE INFORMATION: Subgame Perfect Equilibrium – Rationality, Backward and Forward Induction – Perfect Equilibrium – Sequential Equilibrium – Correlated Equilibria – Properties – Games with Incomplete Information – Aumann Model and Concept of Knowledge – Aumann Model with Beliefs – Infinite Set of States of the World – Harsanyi Model – Interpretation of Mixed Strategies – Common Prior Assumption – Belief Spaces – Belief and Knowledge – Belief Subspaces – Consistency (11)

REPEATED GAMES: Model – T-Stage Repeated Game – Equilibrium Payoffs – Infinitely Repeated Games – Discounted Game – Uniform Equilibrium – Repeated Games with Vector Payoffs – Notation – Model – Approachable and Excludable Sets – Approachability of a Set – Convex Approachable Sets – Applications (11)

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1. Michael Maschler, Eilon Solan, Shmuel Zamir, "Game Theory", Cambridge University Press, 2013.
2. Anna R. Karlin and Yuval Peres (eds), Game Theory, Alive, AMS, 2017.
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21ZC92 OPTIMIZATION TECHNIQUES

3 0 0 3

INTRODUCTION AND LINEAR PROGRAMMING: Mathematical Optimization–Classification – Linear Programming Model– Graphical method– Simplex Method – Sensitivity Analysis –Applications (11)

DUALITY AND POST-OPTIMALITY ANALYSIS: Primal and Dual – Dual Simplex Method – Revised Simplex Method – Sensitivity Analysis – Transportation Problem and its Solution – Assignment Problem and its Solution–Karmarkar’s Method – Applications (11)

INTEGER LINEAR AND HEURISTIC PROGRAMMING: Branch and Bound – Cutting Plane – Set Covering Problem – Zero-One Implicit Enumeration Algorithm – Greedy Heuristics – Discrete Variable – Continuous Variable – Metaheuristics – Tabu Search – Simulated Annealing – Applications (11)

DETERMINISTIC DYNAMIC AND NONLINEAR PROGRAMMING: Recursive Nature – Forward and Backward Recursion – Applications –Unconstrained Algorithms – Direct Search – Gradient –Constrained Algorithms – Separable – Quadratic (12)

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