School of Computer Science and Engineering
Department of Computer and Communication Engineering

B. Tech Syllabus-Year (2019-2023)

EO2001: ECONOMICS [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macroeconomics; Microeconomics: Consumer behaviour, cardinal and ordinal approaches of utility, law of diminishing marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; Production: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; Cost and revenue analysis: Cost concepts, short run and long- run cost curves, TR, AR, MR; Various market situations: Characteristics and types, Break-even analysis; Macro Economics: National Income, Monetary and Fiscal Policies, Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H. L Ahuja, Macroeconomics Theory and Policy, (20e), S. Chand Publication.
2. H. C. Peterson, Managerial Economics, (9e), 2012.
3. P. L. Mehta, Managerial Economics, Sultan Chand & Sons.
4. G. J. Tuesen, H.G. Tuesen, Engineering Economics, Prentice Hall of India.
5. J. L. Riggs, D.D. Bedworth, S. U. Randhawa, Engineering Economics, McGraw Hill.

MA2101: ENGINEERING MATHEMATICS III [2 1 0 3]

Boolean Algebra: Partial ordering relations, Poset, Lattices, Basic Properties of Lattices. Distributive and complemented lattices, Boolean lattices and Boolean Algebra. Propositional and Predicate Calculus: Wellformed formula, connectives, quantifications, Inference theory of propositional and predicate calculus. Elementary configuration: Permutations and Combinations, Generating function, Principle of inclusion and exclusion Partitions, compositions. Ordering of permutations: Lexicographical and Fikes. Graph theory: Basic definitions, Degree, regular graphs, Eulerian and Hamiltonian graphs, Trees and Properties, Center, radius and diameter of a graph, Rooted and binary trees, Matrices associated with graphs, Algorithms for finding shortest path, Algorithm. Group theory: Semi groups, Monoids, Groups subgroups, Normal Subgroups, Cosets, Lagrange's Theorem, Cyclic groups.

References:

1. C. L. Liu, Elements of Discrete Mathematics, (2e), McGraw Hill, New Delhi, 2007.
2. J. P. Trembaly, R. Manohar, Discrete Mathematics Structures with application to computer science, McGraw Hill, 2012.
3. E. S. Page, L. B. Wilson, An Introduction to Computational Combinatorics, Cambridge Univ. Press, 1979.
4. N. Deo, Graph theory with Applications to computer science, Prentice Hall of India, 2012.

CC2101: DIGITAL DESIGN AND COMPUTER ARCHITECTURE [3 1 0 4]

Digital logic circuits: logic gates, Boolean algebra, map simplification, combinational circuits, flip-flops, sequential circuits; Digital components: Integrated circuits, decoders, multiplexers, registers, shift registers, binary counters; Memory unit: Von-Neumann model for computer/ VonNeumann architecture, performance; Machine instructions and programs: numbers, arithmetic operations and characters, memory locations and addresses, instructions and instruction sequencing, addressing modes, assembly language, additional instructions, encoding of machine instructions; Arithmetic: addition and subtraction of signed numbers, design of fast adders, multiplication of positive numbers, signed operand multiplication, fast multiplication, integer division, floating point numbers and operations; Introduction to CPU design: instruction interpretation and execution, micro-operation and their RTL specification, memory hierarchy, main memory, types and interfacing; Cache Memory: organization and operations, levels of caches; memory management module: paging and segmentation, virtual memory, disk memory, raids, back-up memory; RISC and CISC processors; Introduction to input/output processing: programmed controlled i/o transfer, interrupt controlled I/O transfer, DMA controller; Pipelining and pipeline hazards: design issues of pipeline architecture; Instruction level parallelism and advanced issues: introduction to interconnection network and practical issues.

References:

1. M. M. Mano, Computer System Architecture, (3e), Pearson Education, 2014.
2. C. Hamacher, Z. Vranesic, S. Zaky, Computer Organization, (6e), McGraw Hill, 2011.
3. J. P. Hayes, Computer Architecture and Organization, (3e), McGraw Hill, 2017.
4. T. L. Floyd, Digital Fundamentals, (10e), Pearson Education, 2014.
5. W. Stallings, Computer Organization and Architecture–Designing for Performance, (8e), Pearson Education, 2010.

CC2102: DATA COMMUNICATIONS [3 1 0 4]

Introduction: General block diagram of communication system, Data communications, Protocol, Need for Protocol Architecture, OSI Model, TCP/IP Protocol Architecture; Data Transmission: Concepts and Terminology, Analog and Digital Data Transmission, Transmission Impairments, Channel Capacity; Transmission Media: Guided Transmission Media, Wireless Transmission, Wireless Propagation, Line-of-Sight Transmission; Signal Encoding Techniques: Analog and Digital Signals, Digital-To-Digital Conversion: Line Coding Schemes, Block Coding, Scrambling, Analog-To-Digital Conversion: Pulse Code Modulation, Delta Modulation; Digital Data Communication Techniques: Asynchronous and Synchronous Transmission, Types of Errors, Error Detection, Error Correction, Line Configurations; Data Link Control Protocols: Flow Control, Error Control, High-Level Data Link Control (HDLC); Multiplexing: FrequencyDivision Multiplexing (FDM), Time-Division Multiplexing (TDM); Spread Spectrum: The Concept of Spread Spectrum, Frequency Hopping Spread Spectrum (FHSS), Direct Sequence Spread Spectrum (DSSS); Multiple Access- Aloha, Carrier Sense Multiple Access (CSMA), Carrier Sense Multiple Access with Collision Detection (CSMA/CD), Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA), Code-Division Multiple Access (CDMA); Introduction to IEEE 802.X LAN Standards.

References:

1. W. Stallings, Data and Computer Communications, (10e), Pearson Education, 2014.
2. B. A. Forouzan, Data Communications & Networking, (5e), McGraw Hill, 2013.
3. D. P. Bertsekas, R. G. Gallager, Data Networks, (2e), Prentice Hall of India, 2011.
4. A.S. Tenenbaum, Computer Networks, (5e), Prentice Hall of India, 2008.
5. L. L. Peterson, B. S. Davie, Computer Networks: A Systems Approach, (5e), Morgan Kaufmann Publishers, 2011.

CC2103: DATA STRUCTURES AND ALGORITHMS [3 1 0 4]

Introduction: algorithm specification; Performance analysis: time and space complexity, asymptotic notation; C revision: pointer declaration and definition, memory allocation functions, array of pointers, structures in C, arrays of structures, structures and functions; Recursion in C; Linked list: implementation, various types and operations; Stack: implementations using array and linked list, operations and its applications; Queue: implementations using array and linked list, operations and its applications; Tree: terminologies, different types, implementations of binary tree using array and linked structure, binary search tree, different operations (recursive, nonrecursive), red-black tree, AVL trees, B-tree, 2-3 tree, tree applications; Graph: representations, BFS, DFS; Searching techniques and hashing; Sorting.

References:

1. E. Horowitz, S. Sahni, S. Anderson-Freed, Fundamentals of Data Structures in C, (2e), Orient Black Swan, 2008.
2. A. M. Tenenbaum, Y. Langsam, M. J. Augenstein, Data Structures using C, (1e), Pearson Education, 2008.
3. A.V. Aho, J. E. Hopcroft, J. D. Ullman, Data Structures and Algorithms, (1e), Pearson Education, 2002.
4. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, Introduction to algorithms, (3e), Prentice Hall of India, 2010.
5. S. Lipschutz, Data Structures with C (Schaum's Outline Series), (3e), McGraw Hill, 2011.
6. M. A. Weiss, Data structures and Algorithm Analysis in C, (1e), Pearson Education, 2002.

CC2104: OBJECT ORIENTED PROGRAMMING [3 1 0 4]

Introduction: history and evolution of OOP, Introduction to OOPS and classes: class and object fundamentals, introduction to methods/functions, object initialization and clean-up (constructors and destructors), this keyword, overloading, objects as parameters, argument passing, returning objects, recursion, access control, classes within classes, string class; I/O basics: reading console input, writing console output, files; Inheritance: basics, multilevel hierarchy, overriding, abstract classes; Packages and Interfaces; exception handling; Multithreaded programming; String handling; Event handling; GUI and Introduction to AWT: classes, component, container, panel, window, frame, canvas, working with frame, working with graphics, Applet fundamentals; The collection framework: array list and vector, sets, map; Database programming using JDBC; Java Server Technologies: servlet; introduction to JDK, JRF and JVM, variables and data types, Unicode system, naming conventions; References:

1. H. Schildt, Java:The Complete Reference Java, (10e), McGraw Hill, 2017.
2. C. Horstmann, Core Java Volume-1 Fundamentals, (10e), Prentice Hall of India, 2016.
3. S. Holzner, Java 8 programming black book, (1e), Dream Tech, 2015.
4. P. Deitel, H. Deitel, Java How to Program, (11e), Pearson Education, 2018.
5. E. Balagurusamy, Programming with Java A Primer, (5e), McGraw Hill, 2017.

CC2130: DATA COMMUNICATIONS LAB [0 0 2 1]

Signal Modulation Techniques: ASK, PSK, FSK, Pulse Code Modulation (PCM), Delta Modulation; CDMA; Various Line Coding Techniques; Packet Tracer: Introduction, PC to PC Communication using Crossover Cable, Star Topology Using Hub and Switch as Network Devices; Study using Wireless Open Access Research Platform (WARP).

References:

1. W. Stallings, Data and Computer Communications, (10e), Pearson Education, 2014.
2. B. A. Forouzan, Data Communications & Networking, (5e), McGraw Hill, 2013.
3. D. P. Bertsekas, R. G. Gallager, Data Networks, (2e), Prentice Hall of India, 2011.
4. A. S. Tenenbaum, Computer Networks, (5e), Prentice Hall of India, 2008.
5. L. L. Peterson, B. S. Davie, Computer Networks: A Systems Approach, (5e), Morgan Kaufmann Publishers, 2011.
6.
7.

CC2131: DATA STRUCTURES AND ALGORITHMS LAB [0 0 2 1]

Array: application using arrays (1-D, 2-D), string operations; Linked list: applications (singly, doubly, circular, etc) like polynomial addition and multiplications, etc, Stack and queue: applications of stacks (like arithmetic expression conversion and evaluation, etc), applications of queue; Binary tree: creation, deletion and traversal techniques, Binary search tree operations, AVL tree; sorting and searching techniques.

References:

1. E. Horowitz, S. Sahni, S. Anderson-Freed, Fundamentals of Data Structures in C, (2e), Orient Black Swan, 2008.
2. A. M. Tenenbaum, Y. Langsam, M. J. Augenstein, Data Structures using C, (1e), Pearson Education, 2008.
3. A.V. Aho, J. E. Hopcroft, J. D. Ullman, Data Structures and Algorithms, (1e), Pearson Education, 2002.
4. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, Introduction to algorithms, (3e), Prentice Hall of India, 2010.
5. S. Lipschutz, Data Structures with C (Schaum's Outline Series), (3e), McGraw Hill, 2011.
6. M. A. Weiss, Data structures and Algorithm Analysis in C, (1e), Pearson Education, 2002.

CC2132: OBJECT ORIENTED PROGRAMMING LAB [0 0 2 1]

Introduction to Java basics; Control statements and arrays; Stacks and lists; Strings; Classes and methods; Inheritance; Packages; Interfaces; Exception handling; Threads; Input/output; Event handling; Applets; Programs involving AWT; Swing; JDBC; Servlet.

References:

1. H. Schildt, Java:The Complete Reference Java, (10e), McGraw Hill, 2017.
2. C. Horstmann, Core Java Volume-1 Fundamentals, (10e), Prentice Hall of India, 2016.
3. S. Holzner, Java 8 programming black book, (1e), Dream Tech, 2015.
4. P. Deitel, H. Deitel, Java How to Program, (11e), Pearson Education, 2018.
5. E. Balagurusamy, Programming with Java A Primer, (5e), McGraw Hill, 2017.

BB0025: VALUE, ETHICS & GOVERNANCE [2 0 0 2]

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of Personality, Attitude, Behavior, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case Studies*. Governance: Understanding of Public and Private sector Governance systems; Courts & CAG. Public Sector Governance: Need, relevance, stakeholders. Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. Projects on PPP mode-relevance & prospects.CSR: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line. Suggestive Case Studies: Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

1. Professional Module of ICSI.
2. B. N. Ghosh, Business Ethics & Corporate Governance, (1e), McGraw Hill, 2011.
3. S. K. Mandal, Ethics in Business & Corporate Governance, (2e), McGraw Hill, 2012.
4. C. K. Ray, Corporate Governance, Value & Ethics, Vaya Education of India, 2012.
5. A. Chatterjee, Professional Ethics, (2e), Oxford Publications.

MA2201: ENGINEERING MATHEMATICS IV [2 1 0 3]

Basic Set theory, Axioms of probability, Sample space, conditional probability, total probability theorem, Baye's theorem. One-dimensional and two-dimensional random variables, mean and variance, properties, Chebyschev's inequality, correlation coefficient, Distributions, Binomial, Poisson, Normal and Chisquare. Functions of random variables: One dimensional and Two dimensional, F & T distributions, Moment generating functions, Sampling theory, Central limit theorem, Point estimation, MLE, Interval estimation, Test of Hypothesis: significance level, certain best tests; Chi square test.

References:

1. P. L. Meyer, Introduction to probability and Statistical Applications, (2e), Oxford and IBH publishing, 1980.
2. Miller, Freund and Johnson, Probability and Statistics for Engineers, (8e), Prentice Hall of India, 2011.
3. Hogg and Craig, Introduction to mathematical statistics, (6e), Pearson Education, 2012.
4. Sheldon M Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier, 2010

CC2201: COMPUTER NETWORKS [3 1 0 4]

Network Layer: network layer design issues, routing algorithms, congestion control algorithms, Quality of Service (QoS), MPLS; Classful addressing, subnetting, classless addressing, variable length blocks, block allocation, NAT; IPV4: header format, fragmentation, options, checksum; ARP & DHCP: introduction, packet format, message types; ICMP: message format, message types; Dynamic routing protocols: RIP, OSPF & BGP, Multicasting Protocol: IGMP; Introduction to IPV6; Transport Layer: elements of transport protocols: addressing, connection establishment, connection release, congestion control, transport services, transport layer protocols, state diagrams; UDP: UDP datagram, UDP services, checksum; TCP: TCP services, TCP features, segment, TCP connection establishment, data transfer, connection termination, TCP window management, flow control, congestion control, timer management; Application Layer: DNS: Name space, domain resource records, Electronic Mail - SMTP, POP, IMAP, MIME, HTTP, HTTPS, SNMP.

References:

1. B. A. Forouzan, TCP/IP Protocol Suite, (4e), McGraw Hill, 2010.
2. A. S. Tenenbaum, Computer Networks, (5e), Prentice Hall of India, 2008.
3. D. E. Comer, Internetworking with TCP/IP Principles, Protocols and Architecture, (6e), Pearson Education, 2014.
4. W. Stallings, Data and Computer Communications, (10e), Pearson Education, 2014.

CC2202: RELATIONAL DATABASE MANAGEMENT SYSTEMS [3 1 0 4]

Introduction: database systems, RDBMS definition, data models, 3-schema architecture, challenges in building RDBMS, different components of a RDBMS. Relational data model: concept of relation and its characteristics, schema-instance, integrity constraints, E/R Model, Extended E/R model, converting the database specification in E/R and Extended E/R notation to the relational schema; Relational Query Language: relational algebra operators - selection, projection, cross product, various types of joins, division, example queries, tuple relation calculus, domain relational calculus; Introduction to SQL: data definition in SQL, table and different types of constraints definitions, data manipulation in SQL, nested queries, notion of aggregation; Relational Database Design: functional dependencies and normal forms, Armstrong's axioms for FD's, closure of a set of FD's, minimal covers, definitions of 1NF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, algorithms for 3NF and BCNF normalization, multi-valued dependencies and 4NF; Transaction Processing: concepts of transaction processing, ACID properties, concurrency control, locking based protocols, recovery and logging methods; Data Storage and Indexing: file organizations, primary, secondary index structures, hash-based indexing, dynamic hashing techniques, multi-level indexes, B-tree and B+ trees.

References:

1. A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, (6e), McGraw Hill, 2013.
2. R. Elmasri, S. B. Navathe, Fundamentals of Database Systems, (6e), Addison-Wesley, 2010.
3. R. Ramakrishnan, J. Gehrke, Database Management Systems, (3e), McGraw Hill, 2014.
4. I. Bayross, SQL, PL/SQL The Programming Language of Oracle, (4e), BPB Publications, 2010.
5. C. J. Date, An Introduction to Database Systems, (8e), Prentice Hall of India, 2006.

CC2203: OPERATING SYSTEMS [3 1 0 4]

Introduction: evolution of operating system, classification of operating system, operating system structure, services, functions, design and implementation, system programs, system calls, virtual machines, system boot; processes: concept, process scheduling, operations on processes, interprocess communication; Linux threads: basic concepts, multithreaded models, thread libraries; CPU scheduling: scheduling criteria, scheduling algorithms, thread scheduling; Process synchronization: concept of synchronization, critical section problem, Dekker's algorithm, peterson's solution, synchronization hardware, semaphores, classical problems on synchronization, monitors; Deadlock: deadlock concept, deadlock characterization, methods for handling deadlock, prevention, avoidance, detection, recovery from deadlock; Memory management: concept of logical and physical memory, swapping, contiguous memory allocation, paging, page table structure, segmentation, paging combined with segmentation, working of intel32/64; Virtual memory management: demand paging, copy-on write, page replacement, allocation of frames, thrashing, memory mapped files, allocating kernel memory; Files: file concept, access methods, directory structure, file system mounting, file sharing; Disk: architecture, scheduling algorithms; Security problem: program threats, system and network threats; Case study: Linux / Solaris / Mac / Windows operating system.

References:

1. A. S. Tannenbaum, Modern Operating Systems, (4e), Pearson, 2014.
2. A. Silberschatz, P. B. Galvin, Operating System Concepts, (8e), International student version, Wiley, 2009.
3. W. Stallings, Operating Systems: Internals and Design Principles, (9e), Pearson, 2009.
4. H. Sibsankar, A. A. Alex, Operating Systems, (6e), Pearson, 2009.
5. W. Stallings, Operating Systems Design and Implementation, (3e), Prentice Hall Software Series, 2008.
6. J. A. Harris, Schaum's Outline of Operating Systems, (2e), McGraw-Hill publications, 2002.

CC2230: COMPUTER NETWORKS LAB [0 0 2 1]

Experiment with Packet Tracer: Introduction to Packet tracer and networking device components; Router Mode, Switch/Router basic commands; designing of star topology using HUB and Switch, IP configuration of end devices; configuring DHCP server, static routing, RIP, OSPF, VLAN and NAT; Network programming: Transmission Control Protocol (TCP) socket and User Datagram Protocol (UDP) socket; Network Utilities: PING, NETSTAT, IPCONFIG, IFCONFIG, ARP, TRACE-ROUTE

References:

1. B. A. Forouzan, TCP/IP Protocol Suite, (4e), McGraw Hill, 2010.
2. A. S. Tenenbaum, Computer Networks, (5e), Prentice Hall of India, 2008.
3. D. E. Comer, Internetworking with TCP/IP Principles, Protocols and Architecture, (6e), Pearson Education, 2014.
4. W. Stallings, Data and Computer Communications, (10e), Pearson Education, 2014.

CC2231: RELATIONAL DATABASE MANAGEMENT SYSTEMS LAB [0 0 2 1]

Introduction to SQL and its different command categories i.e. DDL, DML, DQL and DCL; Data integrity constraints and built-in functions; Design and implementing the data requirements of a simple DB application; Experiments on views, indexing, triggers, stored procedures, transaction. Platforms: Oracle and/or MySQL.

References:

1. A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, (6e), McGraw Hill, 2013.
2. R. Elmasri, S. B. Navathe, Fundamentals of Database Systems, (6e), Addison-Wesley, 2010.
3. R. Ramakrishnan, J. Gehrke, Database Management Systems, (3e), McGraw Hill, 2014.
4. I. Bayross, SQL, PL/SQL The Programming Language of Oracle, (4e), BPB Publications, 2010.
5. C. J. Date, An Introduction to Database Systems, (8e), Prentice Hall of India, 2006.

CC2232: OPERATING SYSTEMS LAB [0 0 2 1]

Testing the use of UNIX commands; Working with VI editor; Shell: UNIX shell commands, System Administration: user management, security, file management; Inter-process communication: shared memory, message passing, pipes; UNIX system calls: system calls for process management, file management; Process synchronization: bounded buffer problem, Peterson's solution, semaphore; Building multi-threaded and multi-process applications: multithreading using pthread library; CPU scheduling algorithms; Deadlock: detection algorithms, deadlock avoidance algorithms; Page replacement algorithms; Memory allocation algorithms; Disk scheduling algorithms.

References:

1. S. Das, Unix Concepts and Applications, (4e), McGraw-Hill Publications, 2017.
1. 2. R. Blum, C. Bresnahan, Linux Command Line and Shell Scripting Bible, (3e), Wiley India, 2015.
2. A. Silberschatz, P. B. Galvin, Operating System Concepts, (8e), International student version, John Wiley & Sons, 2009.

CC3101: SOFTWARE ENGINEERING [3 1 0 4]

Introduction- The 4 P's in Software Engineering with their Characteristics; Software Crisis; Emergence of Software Engineering; Software Applications; **Software development process models:** Waterfall model, Prototyping model, Incremental model, Evolutionary model, Spiral model, RAD model; Agile modeling; **Requirement engineering:** Problem analysis, requirement verification and validation, Partitioning; Prototyping; Analysis modeling, functional modeling, behavioral modeling; **Software project management:** Project Planning; scheduling and tracking, risk management, Estimation techniques**:** function count, COCOMO; **Software design:** Design Principles; Data design-data structures; functional Independence: Cohesion and coupling; Software Architecture. **Software testing:** White box; black box; Levels of testing (Unit testing, Integration testing, Interface testing, System testing, Alpha and beta testing, Regression testing); Debugging **Software Quality Assurance:** SQA Activities; Formal Technical Reviews (FTRs); The ISO 9001 Standard; Current trends in software engineering.

References:

1. R. S. Pressman, Software Engineering: A Practitioners Approach, (8e), McGraw Hill, 2016.
2. I. Sommerville, Software Engineering, (10e), Pearson Education, 2016.
3. R. Mall, Fundamental of Software Engineering, (5e), Prentice Hall of India, 2018.
4. P. Jalote, Software Engineering a Precise Approach, (1e), Wiley, 2010.

CC3102: DESIGN AND ANALYSIS OF ALGORITHMS [3 1 0 4]

Algorithm analysis: a priori and a posteriori analysis, time space tradeoff, asymptotic notations, properties of asymptotic notations, recurrence equations, solving recurrence equations using substitution method and master's method; Divide and conquer: binary search, finding maximum and minimum, merge sort, quick sort, matrix multiplication; Greedy algorithms: knapsack problem, job sequencing with deadline, optimal merge pattern, single source shortest path, minimum cost spanning tree; Dynamic programming: multistage graphs, matrix chain multiplication, all-pair shortest paths, optimal binary search trees, 0/1 knapsack, travelling salesperson problem, graph traversals, connected components, spanning trees, bi-connected components; String matching algorithms; Complexity classes: introduction to NP-hard and NP completeness; Approximation algorithm; Randomized algorithm.

References:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, Introduction to algorithms, (3e), Prentice Hall of India, 2010.
2. E. Horowitz, S. Sahni, S. Rajasekaran, Computer Algorithms, (2e), University Press, 2017.
3. A. V. Aho, J. E. Hopcroft, J. D. Ullman, The Design and Analysis of Computer Algorithms, (1e), Pearson Education, 1999.
4. S. S. Skiena, The Algorithm Design Manual, (2e), Springer, 2010.

CC3103: FOUNDATIONS OF DATA SCIENCE [3 1 0 4]

Introduction to Data Science Tools and Platforms, Importance of linear algebra, statistics and optimization from a data science perspective, Data Visualization; Linear Algebra: Matrices and their properties (determinants, traces, rank, nullity, etc.), Eigenvalues and eigenvectors, Matrix factorizations, Inner products, Distance measures, Projections, Notion of hyper planes, half-planes; Probability, Statistics and Random Processes: Probability theory and axioms, Random variables, Probability distributions and density functions (uni-variate and multivariate), Expectations and moments, Covariance and correlation, Statistics and sampling distributions, Hypothesis testing of means, proportions, variances and correlations, Confidence (statistical) intervals, Correlation functions, Exploratory Analysis (EDA); Optimization: Unconstrained optimization, Necessary and sufficiency conditions for optima, Gradient descent methods, Constrained optimization, Case Studies in Data Science Applications, Introduction to least squares optimization, Optimization view of machine learning; Introduction to Data Science Methods: Linear regression as an exemplar function approximation problem, Linear classification problems.

References:

1. G. Strang, Introduction to linear algebra, Wellesley, (5e), MA: Wellesley-Cambridge Press, 2016.
2. J. S. Bendat, A. G. Piersol, Random data: analysis and measurement procedures, (4e), John Wiley & Sons. 2010.
3. D. C. Montgomery, G. C. Runger, Applied statistics and probability for engineers, (5e), John Wiley & Sons, 2011.
4. C. O'Neil, R. Schutt, Doing data science: Straight talk from the frontline, O'Reilly Media, Inc., 2016.

CC3104: CRYPTOGRAPHY AND SECURITY [3 1 0 4]

Introduction: confidentiality, integrity, availability, OSI security architecture; Number theory: finite fields, Galois field, primes, primality testing, factoring algorithms; Probability and information theory: Shannon's theory, perfect security; Classical ciphers; Block ciphers: DES, AES, electronic codebook mode, cipher block chaining mode, cipher feedback mode, output feedback mode, counter mode; Pseudorandom number generation; Stream ciphers; Cryptographic hash functions; Message authentication codes; Public-key cryptography: computational security, computational assumptions, RSA, ElGamal, elliptic curve cryptography, digital signatures, DiffieHellman key exchange; Operating systems security: security capabilities of different platforms, identification, authentication, user accounts, file permissions, backups, access control, firewalls, methods of protection, ownership, assessing and securing a system, information warfare, security administration, corporate espionage.

References:

1. W. Stallings, Cryptography and Network Security-Principles and Practice, (7e), Pearson Education, 2017.
2. B. A. Forouzan, D. Mukhopadhyay, Cryptography And Network Security, (3e), McGraw Hill, 2015.
3. D. Stinson, Cryptography: Theory and Practice, (4e), CRC Press, 2018.
4. J. Pieprzyk, T. Hardjono, J. Seberry, Fundamentals of Computer Security, (1e), SpringerVerlag Berlin Heidelberg, 2013.
5. C. P. Pfleeger, S. L. Pfleeger, J. Margulies, Security in Computing, (5e), Pearson Education, 2018.

CC3130: SOFTWARE ENGINEERING LAB [0 0 2 1]

Development of software requirements specification (SRS); Empirical Estimation of Project Metrics-COCOMO; Use of appropriate CASE tools for project estimation and analysis; Data Modeling: ERD, DFD, Class diagram using UML; Functional modeling: Use Case diagrams, Activity diagram; Collaboration Diagram; Behavioral Modeling: State transition diagram, Sequence diagram; Computing test coverage and complexity; Designing test cases for structural testing and basis path testing; Mini project.

References:

1. R. S. Pressman, Software Engineering: A Practitioners Approach, (7e), McGraw Hill, 2016.
2. I. Sommerville, Software Engineering, (10e), Pearson, 2016.
3. R. Mall, Fundamental of Software Engineering, (5e), PHI, 2018.
4. P. Jalote, Software Engineering a Precise Approach, (1e), Wiley India, 2010.
5. L. Bass, DevOps: A Software Architect's Perspective, Pearson Education, 2016.

CC3131: DESIGN AND ANALYSIS OF ALGORITHMS LAB [0 0 2 1]

Implement a doubly linked list & BST, GCD Techniques, Bubble sort, Selection sort, Linear search, String Matching, sorting algorithms, DFS, BFS, Topological sorting, AVL tree, 2-3 tree, Horspool algorithm, Open hash table, Floyd's algorithm, Warshall's algorithm, Greedy Techniques, Dijkstra's algorithm, Backtracking.

References:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, Introduction to algorithms, (3e), Prentice Hall of India, 2010.
2. E. Horowitz, S. Sahni, S. Rajasekaran, Computer Algorithms, (2e), University Press, 2017.
3. A. V. Aho, J. E. Hopcroft, J. D. Ullman, The Design and Analysis of Computer Algorithms, (1e), Pearson Education, 1999.
4. S. S. Skiena, The Algorithm Design Manual, (2e), Springer, 2010.

CC3140: WEB PROGRAMMING [3 0 0 3]

Introduction: overview of internet and "the web", web system architecture; HTTP: basics of HTTP request and response, HTTP methods, headers, content transport (push and pull), drawbacks HTTP1.0, introduction to HTTP1.1, HTTPS, SSL; Client side programming: introduction to HTML, using XHTML – basic syntax and semantics, fundamental elements, URLs – inter-page and intra-page linking, lists, tables, frames and forms, html document object model (DOM), deficiencies of HTML, introduction to HTML5, styling with CSS4, CSS5; JavaScript: fundamental, document object model, event handling, pattern matching and form validation with regular expressions, internal & external JavaScript, working with class, objects, constructors and inheritance, JSON; Server side programming: three tier model, PHP –basics, form validation, sessions and session tracking techniques, ASP; XML: syntax and semantics, document structure, DTDs; Angular JS: overview, MVC architecture, directives, controllers, modules; Node JS: modules, NPM modules, create, edit and publish NPM modules.

References:

1. D. Herron, Node.js Web Development: Server-side development with Node 10 made easy, (4e), Packet Publishing, 2018.
2. S. Seshadri, Angular: Up and Running- Learning Angular, Step by Step, (1e), Shroff/O'Reilly, 2018.
3. DT. E. Services, HTML 5 Black Book, (2e), Dreamtech Press, 2016.
4. J. Sklar, Web Design Principles, (5e), Cengage, 2015.
5. P. J. Deitel, H. M. Deitel, Internet and World Wide Web How to program, (5e), Pearson, 2011.
6. B. M. Harwani, Developing Web Applications in PHP and AJAX, (1e), McGraw Hill, 2010.
7. R. Moseley, M. T. Savaliya, Developing Web Applications, (1e), John Wiley & Sons, 2007.
8. J. C. Jackson, Web Technologies: A Computer Science Perspective, Pearson Education, 2007.

CC3141: SOFT COMPUTING [3 0 0 3]

Introduction: Soft computing and its applications; Neural networks: Architectures, Transfer Functions; Learning models: supervised, unsupervised, reinforcement learning; Types of neural network: perceptron, backpropagation, multi-layer perceptron, radial basis function, recurrent neural network, self-organizing maps, Boltzmann machine; Fuzzy logic and fuzzy systems: introduction and applications, fuzzy versus crisp set, basic operations on fuzzy sets, relations, fuzzy rule based models, fuzzy classification, fuzzy arithmetic, fuzzy numbers, linguistic variables, arithmetic operations on intervals and numbers, lattice of fuzzy numbers, fuzzy equations, properties of membership functions, fuzzification and defuzzification, automated methods for fuzzy systems; Genetic algorithms: overview, applications, operators, fitness function, classifier systems, convergence; Hybrid soft computing approaches.

References:

1. S.N. Sivanandam, S.N. Deepa, Principles of Soft Computing, (3e), Wiley, 2018.
2. T. J. Ross, Fuzzy Logic with Engineering Applications, (2e), Wiley, 2016.
3. S. J. Russel, P. Norvig, Artificial Intelligence, (3e), Pearson, 2015.
4. J. –S Jang, R, C. – T Sun, E. Mizutani, Neuro-fuzzy and Soft Computing, Pearson, 2015.
5. G. J. Klir, B. Yuan, Fuzzy Sets & Fuzzy Logic - Theory and Applications, (2e), Prentice Hall, 2015.
6. M. T. Hagen, H. B. Demuth, M. H. Beale, O. D. Jesus, Neural Network Design, (2e), Cengage, 2014.
7. S. Roy, U. Chakraborty, Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms, Pearson, 2013.

CC3142: DIGITAL COMMUNICATION AND SIGNAL PROCESSING [3 0 0 3]

Introduction to signal and systems: signal presentation, signal classification, signal analysis, Fourier series, Fourier transform, Z-transform, classification of systems, system properties - memory, linearity, causality, invertibility, time invariance and stability, Linear-Time-Invariant (LTI) systems. Pulse modulation systems: PAM, PCM, delta modulation, baseband digital data transmission, Inter Symbol Interference (ISI), Nyquist condition, optimum detection, noise probability of error expression. Digital modulation techniques: ASK, PSK, DPSK, FSK, QAM, QPSK, OQPSK, MSK, GMSK and OFDM. Information theory and coding: Information rate and Shannon-Fano coding, Huffman coding, Shannon's theorem and channel capacity.

References:

1. B. P. Lathi and Z. Ding, Modern Digital and Analog Communication, (5e), Oxford University Press, 2018.
2. S. Haykin, Digital Communications, (2e), John Wiley and Sons, 2013.
3. H. Taub, D. L. Schilling and G. Saha, Principles of Communication Systems, (2e), McGraw Hill, 2017.
4. H. P. Hsu, Analog and Digital Communications, (3e), Schaum's outline series, 2017.
5. J. G. Proakis, Digital Communications, (5e), McGraw Hill, 2014.

BB0026: ORGANIZATION AND MANAGEMENT [3 0 0 3]

Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. Management: Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures, Purchasing and Marketing Management, Functions of Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising. Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower. Motivation – Introduction, Human needs, Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's Theory, Herzberg's Hygiene Maintenance Theory. Leadership - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories. Entrepreneurship-Introduction, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit. Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

Reference:

1. Koontz, Harold, C. O'Donnell, H. Weihrich, Essentials of Management, (1e), McGraw Hill, 1978.
2. Robbins, P. Stephen, M. Coulter, Management, (2e), Prentice Hall of India, 1997.
3. E. S. Buffa, R. K. Sarin, Modern Production / Operations Management, (8e), Wiley, 1987.
4. H. J. Arnold, D. C. Feldman, Organizational Behavior, McGraw Hill, 1986.
5. K. Aswathappa , Human Resource and Personnel Management, McGraw Hill, 2005.
6. W. William, D. Keith , Human Resource and Personnel Management, McGraw Hill, 1986.

CC3201: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING [3 1 0 4]

Artificial intelligence concepts: state space representation and search; Heuristic search techniques: hill climbing, best first search, A*, AO*, constraint satisfaction; Knowledge representation and reasoning; Formal logic and unification algorithms; Planning algorithms, goal stack planning, nonlinear planning using constraint posting, hierarchical planning; Case based reasoning; Optimization algorithms, genetic algorithm, ant colony optimization, particle swarm optimization, simulated annealing; Supervised machine learning algorithms: classification algorithms – KNN, decision tree, naïve bayes, support vector machine, regression, random forests; Un-supervised machine learning algorithms: principal component analysis, k-means; Machine learning performance evaluation metrics: classification accuracy, logarithmic loss, confusion matrix, area under curve, F1 score, mean absolute error, mean squared error.

References:

1. S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, (3e), Pearson Education, 2015.
2. T. M. Mitchell, Machine Learning, (1e), McGraw Hill, 1997.
3. D. Simon, Evolutionary optimization algorithms, (1e), Wiley, 2013.
4. D. Khemani, A First Course in Artificial Intelligence, (1e), McGraw Hill, 2015.
5. O. Richard, E. D. Peter, D. Hart, G. Stork, Pattern Classification, (2e), John Wiley, 2002.
6. C. Bishop, Pattern Recognition and Machine Learning, (1e), Springer, 2006.

CC3202: WIRELESS COMMUNICATIONS [3 0 1 4]

Introduction to Wireless Communications, Types of Wireless Services, Requirements for the Wireless services, Multipath propagation, Parameters of mobile multipath channels, Spectrum Limitations, Principles of Cellular networks, Multiple Access Schemes, Path Loss models, Signal Fading. Wireless Transceivers, Structure of a wireless communication link, Modulation and demodulation Schemes, Signal Processing in Wireless Systems, Principle of Diversity, Equalizers-Linear and Decision Feedback equalizers, Review of Channel coding and Speech coding techniques. Cellular Communications: 1G, 2G, 3G / LTE, 4G / LTE-A, 5G; New air interface and radio access virtualization.

References:

1. T. S. Rappaport, Wireless Communications - Principle and Practice, (2e), Prentice Hall of India, 2012.
2. A. F. Molisch, Wireless Communications, (2e), Wiley, 2011.
3. D. P. Agrawal, .A. Zeng, Introduction to Wireless and Mobile Systems, (3e), Thomson Press, 2012.

CC3203: AUTOMATA THEORY AND COMPILER DESIGN [3 0 0 3]

Introduction to abstract models of computers: Chomsky hierarchy; regular languages: deterministic finite automata (DFA) and nondeterministic finite automata (NFA), their equivalence, minimizing FA, regular expressions, identifying non-regular languages; ContextFree languages (CFLs): Context-Free grammars, push down automata (PDA), nondeterministic PDA and CFLs, deterministic PDA and CFLs; Introduction to Turing machine; Introduction to compiler design: lexical analysis, recognition of tokens, lexeme and patterns; Syntax analysis: LL(1) parsing, SLR parsers, LR parsers, LALR parsers, parser generators (Flex and Bison), parsing and ambiguity; Runtime environments.

References:

1. M. Sipser, Introduction to the Theory of Computation, (3e), Cengage Learning, 2012.
2. P. Linz, An Introduction to Formal Languages and Automata, (6e), Jones & Bartlett Learning, 2016.
3. J.E. Hopcroft, R. Motwani, J.D. Ullman, Introduction to Automata Theory, Languages and Computation: For VTU, (3e), Pearson Education, 2013.
4. J. Martin, Introduction to Languages and the Theory of Computation, (4e), McGraw Hill, 2010.
5. A.V. Aho, M.S. Lam, R. Sethi, J.D. Ullman, Compiler Design: Principles, Techniques and Tools, (2e), Prentice Hall of India, 2006.

CC3230: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LAB [0 0 2 1]

Implementation and/or use of libraries for application of algorithms: KNN, decision tree, naïve bayes, support vector machine, regression, random forests, logistic regression, cross validation, principal component analysis, k-means; Performance evaluation metrics: classification accuracy, logarithmic loss, confusion matrix, area under curve, F1 score, mean absolute error, mean squared error.

Frameworks: Python References:

1. A. Geron, Hands-On Machine Learning with Scikit-Learn and TensorFlow, (1e), O'Reilly, 2017.
2. S. Raschka, V. Mirjalili, Python Machine Learning, (2e), Packt Publishing, 2015.
3. W. Richert, L. P. Coelho, Building Machine Learning Systems with Python, (3e), Packet Publishing Ltd., 2013.
4. P. Harrington, Machine Learning in Action, (1e), Manning Publications Co., 2008.
5. S. Marsland, Machine Learning: An Algorithmic Perspective, (1e), Chapman & Hall/Crc, 2009.

CC3231: LINUX SHELL PROGRAMMING LAB [0 0 2 1]

General Unix Commands: Cal, date, echo, who, bc, script, passwd, who; File System & File Compression: file handling commands such as cat, cp, rm, mv, more, wc, cmp, diff, gzip, unzip, tar, zip, unzip, mkdir, rmdir, pwd, cd, File attribute: ownerships, permissions; The Process Basics, ps, Internal and external commands, Process states and zombies, nice, at, mesg, cron, time, top. VI Editor: The vi editor Basics, Input mode and The ex mode, Navigation, Editing text, I/O redirection, piping data. Regular Expressions: The period (.), dollar ($), caret(^), asterisk(*). cut, paste, sed, grep, sort, uniq. Shell and Shell programming: The Shell's interpretive cycle, Shell offering, Pattern Matching, Parameter substitution. Decisions: test: string, integer, file and logical operators, else, exit, elif and case. Loops: For, while until. Breaking out from loop, Executing loop in background. Reading and printing data: read, program to copy files, mycp, printf commands. Network Commands: Telnet, ipconfig, ping, netstat, firewalls, System configurations.

References:

1. P. Wood, S. G. Kochan, Shell Programming in Unix, Linux and OS X, (4e), AddisonWesley Professional, 2016.
2. S. Das, Unix Concepts and Applications, (4e), McGraw Hill, 2006.
3. W. R. Stevens, S. A. Rago, Advanced Programming in the UNIX Environment, (3e), Addison-Wesley, 2013.

CC3240: ADVANCED INTERNET TECHNOLOGIES [3 0 0 3]

Introduction: web design fundamentals, website strategy and planning, AJAX, web sockets; Client side technologies: client side architecture, XHTML, CSS, JavaScript, generation and session tracking techniques on client-side; XML: XML basics, DTD, XSLT, xml DOM; jQuery: jQuery introduction, jQuery events, jQuery effects, jQuery hide/show, jQuery animate, jQuery call-back, jQuery chaining, jQuery HTML, jQuery Get, jQuery set, add, remove, filtering, AJAX, Get/Post; PHP: variables and constants, strings, regular expressions, operators, conditional statements, looping statements, functions, arrays, PHP forms, cookies, PHP sessions, Introduction to OOP, database connection and various operation; Bootstrap: BS grid basic, BS typography, BS tables, BS images, BS badges/labels, BS progress bars, BS pagination, BS pager, BS groups, BS panels, BS dropdowns; Node.js: introduction, modules, HTTP module, file system, NPM, events, Email, MySQL; Angular 4: ES6, typescript, angular-CLI and angular components, providers, dependency injection, observables, angular modules, directives and pipes; Web/Application/Database servers: structure, architecture of web servers with working (IIS , Apache), installation and configuration of web servers, security aspects, deployment of web pages, maintenance and monitoring of web pages.

References:

1. D. Goldberg, Internet and World Wide Web - How to Program, (5e), Pearson, 2011.
2. R. Nixon, Learning PHP, MySQL & JavaScript, (5e), O'Reilly Media, 2019.
3. D. Flanagan, jQuery Pocket Reference: Read Less, Learn More, (1e), O'Reilly Media, 2019.
4. S. Seshadri, Angular: Up and Running: Learning Angular, Step by Step, O'Reilly Media, 2018.
5. J. Spurlock, Bootstrap: Responsive Web Development, (1e), O'Reilly Media, 2013.

CC3241: COMPUTER VISION [3 0 0 3]

Image formation and image models: cameras, geometric camera models, geometric camera calibration, radiometry measuring light, sources, and shading; Color early vision - single image: linear filters, edge detection; Texture early vision - multiple images: the geometry of multiple views, stereopsis, affine structure from motion, projective structure from motion; Mid-level vision: segmentation by clustering, segmentation by fitting a model, segmentation and fitting using probabilistic methods, tracking with linear; Dynamic models high-level vision: geometric methods: smooth surfaces and their outlines, aspect graphs, range data; High-level vision: probabilistic and Inferential methods, finding templates using classifiers, recognition by relations between templates, geometric templates from spatial relations.

References:

1. D. A. Forsyth, J. Ponce, Computer Vision: A Modern Approach, (2e), Pearson Education, 2008.
2. R. Hartley, A. Zisserman, Multiple View Geometry in Computer Vision, (2e), Cambridge University Press, 2004.
3. R. Szeliski, Computer Vision: Algorithms and Applications, Springer, 2011.
4. J. Leskovec, A. Rajaraman, J. D. Ullman, Mining of massive dataset, (2e), Cambridge university press, 2014.

CC3242: NEXT GENERATION TELECOM NETWORKS [3 0 0 3]

Introduction to 1G/2G/3G/4G/5G terminology; evolution of public mobile services; Motivation for IP based wireless networks: requirements and targets for long term evolution (LTE); Technologies for LTE- 4G advanced features and roadmap evolutions from LTE to LTEA - wireless standards; Review of cellular technologies; Wireless next generation technologies; Next generation networks; GSM technology; Introduction to next generation networks (NGN); Broadband wireline and wireless alternatives; Wireless access technologies; Overview of TCP/IP and packet core; Advanced IP networking; Overview of voice and video transport over IP; NGN requirements; Architecture and protocols; Next generation network and service management; NGN architectural components; NGN standards and protocols; NGN applications and architecture; SATCOM and broadband wireless architecture; NGN operations and management; Understand 5GPP & NGMN; 5G architecture and design objective; ITU-R IMT-2020 vision for 5G; 5G spectrum requirements; 5G RAN & dynamic CRAN; 5G NR logical architecture; 5G mobile edge computing & fog computing; millimeter wave propagation; Distributed massive MIMO principle; 5G ultra dense networks; 5G CoMP; 5G air interface; 5G protocol stack.

References:

1. N. Wilkinson, Next Generation Networks Services, Technologies and Strategies, (1e), Wiley, 2002.
2. R. Wood, Next Generation Network Services, Pearson Education, 2005.
3. S. Misra, Wireless Communication and Networks 3G and beyond, (2e), McGraw Hill, 2013.
4. K. Pahlavan, P. Krishnamurthy, Principle of wireless Networks, Pearson Education, 2002.
5. Dulaimi, X. Wang, C.Lin, 5G Networks: Fundamental Requirements, Enabling Technologies, and Operations Management, (1e), John Wiley & Sons, 2018.
6. T. V. Chien, E. Björnson, 5G Mobile Communications, Springer, 2017.

CC4140: PRINCIPLES OF WEB SERVICES [3 0 0 3]

Evolution and emergence of web services: emergence of web services and Service Oriented Architecture (SOA), introduction to web services –model of web services, tools and technologies enabling web services, benefits and challenges of using web services; Web service architecture: characteristics, web services communication, WSDL, brief over view of XML; SOA design implementation, managing SOA environment: service-oriented design process, design activities, determine services and tasks based on business process model, implementing SOA; SOAP(Simple Object Access Protocol): SOAP as a messaging protocol, UDDI architecture and implementation, UDDI with WSDL, UDDI specification; REST(Representational State Transfer): messages, HTTP request and format, HTTP response and format, query parameters, protocol semantics of HTTP(GET, PUT, POST, DELETE, HEAD, OPTIONS, TRACE) , REST vs SOAP.

References:

1. R. Skoczylas, R.P. Sriganesh, Developing Java Web Services, (2e), Wiley India, 2008.
2. S. Chatterjee, J. Webber, Developing Enterprise Web Services, (2e), Pearson, 2003.
3. Coyle, F. Paul, XML, Web services, and the data revolution, (1e), Addison-Wesley,2008.
4. S. Graham, Building web Services with Java, (2e), Pearson, 2004.
5. B. M. Balachandar, RESTful Java Web Services, (3e), Packt Publishing Limited, 2017.
6. E. Cerami, Web Services Essentials: Distributed Application with XML – RPC, SOAP, UDDI & WSDL, (1e), O' Reilly, 2002.
7. M. Papazoglou, Web Services and SOA: Principles and Technology, (2e), Pearson, 2008.

CC4141: DEVOPS FUNDAMENTALS [3 0 0 3]

Introduction: Overview of DevOps, market trends, skills, Agile SDLC, Concepts of TDD, BDD, delivery pipeline, and ecosystem**.** Continuous Integration (CI): Version Control using Git, standard commands, working with remote repositories, introduction to Jenkins, Jenkins management, adding a slave node to Jenkins, building delivery pipeline, pipeline as a code, Introduction to build management tool, CI Strategies. Continuous Testing (CT): Unit testing, Integration testing, Gherkin for automation testing, Selenium and Webdriver, creating test cases, handling different controls on webpages, API testing, and testing frameworks. Docker ecosystem & Kubernetes: Introduction to container life cycle, Evolution of container orchestration**,** working with docker, publishing image, compose, Swarm, managing and running containers, Docker networking, network types, Kubernetes architecture and components, traditional vs. Kubernetes deployment strategies. Continuous Deployment (CD): Different deployment strategies, Puppet as a tool for CD, installation and configuration, master and agent setup, puppet module, node classification, puppet environment and classes, automation and reporting. Continuous Monitoring: Introduction to Continuous Monitoring in DevOps, Monitoring vs. Logging vs. Tracing, Overview of Monitoring Architectures (pull vs. push models), Infrastructure and network Monitoring metrics (CPU, memory, disk I/O, network traffic), Prometheus architecture, time-series data model, scraping mechanism, Role of Node Exporter for system-level metrics, agent/agentless models, Application Performance Monitoring (APM): concepts and metrics (latency, throughput, error rates), Datadog/Apache Skywalking architecture, Container monitoring metrics, Challenges of monitoring microservices and cloud-native workloads, Alerting, Visualization, and Logging. DevOps on Cloud: Introduction to cloud computing, why DevOps on cloud, Introduction to AWS, various AWS services, DevOps using AWS.

References:

1. L. Bass, DevOps: A Software Architect's Perspective, Pearson Education, 2016.
2. N. Felson, Effective DevOps with AWS, Packet Publishing Limited, 2017.
3. J. Davis, R. Daniels, Effective DevOps: Building a Culture of Collaboration, Affinity, and Tooling at Scale, O'Reilly Media 2016.

CC4142: NATURAL LANGUAGE PROCESSING [3 0 0 3]

Introduction: Stages of Natural Language Processing, Types of Ambiguities. **Preprocessing and Normalization:** Text representation in computers, encoding schemes, Regular expressions, edit distance, lemmatization, stemming. **Grammar and Language modeling:** Part of Speech, Stochastic POS tagging, parser, vocabulary, N-gram probabilities, Perplexity, Hidden Markov Models, Transformation based tagging (TBL), multi word expressions. **Semantics:** Meaning representation using Word Embedding, semantic analysis, lexical semantics, WordNet, Word Sense Disambiguation. **Pragmatics:** Discourse, Reference Resolution, Reference Phenomena, Syntactic and Semantic Constraints on Coreference. Corpora and **Lexicon:** characteristics of Gold Standard Corpora like Treebank, Wordnet, Sentiwordnet etc. **Feature Extraction:** Bag of word, Tf-Idf, Word Embedding using word2vec and GLOVE, Convolutional Neural Network, Recurrent neural network, Long Short-Term Memory. **Applications & Implementation with NLTK package:** Semantic Text Similarity, Sentence or Document Classification, Machine translation, Text Summarization, Named Entity Recognition

References:

1. D. Jurafsky, J. H. Martin, Speech and Language processing, (3e), Prentice Hall of India, 2018.
2. J. Allen, Natural Language Understanding, (2e), Pearson Education, 2002.
3. C. D. Manning, H. Schuetze, Foundations of Statistical Natural Language Processing, (1e), MIT Press, 1999.
4. S. Bird, E. Klein, E. Loper, Natural Language Processing with Python, (1e) O'Reilly Media, 2009.
5. R. Hausser, Foundations of Computational Linguistics: Human- Computer Communication in Natural Language, (2e), Springer, 2012.

CC4143: DEEP LEARNING [3 0 0 3]

Introduction: Neural networks; Training a network: Loss functions, back propagation and Learning Optimization (Stochastic Gradient Descent (SGD), Momentum SGD, Nestorov Accelerated Gradient (NAG), Adagrad RMSProp, Adam), Variance-Bias Tradeoff, neural networks as universal function; Feature Scaling; Regularization (L1 and L2) Convolutional Neural Networks: Introduction to Convnet, training a Convnet, Hu and Glorat weights initialization, batch normalization, pooling, padding, dropouts, hyper parameter optimization; Transfer Learning and Fine Tuning; Recurrent neural network: Recurrent networks, long short term memory(LSTM), gated recurrent units(GRU), recurrent neural network language models; Deep unsupervised learning: Auto encoders, variation auto encoders, generative adversarial networks(GAN).

References:

1. L. Deng & D. Yu, Deep Learning: Methods and Applications, (1e), Now Publishers, 2014.
2. Goodfellow, Y. Bengio, A. Courville, Deep Learning, (1e), MIT Press, 2016.
3. M. Nielsen, Neural Networks and Deep Learning, (1e), Determination Press, 2015.
4. C. R. Shalizi, Advanced Data Analysis from an Elementary Point of View, (1e) Cambridge University Press, 2015.

CC4144: INTERNET OF THINGS (IoT) [3 0 0 3]

Introduction to Internet of Things: Definition & Characteristics of IoT; Physical Design of IoT; Logical Design of IoT: Functional Blocks, Communication Models, Communication APIs; IoT Enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems; IoT Levels: Level-1, Level-2, Level-3, Level-4, Level-5; IoT and M2M: Difference between IoT and M2M, SDN and NFV for IoT; IoT Platforms Design Methodology: Purpose & Requirements Specifications, Process Specification, Domain Model Specification, Information Model Specification, Service Specifications, IoT Level Specification, Functional View Specification, Operational View Specification, Device & Component Integration; IoT Physical Devices & Endpoints: Basic building blocks of an IoT Device, Raspberry Pi, pcDuino, BeagleBone Black, Cubieboard; IoT Physical Servers & Cloud Offerings: Introduction to Cloud Storage Models & Communication APIs, WAMP - AutoBahn for IoT, Xively Cloud for IoT, Django Architecture, Amazon Web Services for IoT, Amazon EC2, Amazon AutoScaling, Amazon S3, Amazon RDS, Amazon DynamoDB, Amazon Kinesis, Amazon SQS, Amazon EMR, SkyNet IoT Messaging Platform; Security issues in IoT based applications and approaches. Domain Specific IoTs (such as Home Automation, Smart Cities, Smart Environment, Smart Energy, Retail, Logistics, Agriculture, IIoT); References:

1. A. Bahga, V. Madisetti, Internet of Things: A Hands-On Approach, (1e), Universities Press (India) Private Limited, 2014.
2. R. Pethuru, A. C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases, CRC Press, 2017.
3. A. McEwen, H. Cassimally, Designing the Internet of Things, (2e), Wiley, 2014.
4. R. Kamal, Internet of Things – Architecture and Design Principles, (1e), McGraw Hill, 2017.

CC4145: 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. Control and Data Plane Separation: Concepts, Advantages and Disadvantages, the OpenFlow protocol. Network Virtualization: Concepts, Applications, Existing Network Virtualization Framework (VMWare and others), Mininet based examples. 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. Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications. Data Centre Networks: Packet, Optical and Wireless Architectures, Network Topologies. Use Cases of SDNs: Data Centres, Internet Exchange Points, Backbone Networks, Home Networks, Traffic Engineering.

References:

1. T. D. Nadeau, Ken Gray, SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies, (2e), O'Reilly Media, 2013.
2. P. Goransson, C. Black, M. Kaufmann, Software Defined Networks: A Comprehensive Approach, (2e), Morgan Kaufmann, 2014.
3. F. Hu, Network Innovation through OpenFlow and SDN: Principles and Design, (1e), CRC Press, 2014.

CC4146: EMBEDDED SYSTEMS [3 0 0 3]

Introduction to embedded systems, with/without communication, chargeable and storage battery; Design and implementation: typical requirements and their representation, generation of specifications, executable specs, behavioural models, hardware software partitioning, embedded software synthesis, mapping of hardware to standard micros; Building blocks of embedded systems: RISC/CISC architectures, multicore, variants of micros, typical building blocks of micros; Memory: RAM, ROM, NVROM, flash memory, DDR, cache; Timers, PIC, ADC, DAC, MUX; Serial communication: USB, I2C, CAN, SPI RF controllers, Bluetooth, ZigBee, WiFi, ethernet; Custom building blocks: TDC, FFT, DCT, FPGAs/PLDs; sensors and actuator, displays, low power modes, battery management; Programming of micros: IDEs, emulators, debuggers, instruction set emulators, MISRA, WELMEC; embedded system development using MATLAB and LabVIEW, low-end applications: custom manager; Kernels & RTOS: kernels, Windows CE, embedded Linux, Android and iOS; embedding real time capabilities: RTK, RTOS, multi-tasking, task scheduler; Networked embedded systems: Wireless Sensor Networks and IoT, Case studies and projects.

References:

1. F. Vahid, T. Givargis, Embedded System Design-A Unified Hardware/Software Introduction, (3e), Wiley, 2009.
2. K. V. Shibu, Introduction to Embedded Systems, (2e), McGraw Hill, 2017.
3. D. E. Simon, An Embedded Software Primer, (1e), Pearson Education, 2014.
4. S. Heath, Embedded System Design, (2e), Elsevier, 2005.
5. J. K. Peckol, Embedded Systems – A Contemporary Design Tool, Wiley Student Edition, 2009.
6. J.W. Valvano, Embedded Microcomputer Systems: Real Time Interfacing, (3e), Cengage Learning, 2011.
7. M. Huth and M. Ryan, Logic in Computer Science: Modeling and Reasoning about Systems, (1e), Cambridge University Press, 2004.
8. Q. Li and C. Yao, Real-time Concepts for Embedded Systems, (1e), CRC Press, 2003.

CC4147: NETWORKS ON CHIP [3 0 0 3]

Introduction: advent of the multi-core, Communication demands of multi-core architectures, onchip vs. off-chip networks; Network basics: a quick primer evolution to on-chip networks; Shared memory networks in chip multiprocessors: impact of coherence protocol; Design requirements for on-chip network: NoC synthesis, case studies; Routing: types of routing algorithms, deadlock avoidance, turn models; Logic based distributed routing; Selection methods; Flow control: basis units of flow control, different types of flow control, virtual channels deadlock-free flow control, escape VCs, buffer, backpressure; Router microarchitecture: virtual channel router microarchitecture, pipeline; Switch design: crossbar designs, crossbar speedup; Fault tolerance in router; Simulations of various strategies of on chip networks by varying different parameters.

References:

1. N. D. E. Jerger, T. Krishna, L.S. Peh, On-chip Networks, (2e), Morgan & Claypool, 2009.
2. M. Palesi, M. Daneshtalab, Routing algorithms in networks-on-chip, (1e), Springer, 2014.
3. W. J. Dally, B. P. Towels, Principles and Practices of Interconnection Networks, (2e), Morgan Kaufmann, 2004.
4. J. Duato, S. Yalamanchili, L. Ni, Interconnection Networks: An Engineering Approach, (2e), Morgan Kaufmann, 2003.

CC4148: WIRELESS SENSORS & AD-HOC NETWORKS [3 0 0 3]

Introduction to ad-hoc networks: definition, characteristics features, applications, characteristics of wireless channel; Ad-hoc mobility models: indoor and outdoor models, MAC protocols: design issues, goals and classification; Contention based protocols: with reservation, scheduling algorithms, protocols using directional antennas; IEEE standards: 802.11a, 802.11b, 802.11g, 802.15, hiperlan; Routing protocols: design issues, goals and classification, proactive vs reactive routing, unicast routing algorithms, multicast routing algorithms, hybrid routing algorithm, energy aware routing algorithm, hierarchical Routing, QoS aware routing; Transport layer: issues in designing, transport layer classification, ad-hoc transport protocols; Security issues in ad-hoc networks: issues and challenges, network security attacks, secure routing protocols; Cross layer design: need for cross layer design, cross layer optimization, parameter optimization techniques, cross layer cautionary perspective; Integration of ad-hoc with mobile IP networks; Mesh networks; vehicular area networks; Ad-hoc networks: cellular and ad-hoc networks, routing, quality of service provisioning; Wireless sensor networks: design constraints and challenges, sensor network architecture; MAC protocols: Issues in designing MAC protocols for wireless sensor networks, MAC protocols for sensor network, S-MAC, IEEE 802.15.4; Routing protocols: table-driven, ondemand, hybrid, flooding, hierarchical, and power aware routing protocols; QoS and energy management: Issues and challenges in providing QoS, need for energy management; Sensor network platforms and tools: sensor node hardware berkeley motes, programming challenges, node-level software platforms, node-level simulators.

References:

1. F. Zhao, L. J. Guibas, Wireless Sensor Networks - An Information Processing Approach, Elsevier, 2007.
2. H. Karl, A. Willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley, 2005.
3. K. Sohraby, D. Minoli, T. Znati, Wireless Sensor Networks- Technology, Protocols, and Applications, John Wiley, 2007.
4. C. K. Toh, Ad-Hoc Mobile Wireless Networks – Protocols and Systems, (1e), Prentice Hall of India, 2001.
5. S. R. Murthy, Ad-Hoc Wireless Networks - Architectures and Protocols, (1e), Pearson Education, 2006.
6. A. Hac, Wireless Sensor Network Designs, (1e), John Wiley, 2003.

CC4149: HUMAN COMPUTER INTERACTION [3 0 0 3]

Foundations of HCI: The human: I/O channels, memory, reasoning and problem solving; The computer: devices, memory, processing and networks; Interaction: models, frameworks, ergonomics styles elements, interactivity, paradigms; Design & software process: interactive design basics, process, scenarios, navigation, screen design, iteration and prototyping; HCI in software process: software life cycle, usability engineering, prototyping in practice, design rationale; Design rules: principles, standards, guidelines, rules; Evaluation techniques, universal design; Models and Theories: cognitive models, socio-organizational issues and stake holder requirements, communication and collaboration models, hypertext, multimedia and www; Mobile HCI: mobile ecosystem, platforms, application frameworks, types of mobile applications: widgets, applications, games mobile information architecture, mobile 2.0; Mobile design: elements of mobile design, tools; Web interface design: designing web interfaces, drag & drop, direct selection, contextual tools, overlays, inlays and virtual pages, process flow; Case studies.

References:

1. A. Dix, J. E. Finlay, G .D. Abowd, R. Beale, Human Computer Interaction, (3e), Pearson Education, 2004.
2. S. Ben, P. Catherine, Designing the user interface Strategies for effective human-computer interaction, (5e), Pearson Education, 2014.
3. T.K. Prabhu, Research methods in human computer interaction, (2e), Oxford Book Company, 2017.
4. B. Fling, Mobile Design and Development, (1e), O'Reilly Media Inc., 2009.
5. C. David, Linear Algebra and applications, (3e), Pearson Education, 2009.

CC4150: MOBILE COMPUTING [3 0 0 3]

Evolution of mobile radio communication, Transmission fundamentals; Modulation techniques: Signal encoding criteria, Overview of ASK, PSK, FSK, MSK, Spread spectrum modulation; Wireless communication technologies: Cellular networks, Mobility in cellular based wireless network: handoff strategies, channel allocation, interferences, handoffs and location management. IP mobility: Mobile IP and IDMP, IEEE802.11, IEEE 802.11 Architecture and Services, Physical Layer and Medium Access Control, TCP/IP in mobile setting, Geolocation and Global Positioning System (GPS), Personal Area Network: Bluetooth and ZigBee, Mobile agent technology and standards.

References:

1. J.H. Schiller, Mobile Communications, Pearson Education, (2e), 2004.
2. R. Pandya, Mobile and Personal Communication Systems and Services, Prentice Hall of India, 2001.
3. R. B'Far, Mobile Computing Principles, (1e), Cambridge University Press, 2004.
4. T.S. Rappaport, Wireless Communications - Principle and Practice, (2e), Prentice Hall of India, 2005.
5. W. Stallings, Wireless Communication and Network, (2e), Prentice Hall of India, 2004.

CC4151: INFORMATION RETRIEVAL [3 0 0 3]

Basic concepts of IR: data retrieval and information retrieval, IR system block diagram, automatic text analysis, Luhn's ideas, conflation algorithms, indexing and index term weighing, probabilistic indexing, automatic classification, similarity scoring, measures of association, different matching coefficients, and feedback analysis. Classification methods: cluster hypothesis, clustering algorithms, single-pass algorithm, single link algorithm, Rochhio's algorithm, and dendrograms. Parallel and Distributed IR: Parallel SIMD and MIMD architectures, distributed IR – collection partitioning, source selection, query processing. File structures and searching algorithms: inverted file, suffix trees and suffix arrays, signature files, ring structure, search strategies, Boolean search, serial search, and cluster-based retrieval. IR models: basic concepts, Boolean model, vector model; probabilistic model, Set-Theoretic Models: Extended Boolean models, Fuzzy set model, models for browsing. Trends and research issues

References:

1. C.D. Manning, P. Raghavan, H. Schuetze, Introduction to Information Retrieval, (1e), Cambridge University Press, 2007.
2. B.Croft, D.Metzler, T. Strohman Search Engines: Information Retrieval in Practice, (1e), Pearson Education, 2009.
3. B. Ricardo, B.Neto Modern Information Retrieval, (2e), Addison-Wesley, 2011.

CC4152: COMPUTER GRAPHICS AND MULTIMEDIA [3 0 0 3]

Computer graphics: introduction, applications; Color models; Overview of graphics systems: raster scan and random scan; Video display devices; 3D viewing devices; Graphics software; Graphics output primitives: line, circle drawing algorithms; Basic 2D and 3D transformations: translation, scaling, rotation, shearing, reflection; Window to viewport transformation; Line and polygon clipping; Projections; Spline representations; Visible surface detection; Illumination and shading models; MultDmedia: Introduction and applications; Interactive graphics systems; Images: file systems, image compression; Sound: file systems, adding sound to multimedia projects; Animation: file systems and techniques; Videos: working, file systems, codecs, compression standards; Authoring systems; Visualization in multimedia; Data and information visualization; Multimedia on the Web; Virtual reality.

References:

1. D. Hearn, M. Baker, W. Carithers, Computer Graphics with OpenGL, (4e), Pearson, 2013
2. D. Hearn, M. Baker, Computer Graphics C Version, (2e), Pearson, 2002
3. Z. Xiang, R. Plastok, Schaum's Outlines Computer Graphics, (2e), McGraw-Hill Education, 2006
4. J. D. Foley, A. V. Dam, S. K. Feiner, F. H. John, Computer Graphics Principles and Practice in C, (2e), Pearson, 2002
5. T. Vaughan, Multimedia: Making it work, (9e), McGraw Hill Education, 2017
6. E. Angel, Interactive Computer Graphics- A top down approach using OpenGL, (5e), Pearson Education, 2012

CC4153: USER INTERFACE DESIGN [3 0 0 3]

Introduction to graphics interface: characteristics of graphics interface, direct manipulation, graphical system, web user interface, popularity, characteristic and principles, usability of interactive systems, guidelines, principles, and theories, managing design processes, evaluating interface designs, software tools & visual prototyping, direct manipulation and virtual environment, menu selection, form fill in, and dialog boxes, command and natural languages, quality of service, balancing function and fashion; Windows: characteristics, components, presentation styles, types, managements, organizations, operations, web systems, device, based controls characteristics, screen, based controls, operate control, text boxes, selection control, combination control, custom control, presentation control.

References:

1. B. Shneiderman, C. Plaisant, Designing the User Interface, (4e), Addison Wesley, 2005.
2. B. Shneiderman, C. Plaisant, S.Jacobs, Designing the User Interface: Strategies for Effective Human-Computer Interaction, (6e), 2017.
3. W.O. Galitz, The Essential Guide to User Interface Design, (3e), John Wiley & Sons, 2001.

CC4154: DIGITAL IMAGE PROCESSING [3 0 0 3]

Elements of digital image processing systems: vidicon and digital camera working principles, elements of visual perception, brightness, contrast, hue, saturation, Mach band effect; Color image fundamentals: RGB, HSI models, image sampling, quantization, dither, two-dimensional mathematical preliminaries, 2D transforms: DFT, DCT, KLT, SVD; Histogram equalization and specification techniques: noise distributions, spatial averaging, directional smoothing, median, geometric mean, harmonic mean, contra harmonic mean filters, homomorphic filtering; Color image enhancement image restoration: degradation model, unconstrained restoration: lagrange multiplier and constrained restoration, inverse filtering-removal of blur caused by uniform linear motion, wiener filtering; Geometric transformations-spatial transformations: edge detection, edge linking via Hough transform, thresholding, region based segmentation, region growing, region splitting and merging; Segmentation: basic concepts, dam construction, watershed segmentation algorithm; Need for data compression: Huffman, run length encoding, shift codes, arithmetic coding, vector quantization, transform coding, JPEG standard, MPEG.

References:

1. R. C. Gonzalez, R. E. Woods, Digital Image Processing, (4e), Pearson, 2018.
2. A. K. Jain, Fundamentals of Digital Image Processing, (2e), Pearson, 2002.
3. W. K. Pratt, Digital Image Processing, (4e), Wiley-Interscience, 2007.
4. A. Rosenfled , A. C. Kak, Digital Picture Processing, Academic Press, 1986.

CC4155: BIG DATA ANALYTICS [3 0 0 3]

Data definitions and analysis techniques: Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing. Big Data: Characteristics of Big Data, Importance of Big Data, Big data use cases, Data in the warehouse and Hadoop. **Data analysis techniques:** Regression analysis, Classification techniques, Clustering, Association rules analysis. Unsupervised Learning, Recommendation Systems. Streaming Algorithms. **Hadoop:** Distributed Architecture, HDFS, MapReduce, Spark, Similarity Search, Link Analysis, Hadoop Ecosystem, Execution and Analysis Tools. **NOSQL:** NOSQL Models, Understanding Storage Architecture, Performing CRUD operations, Querying NOSQL Stores.

Case studies and projects: Understanding business scenarios, Feature engineering and visualization, Sensitivity Analysis. References:

1. R. E. Walpole, R. H. Myers, S. L. Myers, K. Ye, Probability and statistics for engineers and scientists, (9e), Pearson Education, 2014.
2. G. James, D. Witten D, T. Hastie, R. Tibshirani, Statistical Learning. In: An Introduction to Statistical Learning. Springer Texts in Statistics, vol 103, Springer, New York, 2013.
3. H. Trevor, T. Robert, F. Jerome, The elements of statistical learning: data mining, inference, and prediction, (2e), Springer-Verlag New York, 2009.
4. J. Leskovec, A. Rajaraman, J. D. Ullman, Mining of massive datasets, (2e), Cambridge university press, 2014.

CC4156: DATA MINING AND DATA WAREHOUSING [3 0 0 3]

Introduction to data, information, knowledge and wisdom; Data objects and attribute types; KDD process; Introduction to data warehouse; Data preprocessing: data cleaning, integration, reduction and transformation; Data discretization and concept hierarchy generation; Comparison of OLAP with OLTP systems, ROLAP, MOLAP and DOLAP; Data cube computation methods; Multidimensional modeling; Data warehouse architecture and implementation : Parallel execution, materialized views; Data mining: introduction to data mining, classification of data mining systems, integration of a data mining system with a data warehouse; Classification: association rule mining (mining frequent patterns, mining various kinds of association Rules), decision tree induction, rule-based classification, back-propagation, associative classification; Clustering methods: basic statistical descriptions of data, measuring data similarity and dissimilarity, partition based clustering, hierarchical based clustering, model-based clustering; Application trends in data mining; Cluster analysis; Case study on data mining with data sets.

References:

1. J. Han, M. Kamber, Data Mining: Concepts and Techniques, (3e), Elsevier Publications, 2011.
2. I. Witten, E. Frank, M. Hall, C.Pal, Data Mining: Practical Machine Learning Tools and Techniques, (4e), Elsevier Publications, 2016.
3. P.N. Tan, M. Steinbach, V. Kumar, Introduction to Data Mining, (1e), Pearson Education, 2016.
4. S. Sumathi, S.N. Sivanandam, Introduction to Data Mining and its Applications, (1e), Springer, 2006.

CC4157: SOCIAL NETWORK ANALYSIS [3 0 0 3]

Introduction: What is Social Network Analysis? History, Preliminaries, Applications, Defining Networks-Nodes, Edges and Network measures, Describing Nodes and Edges, Describing Networks, Layouts; Visualizing Network features: The role of Tie Strength, Measuring Tie Strength, Tie Strength and Network Structure, Tie Strength and Network Propagation, Link Prediction, Entity Resolution; Link Prediction: Case Study Friend Recommendation, Introduction to Community Discovery, Communities in Context, Quality Functions; Algorithms: The Kernighan-Lin algorithm, Agglomerative Algorithms, Spectral Algorithms, Multi-level Graph Partitioning, Markov Clustering, Other Approaches; Anomaly Detection in Social Networks: Outliers, Network-based Anomalies, Challenges, Anomaly Detection in Static Networks, Anomaly Detection in Dynamic Networks

References:

1. J. Goldbeck, Analyzing the Social Web, Morgan Kaufmann, 2013.
2. C. C. Aggarwal, Social Network Data Analytics, Springer, 2011.
3. J. Scott, Social Network Analysis, (3e), SAGE Publications, 2013.
4. Jay Goldman, Facebook Cookbook, O'Reilly, 2009.
5. S.Kumar, F. Morstatter, H. Liu, Twitter Data Analytics, Springer, 2013.

CC4158: SOFTWARE TESTING [3 0 0 3]

Basics of software testing: Introduction to software Testing, Testing and debugging, Test metrics and measurements, Verification, Validation and Testing, Types of testing, Software defect tracking; Structural testing techniques: Path testing, DD-Paths, Cyclomatic Complexity, Graph Metrics, Data Flow Testing; Functional testing techniques: Boundary Value Analysis, Equivalence Class Testing, Decision Table Based Testing, Cause Effect Graphing Technique, Ad hoc Testing; Top down and Bottom up integration: Bi-directional integration, System integration, Scenario Testing, Defect Bash, Design/Architecture verification, Deployment testing, Beta testing, Scalability testing, Reliability testing, Stress testing; Acceptance testing; Regression testing, Test Planning; Software Test Automation: Scope of automation, Design & Architecture for automation, Generic requirements for test tool framework, Test tool selection, Testing in Object Oriented Systems, Case study on software testing; Advanced Topics on Testing: Prioritizing the Test-cases, Testing event driven applications, Testing Off-the-shelf component, Testing security, Testing Data-warehouse; Introduction to DevOps.

References:

1. R. Mall, Fundamentals of Software Engineering, (4e), Prentice Hall of India, 2014.
2. K. K. Aggarwal, Y. Singh, Software Engineering, (3e), New Age International Publication, 2008.
3. K. Perry, Effective Methods for Software Testing, (3e), Wiley, 2006.
4. B. Beizer, Software Testing Techniques, (2e), Wiley, 2008.
5. S. Desikan, G. Ramesh, Software Testing: Principles and Practices, Pearson Education, 2006.
6. P. C. Jorgenson, Software Testing: A Craftsman's Approach, (4e), CRC Press, 2014.
7. A. P. Mathur, Fundamentals of Software Testing, (2e), Pearson Education, 2014.

CC4159: CLOUD COMPUTING [3 0 0 3]

Introduction: Distributed computing and enabling technologies. **Cloud fundamentals**: cloud definition, evolution, architecture, applications, deployment models, Hybrid & Multi-Cloud Deployments, service models, introduction to FOG computing and Edge Computing, green cloud, mobile cloud computing; **Virtualization**: issues with virtualization, virtualization technologies and architectures, internals of virtual machine monitors/hypervisors, virtualization of data centres, and issues with multi-tenancy; **Implementation**: study of cloud computing systems like Amazon EC2 and S3, GCP, Microsoft Azure, IBM Cloud and Oracle Cloud, open-source tools to build private/hybrid clouds; **Introduction to file systems for cloud:** distributed file systems and object storage systems. introduction to Kubernetes, OpenShift, Amazon ECS, Google Cloud Run and Docker; **Interoperability and Service Monitoring:** issues with interoperability, vendor lock-in, interoperability approaches, SLA management, metering issues, and report generation; **Resource management and load balancing**: distributed management of virtual infrastructures, server consolidation, dynamic provisioning and resource management, resource optimization, resource dynamic reconfiguration, scheduling techniques for advance reservation, and load balancing, various load balancing techniques, use of AI/ML in load balancing; **Migration and fault tolerance**: broad aspects of migration into cloud, migration of virtual machines and techniques, Fault tolerance mechanisms: **Cloud Backup and Disaster Recovery**: Cloud Backup Strategies, Disaster Recovery Models, AI-powered Recovery techniques, grid of clouds.

References:

1. R. Buyya, J. Broberg, A. Goscinski, Cloud Computing Principles and Paradigms, (1e), Wiley, 2013.
2. B. Sosinsky, Cloud Computing Bible, (1e), Wiley, 2011.
3. M. L. Miller, Cloud Computing: Web-based Applications that change the way you work and collaborate online, (1e), Pearson Education, 2008.
4. D. S. Linthicum, Cloud Computing and SOA Convergence in Your Enterprise: A Step-byStep Guide, (1e), Addision Wesley Information Technology Series, 2010.
5. T. Velte, A. T. Velte, R. Elsenpeter, Cloud Computing: A Practical Approach, (1e), McGraw Hill, 2017.

CC4160: INFORMATION THEORY AND CODING [3 0 0 3]

Information Theory: introduction, entropy, information rate, channel capacity, Kraft McMillan inequality, Shannon-Fano coding, Huffman coding, extended Huffman coding - joint and conditional entropies, discrete memoryless channels: BSC, BEC; Error Control Coding: block codes, convolutional codes, code tree, trellis, state diagram, single parity codes, hamming codes, repetition codes, linear block codes, cyclic codes, encoder and decoder – CRC, sequential search, Viterbi algorithm; Text Source Coding; Audio Source Coding; Image and Video Source Coding: image and video formats (GIF, TIFF, etc.), image compression, video compression, H.261, MPEG standard.

References:

1. R. Bose, Information Theory, Coding and Cryptography, (3e), TMH, 2017.
2. F. Halsall, Multimedia Communications: Applications, Networks, Protocols and Standards, (2e), Pearson, 2001.
3. K. Sayood, Introduction to Data Compression, (4e), Morgan Kaufmann, 2012.
4. S. Gravano, Introduction to Error Control Codes, (2e), Oxford University Press, 2007.
5. A. Bhattacharya, Digital Communication, (1e), McGraw Hill Education, 2017.

CC4161: NETWORK SECURITY [3 0 0 3]

Basics of network security: attacks, IP spoofing, packet sniffing, services, and mechanisms; Digital Signature, Key Distribution, and User Authentication, Symmetric Key Distribution Using Symmetric Encryption, Kerberos, Key Distribution Using Asymmetric Encryption, X.509 Certificates, Public-Key Infrastructure, Transport-Level Security: Web Security Considerations, Secure Socket Layer and Transport Layer Security, Electronic Mail Security: PGP, MIME, IP Security: IP Security Policy, Encapsulating Security Payload, Internet Key Exchange, System Security: Firewall, VPN, IDS, DMZ, Malicious Software: Virus, Worm, Trojon horse, Internet security; Secure electronic payment system and protocols. Malicious software: virus, worm, Trojan horse, identification and remedies; Internet security; Secure electronic payment system and protocols.

References:

1. W. Stallings, Cryptography and Network Security-Principles and Practice, (7e), Pearson Education, 2017.
2. W. Stallings, Network Security Essentials: Applications and Standards, (6e), Pearson Education, 2018.
3. B. A. Forouzan, D. Mukhopadhyay, Cryptography and Network Security, (3e), McGraw Hill, 2015.
4. Y. Qian, D. Tipper, P. Krishnamurthy, J. Joshi, Information Assurance Dependability & Security in Networked Systems, (1e), Morgan Kaufmann, 2010.
5. A. Sadeghi, M. Schneider, Electronic Payments Systems, (1e), Springer, 2003.
6. R. D. Pietro, L. V. Mancini, Intrusion Detection Systems, (1e), Springer, 2010.

CC4162: SPATIAL DATA ANALYTICS [3 0 0 3]

Introduction to geospatial data: concepts of spatial data, spatial data storage, representation and different formats, modes of geographic information- aerial photo and image interpretation; Geospatial data processing: data extraction, vector and raster data handling and transformation; Spatial referencing using coordinate system and geographic identifiers, metadata; Spatial Database, spatial query SQL, NoSQL using Oracle spatial extension; Geo-processing of vector and raster data; Spatial data analysis using commercial & open source software-QGIS & SAGA, eo-statistics, and spatial uncertainty, quality of spatial data; GIS analysis functions: retrieval, classification, measurement, neighborhood, topographic, interpolation, overlay, buffering, spatial join and query, connectivity, network functions, spatial pattern analysis, spatial autocorrelation, trend surface analysis; Spatial data mining: classification, patterns, and rules. Introduction to remote sensing: sensors and their characteristics on board remote sensing satellites; Spectral reflectance of soil, water, vegetation and rock types; Data interoperability, extensibility, data visualization and case studies using open source software and python libraries; Advanced topics of 3-DGS & 4-DGS.

References:

1. M. N. DeMers, Fundamentals of Geographic Information Systems, (4e), John Wiley & Sons, 2008.
2. M. M. Fischer, J. Wang, Spatial Data Analysis: Models, Methods and Techniques, Springer Science & Business Media, 2011.
3. D. L. Wang, D. L. Shuliang, Spatial Data Mining, Berlin, Heidelberg: Springer Berlin Heidelberg, 2015.
4. C. Lloyd, Spatial Data Analysis: An Introduction for GIS Users, (1e), Oxford University Press, 2010.
5. R. Haining, Spatial Data Analysis: Theory and Practice, Cambridge University Press, 2013.
6. J. R. Jensen, Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall Press, 2015.
7. H. Wackernagel, Multivariate Geostatistics: An Introduction with Applications, Springer Science & Business Media, 2010.
8. J. Lawhead, Learning Geospatial Analysis with Python. Packt Publishing Ltd, 2013.

CC4163: FOUNDATION OF DIGITAL FORENSICS [3 0 0 3]

Introduction to Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems Associated with Computer Crime, Early Hackers and Theft of Components, Computer Forensics and Investigation Processes. Understanding Computing Investigations, Investigator's Office and Laboratory, Data Acquisitions. Processing Crime and Incident Scenes, Searching and Seizing Computer-Related Evidence, Processing of Evidence and Report Preparation, Current Computer Forensics Tools. Macintosh and Linux, Boot Processes and File Systems, Computer Forensics Analysis, Recovering Graphics Files, Virtual Machines, Network Forensics, and Live Acquisitionsmail Investigations, Cell Phone and Mobile Device Forensics. Report Writing for High- Tech Investigations, Expert Testimony in High-tech Investigations, Ethics, Conclusions and Future Issues.

References:

1. Christopher Steuart, Bill Nelson, Amelia Phillips, *Guide to Computer Forensics and Investigations*, (4e), Cengage (1 March 2013)
2. Marjie ,T. Britz, *Computer Forensics and Cyber Crime: An Introduction,* ,(2e), Prentice Hall (Jan, 2011)
3. C Altheide H Carvey, *Digital Forensics with Open Source Tools*, Syngress Elsevier (2011)

CC4167: Foundations of Blockchain Technology [3 0 0 3]

Introduction to cryptographic primitives: Encryption and decryption, public-key cryptography, ECC, digital signature, Secure Hash Algorithms, SHA-256, Keccak-256, Properties of Hash Algorithm. Introduction to the blockchain: The history of blockchain, Generic elements of a blockchain; Features of a blockchain; Applications of blockchain technology, Blockchain1.0, 2.0, and 3.0; Types of blockchain; Benefits and limitations of blockchain, Merkle Tree, Patricia Tree, Distributed Hash Table. Modelling faults and adversaries, Byzantine Generals problem, Blockchain – hash pointers, consensus, byzantine fault-tolerant distributed computing, Zero Knowledge proofs and protocols in Blockchain, Proof of Work (PoW), Proof of Stake (PoS) based Chains - Hybrid models (PoW + PoS). Introducing Solidity: Solidity and Solidity files, Structure of a contract, State variables, Structure, Modifiers, Events, Enumeration, Functions, Data types in Solidity, Value types, passing by value and reference, Storage and memory data locations, Literals, Integers, Boolean, The byte data type, Arrays, Enumerations, Address, Mappings. Global Variables and Functions. Expressions and Control Structures: Solidity expressions, decision conditional statements, the control statements, the break statement, the continue statement, the return statement; Smart contracts: Writing a simple contract, creating contracts, Using the new keyword, using the address of a contract, Constructors, Contract composition. Inheritance, Encapsulation, Polymorphism, Method overriding, Abstract contracts, Interfaces, Functions, Modifiers, and Fallbacks.

References:

1. Narayanan, Bonneau, Felten, Miller, and Goldfeder (2016), "*Bitcoin and Cryptocurrency Technologies – A Comprehensive Introduction*", Princeton University Press (1st ed.), (ISBN: 9780691171692, pages: 336)
2. Imran Bashir (2018), "*Mastering Blockchain: Distributed ledger technology, decentralization, and smart contracts explained*", Packt Publishing. (2nd ed.) (ISBN: 9781788838672, pages: 625)
3. Modi, Ritesh. (2018) "*Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain"* (1st ed.). Packt Publishing Ltd. (ISBN: 9781788831383, pages: 376.)
4. Josh Thompson (2017), "*Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming*", Create Space Independent Publishing Platform, (ISBN: 1546772804, pages: 75.)
5. Merunas Grincalaitis (2019), "*Mastering Ethereum: Implement Advanced Blockchain Applications Using Ethereum supported Tools, Services, and Protocols*", Packt Publishing (ISBN: 9781789531374, pages

CC2080: INTRODUCTION TO DATA STRUCTURES AND ALGORITHMS [3 0 0 3]

Introduction: algorithm specification; Performance analysis: time and space complexity, asymptotic notation; C revision: pointer declaration and definition, memory allocation functions, array of pointers, structures in C, arrays of structures, structures and functions; Recursion in C; Linked list: implementation, various types and operations; Stack: implementations using array and linked list, operations and its applications; Queue: implementations using array and linked list, operations and its applications; Tree: terminologies, different types, implementations of binary tree using array and linked structure, binary search tree, different operations (recursive, nonrecursive), search trees, tree applications; Graph: implementation and operations; Searching techniques and hashing; Sorting.

References:

1. E. Horowitz, S. Sahni, S. Anderson-Freed, Fundamentals of Data Structures in C, (2e), Orient Black Swan, 2008.
2. A. M. Tenenbaum, Y. Langsam, M. J. Augenstein, Data Structures using C, (1e), Pearson Education, 2008.
3. A.V. Aho, J. E. Hopcroft, J. D. Ullman, Data Structures and Algorithms, (1e), Pearson Education, 2002.
4. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, Introduction to algorithms, (3e), Prentice Hall of India, 2010.
5. S. Lipschutz, Data Structures with C (Schaum's Outline Series), (3e), McGraw-Hill, 2011.
6. M. A. Weiss, Data Structures and Algorithm Analysis in C, (1e), Pearson Education, 2002.

CC3080: INTRODUCTION TO OBJECT ORIENTED PROGRAMMING [3 0 0 3]

Introduction: need of object oriented programming, difference between procedural and object oriented language; Characteristics of object oriented programming; Programming basics: basic program construction, directives, comments, tokens, keywords, identifiers and constants; Data types: basic, user defined, derived; Operators: insertion and exertion operators, scope resolution operator, member access operator; Manipulators; Type casting; Functions: function declaration, function definition, function calling; Recursive functions; Passing arguments; Returning values; Objects and classes: defining classes, object creation, access specifiers; Constructors and its types; Inline functions; Friend functions; Inheritance; Abstract class; Virtual base class; This pointer; Polymorphism: compile time and runtime.

References:

1. H. Schilt, C++: The Complete Reference, (4e), McGraw Hill Education, 2017
2. E. Balagurusamy, Object Oriented Programming with C++, (7e), McGraw-Hill Education, 2017
3. R. Lafore, Object Oriented Programming in C++, (4e), Pearson, 2008

CC3081: INTRODUCTION TO WEB TECHNOLOGY [3 0 0 3]

Web designing: introduction to WYSIWYG design tools, introduction to HTML, introduction to CSS, introduction to word press, website creation and maintenance, web hosting and publishing concepts; Client side programming: the JavaScript language, history and versions, syntax, variables and data types, statements, operators, literals, functions, objects, arrays, built-in objects, JavaScript debuggers; Representing web data: XML documents and vocabularies versions and declaration- namespaces, displaying xml documents in browsers; Server side programming: overview- servlets & life cycle, java server pages, generating dynamic content, parameter data, sessions, cookies; Electronic commerce: e - business model, e - marketing, online payments and security.

References:

1. DT. E. Services, HTML 5 Black Book, (2e), Dreamtech Press, 2016.
2. J. Sklar, Web Design Principles, (5e), Cengage, 2015.
3. P. J. Deitel, H. M. Deitel, Internet and World Wide Web How to program, (5e), Pearson, 2011.
4. R. Moseley, M. T. Savaliya, Developing Web Applications, (1e), John Wiley & Sons, 2007.
5. J. C. Jackson, Web Technologies: A Computer Science Perspective, Pearson Education, 2007.
6. S. Potts, JAVA 2 Unleashed, (6e), Sams Publishing, 2002.

CC3082: INTRODUCTION TO IoT [3 0 0 3]

Introduction to IoT: characteristics, things in IoT, sensing, actuation, M2M and IoT, industrial IoT; Architecture of IoT: device, communication, services, management, security, application, cloud storage; IoT software; IoT physical device : introduction to Arduino, Arduino microcontroller, GPIOs, wireless data transmission; Ardunio programming: basic application development with Arduino; Introduction to wireless modules: Wifi, bluetooth, zigbee, infrared communication modules; Applications and case study of IoT: healthcare IoT, industrial IoT, smart (green) cities, government, safety, smart home, environmental monitoring, vehicular IoT.

References:

1. J. Holler, V. Tsiatsis, C. Mulligan, S. Avesand, S. Karnouskos, D. Boyle, From Machine-toMachine to the Internet of Things: Introduction to a New Age of Intelligence, (1e), Academic Press, 2014.
2. A. Bahga ,V. Madisetti, Internet of Things A Hands-on-Approach, (1e), University Press, 2015.
3. F. daCosta, Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, (1e), Apress Publications, 2013.

CC 3083: INTRODUCTION TO LINUX [3 0 0 3]

Introduction to Linux Operating Systems: Linux Philosophy and Components, Linux History, Linux Community, Linux Terminology, Linux distribution flavours, Installation and configurations. Linux Architecture and General utility commands: cal, date, echo, bc, script, ,who; File System: file handling commands such as cat, cp, rm, mv, more, wc, cmp, diff, gzip ,gunzip, tar, zip, unzip, mkdir, rmdir, pwd, cd, File attributes, ownerships, permissions; The Process Basics, ps, Internal an d external commands, Process states and zombies, nice, at, mesg, cron, time, top; Filters: head, tail, cut, paste ,sort; Filters using regular expression: grep, sed; The vi editor Basics: Input mode and The ex-mode, Navigation, Editing text; Package Management: Introduction to package manager, function of package manager, Package management commands: rpm, yum; Storage management- Types of storages, creating partitions using fdisk command, Logical volume management (LVM), Creating file system, mounting file system.

References:

1. Richard Petersen, Linux: The Complete Reference, (6e), McGraw Hill Education, July,2017
2. Graham Glass, King Ables, UNIX for Programmers and Users, (3e), Pearson Education,2003
3. Wale Soyinka, Linux Administration A Beginners Guide, (6e), McGraw Hill Education, February 2012.
4. Daniel J. Barrett, Linux Pocket Guide: Essential Commands, (1e), Shroff Publishers & Distributors Pvt Ltd, June,2012.
5. Syed Mansoor Sarwar, Robert M Koretsky, Linux: The Textbook, (2e), Chapman and Hall/CRC, June,2020