NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

Department of Information Technology (IT)
Bachelor of Technology in Information Technology

Basic Science Core (BSC)

MA110	Engineering Mathematics – I	(3-0-0)	3
PH110	Physics	(3-1-0)	4
PH111	Physics Laboratory	(0-0-2)	1
MA111	Engineering Mathematics – II	(3-0-0)	3
CY110	Chemistry	(3-0-0)	3
CY111	Chemistry Laboratory	(0-0-3)	2

Engineering Science Core (ESC)

ME110	Elements of Mechanical Engineering	(2-0-0)	2
ME111	Engineering Graphics	(1-0-3)	3
WO110	Engineering Mechanics	(3-0-0)	3
CS110	C Programming	(3-1-0)	3
CS111	C Programming Lab	(0-0-2)	2

Humanities and Social Science Core (HSC)

SM110	Professional Communication	(3-0-0)	3
SM300	Engineering Economics	(3-0-0)	3
SM302	Principles of Management	(3-0-0)	3

Programme Core (PC)

IT110	Digital System Design	(3-0-2)	4
IT150	Object Oriented Programming	(3-0-2)	4
IT200	Computer Communication and Networking	(4-0-0)	4
IT201	Computer Organization and Architecture	(3-0-0)	3
IT202	Data Structures and Algorithms-I	(3-0-0)	3
IT203	Discrete Mathematics	(3-0-0)	3
IT204	Signals and Systems	(3-0-2)	4
IT205	Computer Networking Lab	(0-0-3)	2
IT206	Data Structures and Algorithms-I Lab	(0-0-3)	2
IT250	Automata and Compiler Design	(3-0-2)	4
IT251	Data Structures and Algorithms-II	(3-0-2)	4
IT252	Database Systems	(3-0-2)	4
IT253	Operating Systems	(3-0-2)	4
IT254	Web Technologies and Applications	(3-0-2)	4
IT300	Design and Analysis of Algorithms	(3-0-2)	4
IT301	Parallel Computing	(3-0-2)	4
IT302	Probability and Statistics	(3-0-2)	4
IT303	Software Engineering	(3-0-2)	4
IT350	Data Analytics	(3-0-2)	4
IT351	Human Computer Interaction	(3-0-2)	4
IT352	Information Assurance and Security	(3-0-2)	4

Major Project (MP)

IT449	Major Project-I	(0-0-3)	2
IT499	Major Project-II	(0-0-6)	4

Mandatory Learning Courses (MLC)

CV110	Environmental Studies	(1-0-0)	1
SM111	Professional Ethics and Human Values	(1-0-0)	1
ME100	Introduction to Design Thinking	(2-0-0)	2
UC401	Liberal art Courses/ cocurricular/ extracurricular activities		10
IT290	Seminar		1
IT440	Practical Training		1

Programme Specific Electives (PSE)

IT360	Information Systems	(3-0-2)	4
IT361	Paradigms of Programming	(3-0-2)	4
IT362	Computer Graphics	(3-0-2)	4
IT363	Microprocessors and Interfacing	(3-0-2)	4
IT364	Performance Modeling	(3-0-2)	4
IT365	Advanced Computer Networks	(3-0-2)	4
IT366	Object Oriented Analysis and Design	(3-0-2)	4
IT400	Perceptual Audio Processing	(3-0-2)	4
IT401	Perceptual Video Processing	(3-0-2)	4
IT402	Soft Computing	(3-0-2)	4
IT403	Genetic Algorithms	(3-0-2)	4
IT404	Artificial Neural Networks	(3-0-2)	4
IT405	Fuzzy System Models	(3-0-0)	3
IT406	Distributed Computing Systems	(3-0-2)	4
IT407	Technologies for Internet of Things	(3-0-2)	4
IT408	Mobile Computing	(3-0-0)	3
IT409	Embedded Systems	(3-0-0)	3
IT410	Bioinformatics	(3-0-0)	3
IT411	Knowledge Management	(3-0-0)	3
IT412	Time Series Analysis	(3-0-0)	3
IT413	System Integration	(3-0-0)	3
IT414	Data Warehousing and Data Mining	(3-0-2)	4
IT415	Middleware Technologies	(3-0-2)	4
IT416	Computer Vision	(3-0-2)	4
IT417	Pattern Recognition	(3-0-2)	4
IT418	Cloud Computing	(3-0-2)	4
IT419	Wireless Sensor Networks	(3-0-2)	4
IT420	Mobile Adhoc Networks	(3-0-2)	4
IT421	Semantic Web Technologies	(3-0-2)	4
IT422	Virtual Reality	(3-0-2)	4
IT423	Rich Internet Applications	(3-0-2)	4
IT450	Web Services	(3-0-0)	3
IT451	Software Architecture	(3-0-0)	3
IT452	Advanced Computer Architecture	(3-0-0)	3
IT453	Transaction Processing	(3-0-0)	3
IT454	Software Quality Assurance	(3-0-0)	3
IT455	Information Technology for Healthcare	(3-0-0)	3
IT456	Enterprise Resource Planning and Systems	(3-0-0)	3
IT457	Natural Language Processing	(3-0-2)	4
IT458	Information Retrieval	(3-0-2)	4
IT459	Simulation and Modelling	(3-0-2)	4
IT460	E-Commerce	(3-0-0)	3
IT461	Advanced Database Systems	(3-0-2)	4
IT462	Number Theory and Cryptography	(3-0-2)	4
IT463	Linux Kernel Internals	(3-0-2)	4
IT464	Foundations of Machine Learning	(3-0-2)	4
IT465	Cryptocurrencies and Blockchain Technologies	(3-0-2)	4
IT466	Fundamentals of 5G	(3-0-2)	4
IT467	Robotic Process Automation	(3-0-2)	4
IT468	Quantum Computing	(3-0-2)	4
IT470	Cornerstone/capstone Project		4

Minor Courses (Except for CS and AI Students)

IT210M	Data Structures and Algorithms	(3-0-2)	4
IT252M	Database Systems	(3-0-2)	4
IT254M	Web Technologies and Applications	(3-0-2)	4
IT301M	Parallel Computing	(3-0-2)	4
IT350M	Data Analytics	(3-0-2)	4

For B.Tech. (Honors) in Information Technology:
Students seeking Honors degree shall credit five courses of M.Tech.(IT) including Programme Core/Electives offered by the Department of Information Technology and as decided by DUGC with 20 credits.
For other details please see M.Tech. (IT) Curriculum.

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Suggested Plan of Study

Semester →	I	II	III	IV	V	VI	VII	VIII
1	MA110	MA111	IT200	IT250	IT300	IT350	IT440	IT499
2	CY110	PH110	IT201	IT251	IT301	IT351	UC401	Elective-5
3	CY111	PH111	IT202	IT252	IT302	IT352	IT449	Elective-6
4	WO110	ME110	IT203	IT253	IT303	SM302	IT470	Elective-7
5	CS110	ME111	IT204	IT254	SM300	Elective-1	Elective-2	---
6	CS111	SM110	IT205	IT290	---	---	Elective-3	---
7	CV110	SM111	IT206	---	---	---	Elective-4	---
8	IT110	IT150	---	---	---	---	---	---
9	ME100	---	---	---	---	---	---	---

Degree Requirements:

Category of Courses	Minimum Credits to be Earned
Basic Science Core (BSC)	16
Engineering Science Core (ESC)	13
Humanities and Social Sciences Core (HSC)	09
Programme Core (PC)	77
Electives (ELE): Programme Specific Electives (PSE)	24
Major Project (MP)	6
Mandatory Learning Courses (MLC)	16
Total	161

Department of Information Technology

IT110 DIGITAL SYSTEM DESIGN   (3-0-2) 4
Introduction: Number Systems and Codes; Boolean Algebra and Logic Gates; Karnaugh Maps and Gate-Level Minimization; Combinational Logic Design: Adders, Subtractors, Comparators, Decoders, Encoders, Multiplexers; Sequential Logic Design: latches, Flip-Flops; Registers, Counters and Memory Unit: Shift Registers, Ripple and Synchronous Counters, Random Access Memory; Algorithmic State Machines; Design at the Register Transfer Level; Hardware Descriptive Language.
M. Morris Mano, Digital Logic & Computer Design, 1st Edition, Pearson Education, 2016.
M. Morris Mano and Michael D. Ciletti, Digital Design with VERILOG HDL, 5th Ed., Pearson, 2012.
Mark Zwolinski, Digital System Design with VHDL, 2nd Edition, Pearson, 2004.
B. Holdsworth and R.C. Woods, Digital Logic Design, 4th Edition, Elsevier, 2003.

IT150 OBJECT ORIENTED PROGRAMMING   (3-0-2) 4
Concepts of OOP – Introduction to OOP, Procedural Vs. Object Oriented Programming, Principles of OOP, Benefits and applications of OOP; Beginning with C++: Overview and Structure of C++ Program, Classes and Objects, Constructors and Destructors. Programming with JAVA – Overview of Java Language, Classes Objects and Methods, Method Overloading and Inheritance, Overriding Methods, Final Variables and Methods, Interfaces, Packages, Multithreaded programming, Exception Handling; Introduction to Android Programming : Setting up Development Environment, Basic Building blocks – Activities, Services, Broadcast Receivers & Content providers, UI Components –Views & notifications, Components for communication –Intents & Intent Filters; Introduction to Object-Oriented Design and Analysis, UML, Use Case Modeling. Introduction to Design Patterns (Observer, Strategy, Composite, Decorator, Iterator, Adaptor, Command, Factory Method, Proxy, Singleton, and Visitor).
E. Gamma et al., Design Patterns:Elements of Reusable Object-Oriented Software, 1st Ed., Addison-Wesley, 1994. G. Booch, J. Rumbaugh, and I. Jacobson, The Unified Modeling Language User Guide, Addison-Wesley, 1999. Bruce E. Wampler, The Essence of Object Oriented Programming with Java and UML, Addison-Wesley, 2002. Danny Poo, Derek Kiong and Swarnalatha Ashok, Object-Oriented Programming and Java, 2nd Ed., Springer, 2007.

IT200 COMPUTER COMMUNICATION AND NETWORKING   (4-0-0) 4
Evolution of Data Communication and Networks, Transmission Fundamentals: Signaling Schemes, Encoding and Modulation, Data Transmission over Networks – Switching Techniques, Layered Architecture of Computer Networks, OSI & TCP/IP Architectures and Layers with protocols, Data Link Control and Protocols, Error Detection and Correction, Internetworking & Routing, Transport Layer Protocols, Applications: E-Mail, HTTP, WWW, Multimedia; Implementation of Signaling and Modulation, Bit, Byte & Character Stuffing and Error Detection/Correction Coding Techniques, TCP/IP Level Programming, Routing Algorithms, Exercises comprising simulation of various protocols.
"Computer Networks", Andrew S. Tanenbaum and David J Wetherall, 5th Edition, Pearson, 2013.
"Data Communications and Networking", Behrouz A. Forouzan, 4th Edition, McGraw Hill, 2017.
"Data and Computer Communications", William Stallings, 10th Edition, Pearson, 2013.
"Communication Networks", Leon, Garcia and Widjaja, 2nd Edition, McGraw-Hill, 2003.
"Computer Networking: A Top-Down Approach", James Kurose; Keith Ross, 7th Edition, Pearson, 2016.
"Computer Networks: A Systems Approach", Larry Peterson and Bruce Davie, 5th Ed., Morgan Kaufmann, 2011.

IT201 COMPUTER ORGANIZATION AND ARCHITECTURE   (3-0-0) 3
Introduction to computer organization and architecture, CPU Organization, Data Representation, Instruction Sets, Data path design, Fixed point and floating point arithmetic operations and hardware design, ALU design, Control unit : Hardwired control unit and Micro programmed control unit. Memory organization, Cache memory, Virtual memory. Input output Unit: Programmed Controlled I/O Transfer, Interrupt controlled I/O transfer, DMA controller. Secondary storage and type of storage devices. Pipelining. Performance evaluation.
Carl Hamacher et al., Computer Organization and Embedded Systems, Sixth Edition, McGraw-Hill, 2014. Vincent P Heuring, Harry F Jordan, T. G. Venkatesh, Computer Systems Design and Architecture, Pearson, 2008. Miles Murdocca and Vincent Heuring, Computer Architecture & Organization An Integrated Approach, Wiley, 2007. J. Hennesy and D. Patterson, Computer Architecture –A Quantitative Approach, 6th Ed., Morgan Kaufmann, 2017.

IT202 DATA STRUCTURES AND ALGORITHMS-I   (3-0-0) 3
Elementary Data Types and Abstract Data Types. Computational model and complexity of algorithms (running time and space metrics), Introduction to Asymptotic notation: Big-O, Big-Omega, Big-Theta notations. Worst-case, Best-case, Average-case and amortized analysis. Arrays, Linear search and Binary search on sorted arrays. List ADT,

implementing List ADT using arrays. Pointers, implementing List ADT using Linked Lists. Types of Linked Lists: Single, Double, Circular linked lists and their applications for e.g. in garbage collection. Stack ADT and Queue ADT implementation, applications for parenthesis matching, expression evaluation, implementing recursion, etc. Dynamic set ADT and Dictionary ADT. Hash tables: collisions, open and closed hashing, choosing good hash functions. Trees: Definitions and Representations; Tree traversals and their applications. Binary Search Trees. AVL trees, Red-black trees, Multi-way search trees, B- trees, splay trees; Priority Queue ADT and its implementations using Binary heaps. Applications of Priority Queues. Sorting algorithms: Bubble sort, Selection sort, Insertion sort, Merge sort and Quick sort. Randomized Quick sort and its analysis. Linear-time sorting algorithms like Radix and Counting sort. Lower bound for comparison based sorting.

T H Cormen et al., Introduction to Algorithms, 3rd Edition, PHI Learning Ltd., 2010.
S. Horowitz. Fundamentals of Data Structures in C, Universities Press, 2nd Edition, 2008.
Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1st Edition, 2006.
Knuth D.E., Art of Computer Programming: Fundamental Algorithms, Addison Wesley, 3rd Ed., 1997.

IT203 DISCRETE MATHEMATICS (3-0-0) 3
Mathematical Logic and Proofs: Propositional Logic and Applications, Operations on Propositions, Truth Tables, Tautologies & Logical Equivalence, Predicate Logic, Predicates & Quantifiers, Nested Quantifiers, Inference Rules, Proofs Methods; Set Theory: Sets/Operations, Sequences/Summations, Cardinality of Sets, Functions (Surjections, Injections); Induction and Recursion: Mathematical Induction, Strong Induction and Well-Ordering, Recursive Definitions, Structural Induction; Combinatorics: Counting, Pigeonhole Principle, Permutations/Combinations, Binomial Coefficients, Recurrence Relations, Generating Functions, Inclusion-Exclusion; Relations: n-ary Relations and Applications, Representing Relations, Closures of Relations, Equivalence Relations, Partial Orders; Group Theory: Groups, Semigroups, Monoids, Rings, Fields, Vector Spaces and Lattices; Graph Theory: Graphs and Models, Euler and Hamiltonian Paths, Trees, Tree Traversals, Spanning Trees, Graph Matching, Graph Coloring.

C.L.Liu and D.P. Mahapatra, Elements of Discrete Mathematics, 4th Edition, McGraw-Hill, 2012.
K.H.Rosen, Discrete Mathematics and Its Applications, 7th Edition, McGraw-Hill, 2017.
John A. Dossey, Discrete Mathematics, 5th Edition, Pearson, 2011.
Jean-Paul Tremblay and R Manohar, Discrete Mathematical Structures with Apps., 1st Ed., McGraw-Hill, 2017.
J .L.Mott, A.Kandel, T.P .Baker, Discrete Mathematics for Computer Scientists, 2nd Ed., Prentice Hall of India, 1986.

IT204 SIGNALS AND SYSTEMS (3-0-2) 4
Signals in Physical World: Continuous Time Signals & Spectra, Fourier Series, Fourier Transforms; Signals in Digital World: Sampling, Quantization, Interpolation, Discrete Time Signals & Spectra, Discrete Fourier Transforms (DFT): Fast Fourier Transforms (FFT), Discrete Cosine Transforms (DCT), Systems: Continuous Linear Time Invariant (LTI) and Time Variant (LTV) Systems, Discrete LTI & LTV Systems; Z-Transform; Convolution and Correlation; Filters: Feedforward and Feedback; Modulation: AM, FM, PAM, PCM, Multiplexing: FDM and TDM; Compression: Text (Huffman Coding, Run Length Coding); Audio (MP3); Image (JPEG); Video (MPEG4).

Michael Stiber and Bilin Stiber, "Signal Computing: Digital Signals in the Software Domain", Published by University of Washington Bothell, 2016.
A.V. Oppenheim, A.S. Willsky and S. Hamid Nawab, Signals and Systems, 2nd Edition, Pearson, 2015.
Rodger E. Ziemer, W.H. Tranter and D.R. Fannin, Signals and Systems, 4th Edition, Pearson, 2014.
B.P. Lathi and Roger Green, Linear Systems and Signals, 3rd Edition, Oxford University Press, 2017.
M.J. Roberts, Signals and Systems - Analysis Using Transform Methods & MATLAB, McGraw-Hill, 2017.
Luis F. Chaparro, Signals and Systems Using MATLAB, 2nd Edition, Academic Press, 2014.

IT205 COMPUTER NETWORKING LAB (0-0-3) 2
Implementation of Datalink Layer Protocols, Network Layer Protocols and Application Layer Protocols. Simulate different types of network topology, configure Router and Switches using open source tool such packet tracer. By writing a program/script measure incoming and outgoing network traffic, power consumption and storage status on networking device(s)/server.

IT206 DATA STRUCTURES AND ALGORITHMS-I LAB (0-0-3) 2
Implementation of List ADT operations using arrays and linked lists. Applications of Lists. Stacks, Queues, Circular Queues implementation and application. Implementing Hash Table with chaining and open addressing. AVL tree implementation, B- tree implementation, Application of trees. Array and pointer-based implementation of Binary heaps. Applications of Priority Queues. Searching and sorting. Applications to real world problems.

IT210M DATA STRUCTURES AND ALGORITHMS (3-0-2) 4
Elementary Data Types and Abstract data types. Computational model and complexity of algorithms (running time

and space metrics), Introduction to Asymptotic notation; Worst- case, Best -case, Average-case and amortized analysis. Arrays, Linear search and Binary search on sorted arrays. List ADT and its implementation using arrays and linked lists. Types of linked lists: Single, Double, circular linked lists and their applications. Stack ADT and Queue ADT implementations with applications. Dynamic set ADT and Dictionary ADT. Hash tables – collisions, open and closed hashing, choosing good hash functions. Trees: Definitions and Representations; Tree traversals and their applications. Binary Search Trees. AVL trees, Red-black trees, B-trees; Priority Queue ADT and its implementations using Binary heaps. Applications of Priority Queues. Sorting algorithms: Merge sort and Quick sort. Randomized Quick sort and its analysis. Linear-time sorting algorithms like Radix and Counting sort. Graphs: Definitions and representations. Depth-first and breadth-first search and their applications. Basic Graph algorithms like Dijkstra's shortest path algorithm and Kruskal's MST algorithm.
T H Cormen, C E Leiserson, R L Rivest and C Stein, Introduction to Algorithms, 3rd Edition, PHI Learning, 2010.
S. Horowitz. Fundamentals of Data Structures in C, Universities Press, 2nd Edition, 2008.
Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1st Edition, 2006.
Knuth D.E., The Art of Computer Programming, Vol. I: Fundamental Algorithms, Addison Wesley, 3rd Ed., 1997.

IT250 AUTOMATA AND COMPILER DESIGN (3-0-2) 4
Introduction to Automata and Compiler Design, Regular Expressions, DFA, NFA, Minimization of states, Lexical analysis, usage of Lex, CFG, BNF notation, PDA, Parsing Techniques, Top-down and bottom-up parsing, Error Recovery strategies, Intermediate Code Generation, Runtime environment, Code Generation and introduction to code optimizations. Simple projects to demonstrate the usage of parsers for code generation for a simple C-like language.
John E. Hopcroft et al., Introduction to Automata Theory, Languages and Computation, 3rd Ed., Pearson, 2007.
A.V. Aho et al., "Compilers: Priniciples, Techniques, Tools", 2nd Edition, Pearson, 2006.
Allen I. Holub, "Compiler Design in C", Prentice-Hall, 1990.

IT251 DATA STRUCTURES AND ALGORITHMS-II (3-0-2) 4
Graphs: Definitions and representations. Adjacency List and Adjacency Matrix representations and their relative advantages and disadvantages. Graph Algorithms: Depth-First Search (DFS) and Breadth-First Search (BFS). Applications of BFS and DFS. Topological Sorting and strongly connected components in directed graphs. Dijkstra's shortest path algorithm, and its analysis: runtime and correctness. Data Structure for Disjoint Sets: Union-by-rank and path-compression heuristics; applications to computing connected components and in Minimum Spanning Tree algorithms. Kruskal's and Prim's Minimal Spanning Tree algorithms. Network flows, max-flow min-cut theorem. Applications: network and internet examples. Tries, Suffix trees, Bloom filters and their applications. String Algorithms: Boyer-Moore, Rabin-Karp and Knuth-Morris-Pratt algorithms. Applications to Text Compression, Text similarity testing and Computational Biology. Topics in Computational Geometry: Range-trees, k-d trees, convex hull and other geometric algorithms.
Jon Kleinberg and Eva Tardos, Algorithm Design, 1st Edition, Pearson Education India, 2013.
S Dasgupta, C Papadimitriou, U Vazirani, Algorithms, McGraw-Hill Education, 2006.
T H Cormen, C E Leiserson, R L Rivest, C Stein, Introduction to Algorithms, 3rd Edition, PHI Learning, 2010.
Horowitz and Sahni, Fundamentals of Computer Algorithms, Galgotia Publications, 2nd Ed., 2009.
Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1st Edition, 2006.

IT252/IT252M DATABASE SYSTEMS (3-0-2) 4
Basic Concepts, Data models: ER, EER; Languages: SQL as backend and PHP or equivalent as frontend; Logical Database Design: Normalization; Physical Database Design: Storage organization, Indexing; Query Languages – Procedural , Non-procedural; Logical and Physical Design, Query Processing, Transaction processing: Concurrency Control and Recovery. Current trends in database system, Design and Implementation of Database Systems for applications such as office automation, hotel management, hospital management; Normalization, Query Processing in the above said application projects; Implementation of few important functionalities of relational database management systems.
Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw-Hill, 2014 R.
Elmasri and S.B Navathe , Fundamentals of Database Systems,7th Ed., Pearson, 2017
Silberschatz, Korth A.F., Sudarshan S., Database System Concepts, 6th Ed., McGraw-Hill,2010.

IT253 OPERATING SYSTEMS (3-0-2) 4
Operating Systems Overview, Interrupt Sources and Priorities, Interrupt Service Routines; User and Kernel Threads, Synchronization, Critical Section Problem; Process Synchronization and Coordination, Semaphores, Monitors; Inter Process Communication; Deadlock Prevention, Avoidance, Detection, Recovery; CPU Scheduling Algorithms, Memory Management, Paging and Virtual Memory, Storage Hierarchy, File System Organization; Distributed Operating Systems: System Architectures, Design Issues, Communication Models, Clock Synchronization, Mutual

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Exclusion, Election Algorithms, Distributed Deadlock Detection; Mobile Operating Systems: ARM & Intel Architectures, Mobile OS Architectures, Runtime Issues, Approaches to Power Management; UNIX/LINUX OS as Case Studies; Configure, Compile, and Install a Linux Kernel/Kernel Module from Sources, Performance Analysis; Device Drivers: Building and Running Modules, Char Drivers, Concurrency and Race Conditions, Interrupt Handling, Data Types in the Kernel, PCI Drivers, USB Drivers, Block Drivers, Network Drivers, TTY Drivers.

Andrew S. Tannenbaum and Herbert Bos, Modern Operating Systems, 4th Edition, Pearson, 2015
Abraham Silberschatz et al., Operating System Concepts, 9th Ed., John Wiley, 2012.
Harvey M. Deitel et al., Operating System, 3rd Edition, Pearson, 2007.
William Stallings, Operating Systems: Internals and Design Principles. 9th Ed., Pearson, 2017.
M. J. Bach. Design of the Unix Operating System, 1st Edition, Pearson, 2015.
Jonathan Corbet et al., Linux Device Drivers, 4th Edition, O'Reilly, 2013.

IT254/IT254M WEB TECHNOLOGIES AND APPLICATIONS   (3-0-2) 4

Internet and World Wide Web - Overview, Web System Architecture, Web Clients and Web Servers, Application Servers. Hypertext Transfer Protocol - primitives, methods, content transport, HTTP1.1 and HTTP2, HTTPS, SSL. Client side programming with XHTML, HTML5, CSS3, Event driven programming with JavaScript, Client-side validation; Server side programming, Sessions and Session Tracking techniques, jQuery and AJAX.; XML – Syntax and Semantics, DTD, Namespaces, XML Schemas, XPath and XSLT, Web Frameworks, Search Engines and Search Engine Optimization; The Next Generation Web - Social Web, Semantic Web, Internet/Web of Things, Applications and Research Trends.

Jeffrey C Jackson, "Web Technologies – A Computer Science Perspective", Pearson Education, 2009
Robert W Sebesta, "Programming the World Wide Web", 7th Edition, Pearson Education, 2014 Dietel
and Nieto, "Internet and World Wide Web — How to program", Pearson, 2010

IT290 SEMINAR   1

This seminar is a 1 credit mandatory learning course to be completed during 4th semester. Each student will make technical presentation on a topic of academic interest as per recommendations and evaluation criteria of the DUGC of IT department.

IT300 DESIGN AND ANALYSIS OF ALGORITHMS   (3-0-2) 4

Models of computation, algorithm analysis and asymptotic notation, time and space complexity, average and worst case analysis, lower bounds. Amortized analysis. Algorithm design techniques: recursion, branch-and-bound, divide and conquer, greedy, dynamic programming, randomization. Applications of the above techniques to a variety of problems: Stable matching, linear- time selection, integer, polynomial and matrix multiplications, Fast Fourier Transforms (FFT): FFT Algorithms, computing shortest paths and minimum spanning trees, etc. Reductions and the theory of NP-Completeness, Approximation algorithms.

Jon Kleinberg and Eva Tardos, Algorithm Design, 1ˢᵗ Edition, Pearson Education India, 2013.
S Dasgupta, C Papadimitriou, U Vazirani, Algorithms, McGraw-Hill Education, 2006.
T H Cormen, C E Leiserson, R L Rivest, C Stein, Introduction to Algorithms, 3ʳᵈ Edition, PHI, 2010.
Steven S Skiena, The Algorithm Design Manual, 2nd Edition, Springer-Verlag, 2ⁿᵈ Edition, 2013.
Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1ˢᵗ Edition, 2006.
Horowitz and Sahni, Fundamentals of Computer Algorithms, Galgotia Publications, 2ⁿᵈ Edition, 2009.

IT301/IT301M PARALLEL COMPUTING   (3-0-2) 4

Introduction to Parallel Computer Architectures, Shared memory and distributed memory programming techniques, Parallel Programming with OpenMP, MPI, Parallel Programming techniques like Task Parallelism using TBB, TL2, Cilk++ etc. and software transactional memory techniques. Introduction to accelerator programming using CUDA/OpenCL and Xeon-phi. Concepts of Heterogeneous programming techniques. Projects to implement a few of the techniques introduced in this course.

J. Dongara, I. Foster, G. Fox, W. Cropp et al, "Sourcebook of Parallel Programming", Morgan Kaufmann, 2002.
Barbara Chapman et.al, "OpenMP: Portable Shared Memory Parallel Programming", Scientific & Engineering Computation, MIT 2008.
B. Wilkinson and M. Allen, "Parallel Programming: Techniques and Applications", 2nd ed., Pearson, 2004.
Benedict R. Gaster et al., Heterogeneous Computing with OpenCL, 2nd Edition, Morgan Kaufmann. 2012.
Rezaur Rahman, Intel Xeon-Phi Coprocessor Architecture/Tools - The Guide for App. Developers, Apress, 2013.
CUDA for Engineers by Duane Storti and Mete Yurgotlu, Addison-Wesley, 2016.

IT302 PROBABILITY AND STATISTICS   (3-0-2) 4

Introduction to Statistics and Data Analysis; Probability Theory: Non-deterministic models, Finite Probability Space

and related concepts, Conditional Probability, Independent and mutually exclusive events, Bayes' Theorem, Random Variables – One and Two dimensional, Expectation, Variance, Correlation, Statistical Distributions – Uniform, Normal, Binomial, Gamma, Exponential, Poisson, Chi-Square, Log-Normal, Weibull; Stochastic Processes: Markov Chains, Binomial & Poisson; Queuing Systems: M/M/1 and M/M/K; Sampling Theory: Random Sampling and Applications, Mean, Median, Mode, Variance, Standard Deviation; Hypothesis Testing: Formulation of hypotheses – null and alternate hypothesis, Parametric and non -parametric tests and their applicability, Criteria for acceptance of hypothesis, Level of Significance, t-test, z-test and Chi-Square Tests with applications.

P. L. Meyer, Introductory Probability and Statistical Applications, Oxford & IBH Publishers, 2017.
S. M. Ross, Introduction to Probability & Statistics for Engineers and Scientists, 5th Ed., Academic Press, 2014.
Michael Baron, Probability and Statistics for Computer Scientists, 2nd Edition, CRC Press, 2014.
R. V. Hogg, J. W. McKean and A. T. Craig, Introduction to Mathematical Statistics, 7th Edition, Pearson, 2012.
R. E. Walpole et al., Probability and Statistics for Engineers and Scientists, 9th Edition, Pearson, 2010.
Jane M. Horgan, Probability with R with Computer Science Applications, 1st Edition, John Wiley, 2009.
John Verzani, Using R for Introductory Statistics, 2nd Edition, CRC Press, 2014.
G. Jay Kerns, Introduction to Probability and Statistics Using R, 1st Edition, G. Jay Kerns, 2010.
Maria Dolores Ugarte et al., Probability and Statistics with R, 2nd Edition, CRC Press, 2015.

IT303 SOFTWARE ENGINEERING (3-0-2) 4

Software Requirements Fundamentals: Product and Process Requirements, Functional and Nonfunctional Requirements, Quantifiable Requirements, System Requirements and Software Requirements, Requirements Process Models , Process Actors, Requirements Elicitation, Requirements Classification, Architectural Design and Requirements Allocation , Formal Analysis , Requirements Specification, Software Requirements Specification Requirements Reviews, Prototyping. Key Issues in Software Design: Concurrency , Control and Handling of Events , Data Persistence, Distribution of Components, Error and Exception Handling and Fault Tolerance, Interaction and Presentation , Security , Software Structure and Architecture, , Architectural Structures and Viewpoints , Architectural Styles, Architecture Design Decisions, Families of Programs and Frameworks , User Interface Design, General User Interface Design Principles, Software Design Quality Analysis and Evaluation ,Quality Attributes , Quality Analysis and Evaluation Techniques , Measures. General Strategies: Function-Oriented (Structured) Design, Object-Oriented Design, Data Structure-Centered Design, Component- Based Design; Software Construction : Minimizing Complexity, Anticipating Change, Constructing for Verification, Reuse, Coding, Integration, Construction Technologies, API Design and Use, Object-Oriented Runtime Issues, Parameterization and Generics, Assertions, Design by Contract, and Defensive Programming, Performance Analysis and Tuning , Unit Testing Tools, Profiling, Performance Analysis, and Slicing Tools; Software Testing, Input Domain-Based Techniques, Code-Based Techniques, Fault-Based Techniques, Usage-Based Techniques, Model-Based Testing Techniques, Software Maintenance Fundamentals, Techniques for Maintenance, Program Comprehension, Reengineering, Reverse Engineering, Migration, Retirement; Software Configuration Management, Management of the SCM Process, Organizational Context for SCM, Constraints and Guidance for the SCM Process, Planning for SCM, Surveillance of Software Configuration Management, Software Configuration Identification, Identifying Items to Be Controlled, Requesting, Evaluating, and Approving Software Changes, Implementing Software Changes, Deviations and Waivers, Software Configuration Status Accounting, Software Configuration Auditing , In-Process Audits of a Software Baseline, Software Release Management and Delivery, Software Building Software Release Management, Software Configuration Management Tools.

Axel van Lamsweerde, Requirements Engg: From System Goals to UML Models to Software Specs., Wiley,2009.
Lenny Delligatti, SysML Distilled: A Brief Guide to the Systems Modeling Language, 1st Ed., Addison-Wesley, 2013.
J.H. Allen et al., Software Security Engineering: A Guide for Project Managers, Addison-Wesley, 2008.
R.S. Pressman, Software Engineering: A Practitioner's Approach, 7th ed., McGraw-Hill, 2010.
P. Clements et al., Documenting Software Architectures: Views and Beyond, 2nd ed.,Pearson Education, 2010.
M. Utting and B. Legeard, Practical Model-Based Testing: A Tools Approach, Morgan Kaufmann, 2007.
J.W. Moore, The Road Map to Software Engg: A Standards-Based Guide, Wiley-IEEE Computer Society Press, 2006.
S.P. Berczuk and B. Appleton, Software Configuration Management Patterns:Effective Teamwork, Practical Integration, Addison-Wesley Professional, 2003.

IT350/IT350M DATA ANALYTICS (3-0-2) 4

Introduction to Data analysis: statistical modelling, total information awareness, Bonferroni's Principle; Distributed File systems: MapReduce and Spark; Dimensionality Reduction: PCA, SVD; Finding Similar Items: Distance Measures, Near Neighbour Search; Mining Data Streams; Link Analysis, Mining Social-Network Graphs: graph centrality concepts, clustering, community detection, partitioning, overlapping community detection, SimRank; Applications of Large-scale Machine Learning, Neural Network Models like Multi-Layer Perceptron (MLP), Recurrent Neural Networks (RNN), Convolutional Neural Network (CNN), Long Short Term Memory (LSTM).

Josh Patterson and Adam Gibson, "Deep learning: A Practitioner's Approach", O'Reilly, 2017

Ian Goodfellow, Y. Bengio and A. Courville, "Deep Learning", MIT Press, 2016.
Michael A. Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015
Li Deng and Dong Yu, "Deep Learning: Methods and Applications", 2013
Koller, D. and Friedman, N. Probabilistic Graphical Models . MIT Press. 2009
Hastie, Trevor, et al. The elements of statistical learning. Vol. 2. No. 1. New York: springer,   2009.
Jure Leskovec et al., "Mining of Massive Datasets" Cambridge University Press, 2014
Tom White " Hadoop: The Definitive Guide" Fourth Edition, O'reily Media, 2015.

IT351 HUMAN COMPUTER INTERACTION   (3-0-2) 4
Foundations: The Human, The Computer, The Interaction and Paradigms; User Experience Design; The Process of Developing Interactive Systems: Models, Theories, Design Process and Evaluation; Interacting with Computers: Vision, Graphic Design, and Visual Displays - Touch, Gesture and Marking, Speech, Language and Audition; Human Factors in Design; Effective Interfaces; Application Domain Aspects; Affective User Experiences; Human Centered Evaluations; Assistive Technologies and Accessibility; User Advocacy; Research Trends.
Andrew Sears and Julie A. Jacko, The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications, 3rd Edition, CRC Press, New York 2012.
Philip Kortum, HCI Beyond the GUI: Design for Haptic, Speech, Olfactory and other Nontraditional Interfaces, Morgan Kaufmann Inc., Originally Published by Elsevier, 2008.
Alan Dix et al., Human Computer Interaction, 3rd Edition, Pearson, 2004.
Don Norman, The Design of Everyday Things: Revised and Expanded Edition, Basic Books, 2013.
Ben Shneiderman et al., Designing the User Interface: Strategies for Effective HCI, 6th Edition, Pearson, 2016.
J. Preece et al., Interaction Design: Beyond Human Computer Interaction, 4th Edition, Wiley, 2015.
Joel March, UX for Beginners: A Crash Course in 100 Short Lessons, O'Reilly Media, *2015*
Jesse James Garrett, The Elements of User Experience: UCD for the Web and Beyond, New Riders, 2011.
Jeff Gothelf and Josh Seiden, Lean UX: Designing Great Products with Agile Teams, O'Reilly Media, 2016.
Constantine Stephanidis, User Interfaces for All: Concepts, Methods and Tools, LEA Inc., New Jersey, 2009.
Nicola Millard, Designing Motivational User Interfaces: Balancing Effective and Affective User Interface Design to Motivate Call Centre Advisors, VDM Verlag Dr. Müller, 2009.
Rex Hartson and Pardha S. Pyla, UX Book: Process/Guidelines for Ensuring QUX, Morgan Kaufmann, 2012.

IT352 INFORMATION ASSURANCE AND SECURITY   (3-0-2) 4
Cryptography: Private and Public Key Encryption, Uses of Encryption; Network Security: threats, controls –
Encryption, Authentication, Network Security tools (Firewalls, Intrusion Detection); Program Security: non-malicious program errors such as buffer overflow, viruses, other malicious code, targeted malicious code, controls against program threats; Protection in Operating Systems: protected objects, methods of protection, access control, authentication; Web Security; Data security and privacy; Forensics and Incident response; Security Policies and Procedures.
"Network Security Essentials", William Stallings, 4th Edition, Pearson Education, 2008.
"Cryptography & Network Security", Atul Kahate, McGraw Hill, 2004.
"Information Assurance–Dependability & Security in Networked Systems", Yi Qian et al, Morgan Kaufmann, 2008.
*"A. Abraham et al,Computational Intelligence in Information assurance and security",*N.Nedjah, Springer

IT360 INFORMATION SYSTEMS   (3-0-2) 4
Introduction to Information Systems; Information Systems Development: Life Cycle, Management, Strategies,
Construction Approaches; Systems Planning; Systems Analysis: Requirements, Tools for Business Process Modelling, Data Flow Diagram & Its Use, Data Modelling, Analysis Report; Systems Design: Acquisition Development, Construction Development, Systems Design Report; Systems Implementation; Systems Maintenance: Management, Post-Project Evaluation.
Shouhong Wang and Hai Wang, Information Systems Analysis and Design, Universal Publishers, 2012.
V. Rajaraman, Analysis and Design of Information Systems, 3rd Edition, PHI Learning, 2011.
Dennis, Wixom and Roth, Systems Analysis & Design, 5th Edition, John Wiley, 2012.
Langer A.M, Analysis and Design of Information Systems, 3rd Edition, Springer, 2008.
James A. Senn, Analysis & Design of Information Systems, 2nd Edition, McGraw-Hill, 2008.
Jeffrey L. Whitten and Lonnie D. Bentley, System Analysis and Design Methods, 7th Ed., McGraw-Hill, 2007.
Raul Sidnei Wazlawick, Object Oriented Analysis and Design for Information Systems: Modelling with UML, OCL, and IFML, Elsevier, 2014.

IT361 PARADIGMS OF PROGRAMMING   (3-0-2) 4
Programming domains; Language Evaluation; Programming Paradigms – Imperative, Functional, OOP and Logic

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programming; Formal methods: syntax and semantics - Backus Naur Form, Attribute grammars; Describing semantics - Denotational semantics; Data types, Names, Variables, Bindings, Scope and lifetime, Referencing Environments; Named Constants-Variable Initialization-Subprograms-Parameter Passing – Coroutines; Even Driven Programming: Fundamentals; Case studies from Desktop to Mobile applications, VB.NET, ANDRIOD Applications; Functional programming languages - Lambda calculus - LISP; Application of functional programming languages; Logic programming languages –introduction to predicate calculus - Horn clauses - Logic programming: Prolog, Applications; Asynchronous Programming Model with a Case Study (AJAX, C#...); Run-time Program Management; Virtual Machines: Java Virtual Machine, Common Language Infrastructure, Late Binding of Machine Code, Just-in-Time and Dynamic Compilation, Binary Translation, Binary Rewriting, Mobile Code and Sandboxing, Performance Analysis.

Robert W.Sebesta, "Concepts of Programming Languages", 11th Edition, Pearson, 2016.
Ravi Sethi, "Programming Languages - Concepts and Constructs", 2nd Edition, Pearson, 2002.
Michael L. Scott, "Programming Language Pragmatics", 4th Edition, Morgan Kaufmann, 2015.
Kenneth.C.Louden, "Programming Languages: Principles and Practices", 3rd Edition, Cengage Learning, 2011.

IT362 COMPUTER GRAPHICS   (3- 0-2) 4
Computer Graphics Hardware; Scan Conversion: lines, circles, ellipses; Filling Algorithms, Clipping Algorithms, Viewing in 3D: Projections, 2D & 3D transformations, Visible surface determination, Animation of 2D images: Implementation of 2D packages which support graphics editor with classical input techniques and animation.

Hearn and Backer, Computer Graphics Principles and Practice-3rd Edition, Addison Wesley, 2013.
Van Dam, Foley, Feimer, Hugher Computer Graphics Principles and Practice in C, 1st ed., Pearson, 2013.

IT363 MICROPROCESSORS AND INTERFACING   (3-0-2) 4
Microprocessor history, Microprocessor architecture, 8086, instruction set, subroutines, Programming examples, software development systems, Interrupts, Polling, Daisy chain, RST instructions, Priority encoder, Programmable peripheral devices, 8255, 8253, 8259, 8257, Intel 80386, 80486 & Pentium Processors, Motorola 68000, 68020, 68030 processors, Mother boards, I/o bus, I/O channel, BIOS, DOS PC bus, Multibus I& II, VME and peripheral controllers.

Douglas V. Hall, Microprocessors and Interfacing, 2nd Edition, Tata McGraw-Hill, 2006.
Babby B.Brey, The Intel Microprocessors – Architecture, Programming & Interfacing, Pearson/Prentice Hall, 2008

IT364 PERFORMANCE MODELING   (3-0-2) 4
Performance Evaluation methods. Analytical versus simulation modeling. Performance measurement and benchmarking. Workload modeling. Random variables. Commonly used distributions. Stochastic processes. Markov chain models of computer systems. Queuing models. Discrete event simulation. Simulation Languages. Confidence intervals. Variance reduction techniques. Case studies of analytical & simulation of computer systems.

Raj Jain, The Art of Computer Systems Performance Analysis, Jon Wisely and Sons, New York, USA, 1991.
KS Trivedi, Probability and Statistics with Reliability, Queuing and computer science, PHI 1982.
Paul & Howard, Computer systems performance Evaluation & Prediction, Elsevier, 2005.

IT365 ADVANCED COMPUTER NETWORKS   (3-0-2) 4
Review of TCP/IP Protocol suit with latest developments, Broadband networks, advanced concepts: ATM, Frame Relay,   Fiber Optic Networks: SONET, VOIP, MIPv6 etc., Remote   Access and Wireless Networking: Virtual Private Networks - L2 and L3 Switches, Tunneling; BGP and Adaptive Routing, MPLS: QoS, Network Recovery/Restoration; Security Issues in TCP/IP and BGP, DoS/DDoS attacks, Mitigation with recent trends, Cryptography, Intrusion Detection; Network Management issues and protocols, Internet Management, Common Management Information services/protocol (CMIS/CMIP), Network Trouble Shooting, QoS (Integrated/Differentiated Services), Port based Network Access control, Availability, Scalability, Load Balancing and Recent Trends.

James F Kurose and Keith W Rose, Computer Networking, Pearson Education, 2003 Andrew. S.
Tannenbaum, Computer Networks, Prentice Hall of India, 2nd Edition, 2002. M. Subramanian,
Network Management: Principles and Practice, Addison- Wesley, 2000. William Stallings, Data and
Computer Communications and Networking, 2nd Edition, TMH, 2002. Behrouz A Forouzan, Data
Communications and Networking, 2nd edition, TMH, 2002. Leon,Garcia and Widjaja -
Communication Networks, TMH 2002.

IT366 OBJECT ORIENTED ANALYSIS AND DESIGN   (3-0-2) 4
Introduction to object technology and applications; object oriented decomposition vs. structured decomposition in software development, concepts and applications of object oriented analysis and design, object oriented databases, application development using programming language JAVA.

Grady Booch, Object Oriented Analysis and Design with Applications, 3rd Edition, Addison Wesley, 2007.
Michael R. Blaha and James Rumbaugh, Object Oriented Modeling/Design with UML, 2nd Ed., Pearson, 2004.
Raul Sidnei Wazlawick, Object Oriented Analysis and Design for Information Systems: Modelling with UML, OCL, and IFML, Elsevier, 2014.

IT400 PERCEPTUAL AUDIO PROCESSING   (3-0-2) 4
Fundamentals of Audio and Speech Processing; Speech and Audio Analysis: Transforms – STFT, DCT;
Audio and Speech Compression Standards: MPEG and AAC; Human Auditory Perception; Perceptual
Audio Quality Metrics, Perceptual Processing of Digital Speech; Speech and Audio Rendering; Speech
and Audio Storage and Retrieval; Applications and Research Trends.
Jacob Benesty, M. Mohan Sondhi and Yiteng Huang, Handbook of Speech Processing, Springer-Verlag, 2008.
A Spanias, T Painter and Venkatraman A, "Audio Signal Processing and Coding", Wiley-Interscience, 2007.
Hugo Fastl and Eberhard Zwicker, "Psychoacoustics: Facts and Models", Springer, 3rd edition, 2006. Marina
Bosi and Richard E. Goldberg, "Introduction to Digital Audio Coding Standards", Springer, 2002. Ben G,
Nelson M, "Speech & Audio Signal Processing: Processing/Perception of Speech/Music", Wiley, 1999.

IT401 PERCEPTUAL VIDEO PROCESSING   (3-0-2) 4
Fundamentals of Image and Video Processing; Image and Video Analysis: Image Transforms - DCT, Hadamard,
Haar, KL and Wavelets; Image and Video Compression Standards: JPEG, JPEG2000, MPEG1, MPEG2, MPEG4 &
MPEG7; Image and Video Rendering and Assessment; Human Visual Perception; Perceptual Video Quality Metrics,
Perceptual Coding and Processing of Digital Pictures; Image and Video Storage, Retrieval; Applications and Research
Trends.
Perceptual Based Image Processing, Morgan & Claypool, 2009
Al Bovik, "Handbook of Image and Video Processing", Elsevier Academic Press, 2005
H. R. Wu and K. R. Rao, "Digital Video Image Quality and Perceptual Coding", CRC Press, 2005
R. C. Gonzalez and R E Woods, "Digital Image Processing", Pearson Education, 2002 William K
Pratt, "Digital Image Processing", Wiley, 2001.

IT402 SOFT COMPUTING   (3-0-2) 4
Optimization and Some Traditional Methods and issues, Introduction to Genetic Algorithms, Some Specialized Genetic
Algorithms, Introduction to Fuzzy Sets, Fuzzy Reasoning and Clustering, Fundamentals of Neural Networks,
Fundamentals biologically inspired computing, Hybrid soft computing methods, Swarm optimization techniques:
Particle swarm optimization and Global swarm optimization, Applications and Recent Research Trends.
Vojislav Kecman, Learning and Soft Computing , Pearson Education (Asia) PTE, 2004
Ross T.J., Fuzzy logic with engineering applications-McGraw Hill, 1995
J. M. Zurada, Introduction to artificial neural networks, Jaico publishing, 1997.
Goldberg D., Genetic algorithms- Addison-Wesley, 1st edition,1989.
S. N. Sivanandam, S. N. Deepa, Principles of Soft Computing 2nd edition, Wiley, 2011.
*Shishir K. Shandilya, Smita Shandilya, Kusum Deep, Atulya K. Nagar, Handbook of Research on Soft Computing and
Nature-Inspired Algorithms, IGI Global, 2017.*
*Evolutionary Algorithm for Solving Multi-objective, Optimization Problems (2nd Edition), Collelo, Lament,
Veldhnizer (Springer)*
J. Han and M. Kambar, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers Elsevier), 2008

IT403 GENETIC ALGORITHMS   (3-0-2) 4
Robustness of traditional optimization and search techniques, Simple Genetic Algorithms, Similarity templates, goals
of optimization, Schema Theorem of John Holland, Computer Implementation and Applications of genetic algorithms,
advanced operators and techniques in genetic algorithms, Recent research Trends.
David Goldberg, Genetic Algorithms in search, optimizations and machine learning, Addition Wesley, 1999
Charles L Karr and L Michael Freeman, Industrial applications of Genetic Algorithms, CRC Press 1998.

IT404 ARTIFICIAL NEURAL NETWORKS   (3-0-2) 4
Introduction to Artificial Neural Networks , Artificial Neuron Model and Linear Regression, Gradient Descent
Algorithm, Nonlinear Activation Units and Learning Mechanisms, Learning Mechanisms, Associative Memory
Model, Statistical Aspects of Learning, Single-Layer Perceptron, Least Mean Squares Algorithm, Perceptron
Convergence Theorem, Bayes Classifier, Back Propagation Algorithm, Multi-Class Classification Using Multi-layered
Perceptrons, Radial Basis Function Network, Introduction to Principal Component Analysis and Independent

Component Analysis, Introduction to Self Organizing Maps, Applications and Recent Research Trends
Simon Haykin, "Neural Networks - A Comprehensive Foundations", Pearson, 2004
Laurene Fausett: "Fundamentals of Neural Networks: Architectures, Algorithms & Apps.", Pearson, 2004.
James A. Anderson, "An Introduction to Neural Networks", MIT press, 1995.
Yegnanarayana: "Artificial Neural Networks", Prentice Hall of India,2004.

IT405 FUZZY SYSTEM MODELS (3-0-0) 3
Classical /crisp set, fuzzy sets, Fuzzy numbers, Fuzzy arithmetic, Fuzzy measures, Operations on Fuzzy sets, Fuzzy relations, Multi valued logic, Fuzzy logic, Uncertainty and information, Approximate reasoning, Fuzzy decision making, Fuzzy models, case studies.
Klir and Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India 2001.
Li Xin Wang, A Course in Fuzzy Systems and Control, Prentice Hall, 1996.
J. Yen and R. Langari, Fuzzy logic: Intelligence, Control and Information, Pearson, 1998.

IT406 DISTRIBUTED COMPUTING SYSTEMS (3-0-2) 4
Basic concepts - Computer networks, Distributed systems andComputing, Design goals, Fundamental
issues and transparencies in DCS, Ordering of events, Ordering of messages and concerned protocols, Global state detection Process synchronization, Process communications, Load balancing techniques. *Mukesh Singhal and Niranjan G. Shivaratri, Advanced Concepts in Operating System, Tata McGraw Hill, 1994.*
A.S Tanenbaum and M.V. Steen, Distributed Systems – Principles and Paradigms, Prentice-Hall, 2006.
Randy Chow, Distributed Operating Systems and Algorithms, Addison Wesley, 1997.
G.F. Coulouies, J.D. Dollimore and T. Kindberg, Distributed Systems: Concepts & Design, Addison Wesley, 1994.

IT407 TECHNOLOGIES FOR INTERNET OF THINGS (3-0-2) 4
Introduction, IPv6 packet: IPv6 base header, Hop by Hop extension Header, Source Routing, Structure of IPv6 packet: fragmentation, IPv6 packet processing in routers, IPv6 address architecture, Current IPv6 prefix allocation, IPv6 addressing. ICMPv6: functionalities, neighbor discovery, address auto
configuration. Communication standards: IEEE 802.15.4, IEEE 802.11, 6LoWPAN. Routing in low power lossy networks: RPL. Introduction to service oriented architecture and Web services, RESTful web services and applications for networked embedded systems. The Constrained Application Protocol (CoAP): features, interaction model, messages and request and response sub layer
J. Biron and J. Follett, Foundational Elements of an IoT Solution, O'Reilly Media, 2016.
Keysight Technologies, The Internet of Things: Enabling Technologies and Solutions for Design and Test, Application Note, 2016.
Charles Bell, Beginning Sensor Networks with Arduino and Raspberry Pi, Apress, 2013
Arshdeep Bahga and Vijay Madisetti, Internet of Things: A hands on approach, VPT Publications 2014
Olivier Hersent, David Boswarthick, Omar Elloumi, The IoT: Key Applications and Protocols, Wiley, 2015.

IT408 MOBILE COMPUTING (3-0-0) 3
Evolution of Wireless and Cellular Systems; Wireless Propagation: Encoding, Modulation,
Multiplexing, and Error Handling Techniques; MAC Layer: Channel Allocation Techniques; Study of MobileCommunication Systems:Infrastructure, Registration and basic Call Establishment and Termination, Handoff, Roaming Support; Threat, Logical Migration, Mobile agents, Security issues.
Kumkum Garg, Mobile computing - Theoory and Practice, 2010
Raj Kamal, Mobile computing, Oxford University Press 2007. Joschen Schiller, Mobile Commns, Pearson, 2003.
Dharma Prakash Agarwal & Qing-An Zeng, Wireless & Mobile Systems, CENGAGE, 2nd Edition, 2006.
William Stallings, Wireless Communication & Networks, Prentice Hall of India, 2nd Edition, 2004.

IT409 EMBEDDED SYSTEMS (3-0-0) 3
Embedded System Design Process: Embedded Computing Platform, Program Design and Analysis, Real Time Operating Systems, Networks: Distributed Embedded Architeture, System on Chip (SOC) and the current trends. *David E Silmon, An Embedded Software Printer Pearson Edition Asia, 2001 Wayne Wolf, Computer as Components – Harcort India Pvt. Ltd. 2001*

IT410 BIOINFORMATICS (3-0-0) 3
Introduction to Bioinformatics, Biological Databanks, Biological Sequence Analysis: Genome- Microarray, pairwise sequence alignment, Dynamic programming, global and local alignment, Progressive multiple sequence alignment, Iterative multiple sequence alignment. BLAST Scoring matrices, gap penalty, statistical significance of multiple

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sequence alignment, sum-of-pairs method, CLUSTAL W, searching motifs in sequence alignment. Structure Prediction – Protein Secondary Class prediction, Protein Folding.
Protein-Protein Interaction, Protein Subcellular Localization, Emerging Areas in Bioinformatics.
Durbin, R., Eddy, S., Krough, A. & Mitchison, G. (1998). Biological sequence analysis: probabilistic models of proteins and nucleic acids. Cambridge University Press.
Jones, N.C. & Pevzner, P.A. (2004). An introduction to bioinformatics algorithms. MIT Press.
Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press (2001)
Developing Bioinformatics Computer Skills by C. Gibas and P. Jam beck, 0' Reilly (2001)
Biological Sequence Analysis: Probabilistic models of proteins and nucleic acids by R. Durbin, S.Eddy, A. Krogh and G. Mitchison, Cambridge University Press (1998)

IT411 KNOWLEDGE MANAGEMENT   (3-0-0) 3
Introduction to knowledge management, Types of Knowledge within an organization. Intellecutal capital. KM Architecture and Tools. ERP for KM. Knowledge sharing tools. Data ware housing, Knowledge strategy creation. KM practice. KM Process. Integrating knowledge sharing and learing, The chief knowledge Officer (CKO) and his/her job. T4raining programmes for organization. widelearing. Making KM work across various segments of industry and business firms. Case studies of KM practices in successful companies, Future challenges in KM *Ratnja Gogula, Knowledge management: A New Dawn, Institute of Chartered Financial Analysts of India, 2002.*

IT412 TIME SERIES ANALYSIS   (3-0-0) 3
Introduction, Stochastic Processes, Stationary Time Series Process (Time Domain), Univariate Analysis: Autoregressive (AR) Process. Moving Average (MA) Process, Autoregressive Moving Average (ARMA) Process, Causality, Multivariate Anbalysis: Autoregressive Distributed Lag (ARDL) Model, Vector Error Correction (VEC) Model, Vector Autoregressive (VAR) Model, Spectral Analysis (Frequency Domain), Non- Stationary Time Series Process, Unit Root Tests: Dickey-Fuller Test Phillips-Peron Test Elliott-Rothenberg-Stock Test, Schmidt-Phillips Test, Kwiatkowski-Phillips-Schmidt -Shin (KPSS) Test, Zivot-Andrews Test, Cointegration introduction and tests, ARCH GARCH Model, Generalized Method of Moments (GMM)
Shumway and D. S. Stoffer (2006), Time Series Analysis and Its Applications (With R Examples), Springer.
kwell, Peter J & Davis, Richard A: Introduction to Time Series and Forecasting. Springer Series, Second Edition.
field, Chris: Analysis of Time Series: an Introduction. Chapman & Hall. Sixth Edition.
epohl, Helmut: Introduction to Multiple Time Series Analysis. Springer-Verlag.
ilton James D: Time Series Analysis. Princeton University Press.

IT413 SYSTEM INTEGRATION   (3-0-0) 3
Enterprise Integration Drivers, Requirements and Strategies, The Business Imperative for Enterprise Integration. Business Drivers and Requirements. Enterprise Integration: Strategy, Architecture Overview. Current Integration Architecture Assessment. Technical Integration Architecture, Service Integration Architecture, Information Integration Architecture. Process Integration Architecture, Enterprise Integration Solutions: Application, Information, Composite Application and Process-Driven Integrations; Best Practices for Enterprise Integration.
B. G. Bernstein and W. Ruh. Enterprise Integration: The Essential Guide to Integration Solutions, Addison-Wesley.
C. Britton, P. Bye, IT Architecture, Middleware: Strategies for Building Large Integrated Systems, Addison-Wesley.

IT414 DATA WAREHOUSING AND DATA MINING   (3-0-2) 4
Introduction to data mining: Motivation and significance of data mining, data mining functionalities, interestingness measures, classification of data mining system, major issues in data mining; Data pre-processing: Need, data summarization, data cleaning, data integration and transformation, data reduction techniques, data discretization and concept hierarchy generalization; Data warehouse and OLAP technology: multidimensional data model(s), data warehouse architecture, OLAP server types, data warehouse implementation, on-line analytical processing and mining; Data cube computation and data generalization: Efficient methods for data cube computation, discovery driven exploration of data cubes, complex aggregation, attribute oriented induction for data generalization; Mining frequent patterns, associations and correlations: Basic concepts, efficient and scalable frequent itemset mining algorithms, mining various kinds of association rules – multilevel and multidimensional, association rule mining versus correlation analysis, constraint based association mining; Classification and prediction: Definition, decision tree induction, Bayesian classification, rule based classification and support vector machines, associative
classification, lazy learners, prediction, accuracy and error measures; Cluster analysis: Definition, clustering algorithms – partitioning, hierarchical, density based, grid based and model based; Clustering high dimensional data, constraint based cluster analysis; Data mining on complex data and applications: Algorithms for mining of spatial data, multimedia data, text data; Data mining applications, social impacts of data mining, trends in data mining.

Han, J. and Kamber, M., "Data Mining - Concepts and Techniques", 3rd Ed., Morgan Kaufmann Series, 2008.
Alex Berson , S. J. Smith, "Data Warehousing, Data Mining & OLAP" , McGraw Hill
Tan, P.N., Steinbach, M. and Kumar, V., "Introduction to Data Mining", Addison Wesley – Pearson,
2006 Pujari, A. K., "Data Mining Techniques", 4th Ed., Sangam Books.
Oded Maimon, Lior Rokach, The Data Mining and Knowledge Discovery Handbook, Springer, 2005.
S. Weiss and N. Indurkhya, Predictive Data-Mining: A Practical Guide, Morgan Kaufmann, 1998.
S. Weiss, N. Indurkhya, T. Zhang and F. Damerau, Text Mining: Predictive Methods for Analyzing Unstructured
Information, Springer, 2004.

IT415 MIDDLEWARE TECHNOLOGIES   (3-0-2) 4
Introduction to Middleware Technologies, General Middleware, Service Specific Middleware, Client/Server
Building blocks: RPC, Messaging – P2P, Java RMI, Computing standards, OMG, Introduction to CORBA, EJB and
.NET, XML Technologies - XML, DTD, XSD, XSLT, XQUERY, XPATH, Web Services and SOA.
G. Sudha Sadasivam, Distributed Component Architecture, Wiley India Edition.
Thomas Erl ,Service Oriented Architecture: Concepts , Technology & Design, Prentice Hall
G.Brose, A Vogel and K. Duddy, Java programming with CORBA, 3rd Edition, Wiley India Joha Wiley and Sons
Ed Roman, Mastering Enterprise Java Beans, John Wiley & Sons Inc.

IT416 COMPUTER VISION   (3-0-2) 4
Introduction to Computer Vision, Color + Math basics, Linear Algebra, Pixels and filters, Edge detection, Features and
fitting, Feature descriptors, Resizing, Semantic segmentation, Clustering, Object recognition, Dimensionality reduction,
Face identification, Visual Bag of Words, Detecting objects by parts, Image classification, Motion Tracking,
Introduction to Deep Learning.
Sonka M., Hlavac V., Boyle R., Image Processing Analysis and Machine Design. PWS Publishers
Ballard D., Brown C., Computer Vision, Prentice Hall, 1982.
R. C. Gonzalez and R. E. Woods, Digital Image Processing, Addison Wesley, 1992.
Digital Image Processing and Computer Vision";; John Wiley and Sons, 1989.
Robert J. Schallkoff , Pattern Recognition: Statistical. Structural & Neural Approaches, John Wiley and Sons, 1992.
D. A. Forsyth and J. Ponce, Computer Vision: A Modern Approach, Pearson Education, 2003.
Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag, 2011.

IT417 PATTERN RECOGNITION   (3-0-2) 4
Patterns/features. Pattern recognition approaches. Discriminant functions. Statistical pattern recognition, Gaussian
model. Parametric estimation. Bayesian parameter estimation, pattern classification by distance functions Cluster
analysis, Syntactics pattern recognition. Features extraction and recent advances.
Earl Gose, Richard Johnsonbaugh, Steve Jost, Pattern Recognition and Image Analysis, Prentice Hall 1999.
Duda RO and Hart PE, Pattern Classification and Scene Analysis, Wiley 1973.

IT418 CLOUD COMPUTING   (3-0-2) 4
Introduction to Cloud Computing, Cloud Computing Delivery Models, Open Source and Industry Case Studies of
Cloud (Apache VCL, Amazon, IBM and Eucalyptus), Map/Reduce and Apache Hadoop Programming models for
cloud computing and examples/applications, Virtualizations as an enabler for cloud computing infrastructure, Cloud
Application Design & Development, Containers and Dockers.
George Reese, Cloud Application Architectures, O'Reilly Publications, 2009
Tim Mather, Subra Kumaraswamy. Cloud Security and Privacy , O'Reilly,
2009 Tom White, The Hadoop – Definitive Guide, O'Reilly, 2009.
Arshadeep Bagha and Vijay Madisetti, Cloud Computing: A Hands on Approach, Universities Press, 2014.

IT419 WIRELESS SENSOR NETWORKS   (3-0-2) 4
Introduction to wireless communication and wireless sensor networks, Network architecture and design principles,
MAC and link layer protocols, Topology control in WSN, Routing protocols, Information Aggregation, Information
Storage, Query, Localization, Security issues, Applications and recent trends: Wireless multimedia sensor networks.
F. Zhao and L. Guibas, Wireless sensor networks: An information Processing Approach , Morgan-Kaufmann, 2004.
Carlos de Morais Ciordeiro   nad Dharma Prakash Agrawal,Adhoc and Sensor Networks: Theory and
Applications,World Scientific Publications, 2006.

IT420 MOBILE ADHOC NETWORKS   (3-0-2) 4
 Mobile ad hoc networking; imperatives, challenges and characteristics, Bluetooth networks, Routing approaches,

Proactive and reactive protocols. Clustering and hierarchical routing, Multipath routing, Security aware routing, Energy efficient communication in Mobile ad hoc networks, Measuring energy consumption, Power save protocols, Maximum life time routing, Secure routing protocols, Intrusion detection, Security considerations in ad hoc sensor networks, Key management, Characterization of IP traffic, QOS classification, Self similar processes, Statistical analysis of both non – real time traffic and real – time services.

C.S. Murthy & B.S. Manoj, AdHoc Wireless Networks, Pearson, 2006.
T.Janevski, Traffic Analysis and Design of Wireless IP Networks, Artech House, 2003.
Ozan K. Tonguz & Gianluigi, Adhoc Wireless Networks, Wiley, 2006.

IT421 SEMANTIC WEB TECHNOLOGIES   **(3-0-2) 4**
Introduction to the Semantic Web – What is Semantics; Syntax, Structure and Semantics, Layered Cake Architecture; Structured Web Documents and Resource Description Framework – Understanding content, Metadata, metadata standards, XML + metadata specification, RDF and metadata processing; Programming with RDF/XML; Web Ontology Language (OWL)- Domain Modeling, Logic, Inferencing, Context; Logic Reasoning for the Semantic Web- Classification and semantic metadata extraction techniques: statistical, statistical learning/AI, lexical and natural language, knowledge based; Programming with Ontologies; Semantic Applications- semantic technology for services, search, personalization, contextual/custom/ enterprise applications; Linked Open data and next generation semantic content management; Research trends and open issues.

Pascal Hitzler et al, Foundations of Semantic Web Technologies, Chapman & Hall, 2009.
Karin Breitman et al, Semantic Web: Concepts, Technologies and Applications, Springer, 2010.
Grigoris Antoniou and Frank van Harmelen, A Semantic Web Primer, The MIT Press, 2nd Edition, 2008.
John Hebeler, Matthew Fisher, Ryan Blace, Andrew Perez-Lopez, Semantic Web Programming, Wiley, 2009.

IT422 VIRTUAL REALITY   **(3-0-2) 4**
Introduction to Virtual Reality Technology and its effectiveness in Real -Time Applications, Scientific Visualization, Input Devices: Trackers, Navigation and Gesture Interfaces; Output Devices: Graphics, 3D Sound and Haptic Displays; Computing Architectures for Virtual Reality, Modeling, Virtual Reality Programming, Human Factors in Virtual Reality; Overview of Virtual Humans, Face Cloning & Face Motion Capture/Analysis and Research Trends.

Gerard Jounghyun Kim, Designing Virtual Reality Systems – The Structured Approach, Springer-Verlag, 2005.
N Magnenat-Thalmann and D Thalmann, Handbook of Virtual Humans, Wiley, 2004.
L.J. Hettinger, M W. Haas, Virtual & Adaptive Environment: Apps, Human Performance, Lawrence Erlbaum, 2003.
Grigore C Burdea and Phillippe Coiffet, Virtual Reality Technology, John Wiley, 2003.

IT423 RICH INTERNET APPLICATIONS   **(3-0-2) 4**
Web2.0 concepts, SaaS model, Evolution of Web 2.0, Web Programming concepts, HTML, XHTML, CSS, Javascript. JS Execution Environment, Overview of XML, Web Services, Building Rich Internet Applications, AJAX, XML HTTP Object, ActionScript, Products from Industry like Flex (Adobe), Flash/AIR (Adobe)., Silverlight (MS), JavaFX (SUN), OpenLazzlo technologies, Recent Trends.

Robert Sebesta, Programming the World wide web, Pearson Education, Third Edition
Nicholas C Zakas et al, Professional AJAX, Wrox publications, 2006
Chafic Kazoun, Programming Flex 2, O'Reilly publications, 2007
Colin Moock, Essential Action script 3.0, O'Reilly Publications, 2007
Steven Holzner, Ajax Bible, Wiley India Edition, 2007
Justin Gehtland et al, A Web 2.0 primer Pragmatic Ajax, SPD Publications, 2006.

IT440 PRACTICAL TRAINING   **1**
The Student has to undergo a practical training programme or carrying out a research/practical oriented project or any equivalent training programme fixed by the DUGC of IT department. This practical training will be done during summer vacation (10-12 weeks) before the evaluation semester. Final evaluation is based on the report/seminar by the student.

IT449 MAJOR PROJECT – I
The student has to select a project based on a topic of interest before starting of VII semester. This project work will be commencing in VII semester and continued in VIII semester, at the end of each semester, the project will be evaluated internally and externally as per the evaluation criteria decided by the DUGC.

IT450 WEB SERVICES   **(3-0-0) 3**
IT Architecture, Distributed Information Systems, Middleware and Enterprise Application Integration, Introduction to

Service Oriented Architecture, Web Services origins, standards, basic concepts, Web Service Technologies and Architecture; protocols for Web service Description, Discovery and Access (WSDL, UDDI and SOAP); Web Service Application Management: Co-ordination, Service Orchestration and Compositions; Web Service Application Development: developing Web services, exposing functions as web methods, accessing service endpoints, WCF Framework; RESTful Web Services - basics, concepts, Restful application development and deployment; Services for the Internet of Things - Constrained Application Protocol (CoAP), features, interaction model; Semantic Web Services - background, motivation, advantages, basic concepts; Research Trends and open problems.

Alonso G, Casati F, "Web Services - Concepts, Architectures and Application Series: Data-Centric Systems and Applications", Springer, 2011
Robert Daignea, "Service Design Patterns: Fundamental Design Solutions for SOAP/WSDL and RESTful Web Services" 1st Edition , Addison Wesley Professional, 2011
Sam Newman, "Building Microservices: Designing Fine-Grained Systems", O-Reilly, 2015
Thomas Erl, "Service-Oriented Architecture: Concepts, Technology, and Design", Prentice Hall, 2005.

IT451 SOFTWARE ARCHITECTURE   (3-0-0) 3
Definition and overview of software architecture, The architecture business cycle: what influences software architects, Different Architectural styles, Architecture description language, Understanding and achieving quality attributes, Attribute-driven design, Documenting/Evaluating Software Architecture and its reuse, Case studies and Recent Trends.

Mary Shaw, David Garlan, Software Architecture, Prentice Hall ,India, 2000
Bass, Len; Paul Clements, Rick Kazman, Software Architecture In Practice, Second Edition. Addison-Wesley, 2003.
Clements, Paul et al, Documenting Software Architectures: Views and Beyond. Addison-Wesley, 2003.

IT452 ADVANCED COMPUTER ARCHITECTURE   (3-0-0) 3
Flynn's Classification, RISC Vs CISC, Data and control flow, Pipelining: Linear and non linear, pipeline hazards, instruction scheduling, Branch handling techniques, Arithmetic pipeline, VLIW architecture, Superscalar processors. Instruction level Data -Parallel architectures: SIMD architectures, Systolic and Vector architecture; MIMD architectures, Systems interconnect architecture: Network properties/routing, Static/dynamic interconnection networks. Multiprocessor architectures, models of memory consistency, cache coherence/directory protocols. Multicore architecture.

J. Hennesy and D. Patterson, Computer Architecture –A Quantitative Approach, 6th Ed., Morgan Kaufmann, 2017
Yan Solihin, Fundamentals of Parallel Multicore Architecture, Chapman and Hall/CRC, 2015
Dezso Sima, Peter Karsuk, Advanced Computer Architectures: A Design Space Approach, Addison- Wesley, 2002

IT453 TRANSACTION PROCESSING   (3-0-0) 3
Introduction and need of transaction processing, online transaction process (OLTP), OLTP program design, OLTP and system Reliability, OLTP and CICS standards in OLTP, current trends.
Gary McClain, OLTP handbook, McGraw Hill, 1997.

IT454 SOFTWARE QUALITY ASSURANCE   (3-0-0) 3
Overview of Software Engineering. Requirement Engineering Analysis, software reliability. Definition and concepts of software reliability, software quality. Introduction to software quality principles, total quality management, Quality Assurance Standards. ISO 9000 Tick-It method. Miscellanious Issues: Software maintenance. Future OF SQA
John J. Marciniak, Encyclopedia of Software Engineering. - Vol. I & II. John Wiley & Sons,
1994. Ince Darrel. ISO 9001 and Software Quality Assurance. McGraw Hill, 1994
Pankaj Jalote, An Integrated Approach to Software Engineering Narosh Publications, 1995
Isabel Evans, Achieving software Quality through team work, Allied publishers, 2004.

IT455 INFORMATION TECHOLOGY FOR HEALTHCARE   (3-0-0)3
Evolution of IT Enhanced Healthcare, Internet Technologies in Telemedical Systems, Wireless Systems in E-Health, Decision Support Systems in Medicine, Health Telematics Networks, Computer Aided Diagnosis and Recent Trends.
Krzysztof Zielinski, Mariusz Duplaga and David Ingram, IT Solutions For Healthcare, Springer, 2006
Robert E Hoyt, Nora Bailey, Ann Yoshihashi, Health Informatics, 5th Edition, Lulu Publishers, 2012
Kevin Beaver, Healthcare Information Systems, Auerbach Publications, 2nd Edition, 2002.

IT456 ENTERPRISE RESOURCE PLANNING AND SYSTEMS   (3-0-0) 3
ERP: Needs, Models, Commercial ERP Packages, Client Server and Open Technology Solutions, Supply Chain Management-Issues, Drivers and Obstacles, Coordinating SCM and ERP in E-Business

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Vinod Kumar G & N.K. Venkitakrishna, ERP- Concepts and Practice, PHI, 1998
Sunil C & Peter-SCM – Strategy and Planning and Operation, Pearson Education, LPE, 2002
Pete Loshin, Paul A. Murphy, Electronic Commerce, A JAICO Book.

IT457 NATURAL LANGUAGE PROCESSING (3-0-2) 4

Introduction and Overview, Language Modeling, History and Applications, Basic Text Processing - Word stemming, tokenization, normalization, Part of Speech tagging, Text Classification – basics and process, tools, Information Retrieval, TF/IDF, Ranked IR, Vector Space Models, Query analysis and processing, Basics of Information Extraction, Named Entity Recognition, Maximum Entropy models, Relation Extraction; Introduction to Semantics, word sense and word similarity, Basics of Wordnets, tools, Emerging trends, research issues, challenges, interesting applications in various domains.

Daniel Jurafsky and James H. Martin. "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition". Second Edition. Prentice Hall, 2008 Christopher D. Manning and Hinrich Schütze, "Statistical Natural Language Processing" MIT Press, 1999 Tanveer Siddiqui, U. S Tiwary, "Natural Language Processing/Information Retrieval", Oxford Univ. Press, 2008.

IT458 INFORMATION RETRIEVAL (3-0-2) 4

Introduction: Basic Concepts, Information need vs. Query, Modern Search Interface requirements, IR System Architecture, Classic IR Models for unstructured text, preprocessing techniques, Tokenizing, Indexing, and Implementation of IR models, Structured IR models, Multimedia IR, Experimental Evaluation of IR Systems, Implicit and Explicit Relevance Feedback techniques, Document/Query Properties and Representations, Web Search and Link analysis algorithms, Recommender Systems, Learning to Rank and Learning the ranking function based techniques, Machine learning in IR, Selected research papers on emerging trends and open problems in IR.

C. D. Manning et al., "Introduction to Information Retrieval",, Cambridge University Press. 2008.
Baeza-Yates & Ribeiro-Neto, "Modern Information Retrieval", Pearson Education, 2010
Donald Metzler et al., "Search Engines: Information Retrieval in Practice", Pearson Education, 2010

IT459 SIMULATION AND MODELING (3-0-2)4

System models and Role of Simulation, Types of Systems, Statistical Tools and Techniques, Discrete Event Simulation Languages, Modeling and Performance Evaluation of Computer Systems, Biological and Sociological System Simulation, Verification and Validation.

A. M. Law and W.D. Kelton, Simulation Modeling and Analysis, McGraw Hill, 2000
A. M. Law, Simulation Modeling and Analysis, McGraw Hill, 4th Edition, 2008

IT460 E-COMMERCE (3-0-0) 3

Infrastructure and Tools for E-Commerce, Current Trends in E-Commerce applications development, The Business of Internet Commerce, Enterprise level E-Commerce, Security and encryption, Electronic payment systems, Search engines, Intelligent agents in E-Commerce, On-line auctions, Data mining for e-commerce, Web metrics, Recommender systems, Knowledge management, Mobile e-commerce, Legal, ethical and social issues.

Henry Chan et al., E-Commerce- Fundamental and applications, John Wiley & Sons, 2002
G.Winfield Treese and Lawrence C.S, Designing Systems for Internet Commerce, Pearson Education, LPE, 2002
Fensel, Dieter, Brodie M. L., Ontologies: A Silver Bullet for Knowledge Management and E-Commerce, Allied Publishers, 2004.
Zimmermann, Olaf; Tomlinson, Mark R.; Peuser, Stefan, Perspectives on Web Services, Allied Publishers, 2004.

IT461 ADVANCED DATABASE SYSTEMS (3-0-2)4

Basic concepts, Buffer management, Query optimization, Selectivity estimation, Concurrency control, Recovery, Database tuning, Distributed databases– principles, architecture, design, query processing, transaction management, Replication, Web databases, Current trends in database system.

M. Tamer Özsu, Principles of Distributed Database Systems, Prentice Hall, 1999.
Ceri S and Pelagatti G, Distributed databases: Principles and Systems, McGraw Hill, 2000.
Thomas Connolly and Carolyn Begg, Database Systems: A Practical Approach to Design, Implementation and Management, Pearson Education, 2002.

IT462 NUMBER THEORY AND CRYPTOGRAPHY (3-0-2)4

Introduction to Number Theory: Prime Numbers, Fermat' s Little Theorem and Euler's Theorem, Testing for Primality, Chinese Remainder Theorem, Discrete Logarithms. Euclidean Algorithm, Extended Euclidean Algorithm, Euler' s Phi Function. Finite Fields: Groups, Rings, and Fields, Modular Arithmetic, Euclidean Algorithm, Finite Fields of The

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Form GF(p), Polynomial Arithmetic, Finite Fields Of the Form GF(2n); Introduction to Cryptography: Symmetric Cryptography, Substitution Cipher, Shift Cipher (or Caesar Cipher), Affine Cipher, Hill cipher. Stream Ciphers: Stream Ciphers vs. Block Ciphers, Encryption and Decryption with Stream Ciphers, Random Numbers and an Unbreakable Stream Cipher, Random Number Generators, One-Time Pad, Towards Practical Stream Ciphers, Shift Register-Based Stream Ciphers, Linear Feedback Shift Registers (LFSR), Known-Plaintext Attack Against
Single LFSRs. The Data Encryption Standard (DES) and Alternatives: Confusion and Diffusion, Double DES (2DES) and Triple DES (3DES). Advanced Encryption Standard (AES). Block Ciphers: Modes of Operation, Electronic Codebook Mode (ECB), Cipher Block Chaining Mode (CBC), Output Feedback Mode (OFB), Cipher Feedback Mode (CFB), Counter Mode (CTR), Galois Counter Mode (GCM). Introduction to Public-Key Cryptography: Practical Aspects of Public-Key Cryptography, RSA Cryptosystem, Elliptic Curve Cryptosystems. Digital Signatures: RSA Signature Scheme, Elgamal Digital Signature Scheme, Digital Signature Algorithm (DSA), Elliptic Curve Digital Signature Algorithm (ECDSA).

"Cryptography and Network Security: Principles and Practices", 4th Edition, W. Stallings, Prentice Hall, 2005.
"Cryptography and Network Security", 6th Edition, William Stallings, Pearson, 2013.
"Understanding Cryptography A Textbook for Students and Practitioners", Christ of Paar, Jan Pelzl, Springer.
"Cryptography, Theory and Practice", 3rd Edition, Douglas R. Stinson, CRC Press, 2006.
"Network Security Private Communication in a Public World", C. Kaufman et al., Prentice Hall, 2002.
"Applied Cryptography", 2nd Edition, Bruce Schneier, Wiley, 1996.
"Handbook of Applied Cryptography", A. Menezes, P. Van Oorschot, S. Vanstone, CRC Press, Fifth Printing, 2001.
"Elementary Number Theory with Applications", Thomas Koshy, 2nd Edition, Academic Press, 2007.
"A Computational Intro. to Number Theory and Algebra", Victor Shoup, 2nd Ed., Cambridge Univ. Press, 2005.

IT463 LINUX KERNEL INTERNALS (3-0-2) 4

Introduction to the Kernel: Important data structures, task structure, process table, files and inodes, dynamic memory management, queues and semaphores, system time and timers, main algorithms, signals, interrupts, booting the system, timer interrupt, scheduler, implementing system calls. Memory Management: LINUX, virtual address space for a process, block device caching, paging under LINUX. Inter- Process Communication: Synchronization in the kernel, Communication via files, pipes, debugging using ptrace, IPC with sockets. The LINUX File System: Basic principles, representation of file systems in the kernel, Proc file system, Ext2 file system. Device drivers under LINUX: Character and block devices, Polling and interrupts, Implementing a driver, Multi-processing: Intel multi-processor specification, problems with multi-processor systems, changes to the kernel, kernel initialization, scheduling, message exchange between processors, entering kernel mode, Interrupt handling, compiling LINUX SMP.

"Linux Kernel Internals", Michael Beck et al., Second Edition, Addison-Wesley, 1998.
"Linux Kernel Programming", Michael Beck et al., Third Edition, Addison-Wesley, 2002.

IT464 FOUNDATIONS OF MACHINE LEARNING (3-0-2) 4

Linear algebra and probability theory basics – Machine learning- Types- Classification- Regression- Multi-class classification. dimensionality reduction –Linear and Logistic Regression. Naive Bayes, Parameter Estimation, Sequential Pattern Classification. Neural Network Basics – Backpropagation –Support Vector Machines, Kernel methods – Bias-Variance tradeoff. Regularization and model/feature selection. Ensemble Methods: Boosting, Bagging, Random Forests. Unsupervised learning – K-Means clustering- EM Algorithm – Reinforcement learning – introduction to deep learning. Recent Applications and trends of Machine Learning.

Understanding Machine Learning, Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press, 2017.
Tom M. Mitchell, -Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
Stephen Marsland, - Machine Learning: An Algorithmic Perspective, Second Edition, 2014.
Pattern recognition and machine learning by Christopher Bishop, Springer Verlag, 2006.

IT465 CRYPTOCURRENCIES AND BLOCKCHAIN TECHNOLOGIES (3-0-2) 4

Introduction to Crypto currency, peer-to-peer network, Abstract Models for BLOCKCHAIN – GARAY model – RLA Model, Hybrid models cryptographic basics for cryptocurrency – a short overview of Hashing, signature schemes, encryption schemes and elliptic curve cryptography, Bitcoin – Wallet – Blocks – Merkley Tree transaction verifiability – anonymity – forks – double spending, Ethereum, Wallets for Ethereum – Solidity – Smart Contracts – some attacks on smart contracts, Applications of smart contracts, Block chain Application in various areas- Health care, Insurance, IoT etc.

Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.
Joseph Bonneau et al, SoK: Research persepectives and challenges for Bitcoin and crptocurrency, IEEE Symposium on security and privacy, 2015 (article available for free download) {curtain raiser kind of generic article, written by seasoned experts and pioneers}. 2. J. A. Garay et al, the bitcoin backbone protocol – analysis and applications

EUROCRYPT 2015 LNCS VOl 9057. (VOLII), pp 281-310.. serious beginning of discussions related to formal models for bitcoin protocols. 3. R.Pass et al, Analysis of Blockchain Protocol in Asynchronous networks, EUROCRYPT 2017. A significant progress and consolidation of several principles. 4. R.Pass et al, Fruitchain, a fair blockchain, PODC 2017.

IT466 FUNDAMENTALS OF 5G   (3-0-2) 4

LTE An Overview, Different releases of LTE, 5G Introduction, The E- UTRAN protocol Stack, The core network - EPC, PDN Gateway (P-GW), Service Gateway (S-GW), Mobility Management Entity (MME), Cell Architecture - Small Cell, Femto Cell, Pico Cell, 5G radio protocol architecture - User Planes and Control Planes, Duplexing Schemes, Physical Layer Controlling Signals - Uplink and Downlink, Retransmission Protocol - Hybrid ARQ, Scheduling - Dynamic Uplink and Downlink Scheduling, Handover Techniques, 5G and IoT introduction, 5G and IoT Use Cases, Introduction to Machine to Machine (M2M) Communication, Proximity Services (D2D communication), millimeter Wave Communication (mmWave), Massive Multiple Input and Multiple Output (MIMO). 5G Use Cases. Beyond the first release of 5G. 5G Simulation - Implementation of 5G in Network Simulator - 3 (NS-3), patch installation, basic programs on handover and resource allocation.

Erik Dahlman, Stefan Parkvall, Johan Sko´ld "5G NR: The Next Generation Wireless Access Technology", Elsevier, Academic Press, 2018

Afif Osseiran, Jose F Monserrat, Patrick Marsch, "5G Mobile and Wireless Communication Technology" Cambridge University Press, 2016

Jonathan Rodriguez "Fundamentals of 5G Mobile Networks" , Wiley, 2015.

IT467 ROBOTIC PROCESS AUTOMATION   (3-0-2) 4

RPA Basics – History of Automation – What is RPA – RPA vs Automation – Programming Constructs in RPA – What Processes can be Automated – Types of Bots – Workloads which can be automated; Process Models and Process Discovery, Different Types of Process Models, Process Discovery Techniques and Conformance Checking – RPA Development methodologies-Determining and Designing Automation Process – -Generating RPA Analytics; **Develop bots to accomplish the common business scenarios like :** Capturing user interactions using appropriate Recorders, Running bots from the Workbench and the Control Room, Creating a Meta bot to handle an application login, Integrating with common desktop applications, Writing data from a text file to an Excel spreadsheet, Copying spreadsheet data to a Windows application, Hardening bots against common exceptions, Debugging bots using the debugging feature, Extracting data from web pages, sending and receiving emails, Downloading email attachments, Extracting data from Adobe PDFs, Calling REST web services, Error handling.

Alok Mani Tripathi, Learning Robotic Process Automation, Publisher: Packt Publishing Release Date: March 2018 ISBN: 9781788470940

The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems; Tom Taulli; Apress, 2020 ISBN 1484257286, 9781484257289.

IT468 QUANTUM COMPUTING   (3-0-2) 4

History of quantum computation and quantum information, Future directions, Basic Mathematics: Linear operators and matrices, Tensor products, Operator functions. Quantum Logics: QISKIT, Introduction to Qubit, Single qubit operation, Multiple Qubit operation, Single qubit gates, Multiple qubit Gates, Controlled Not gate, Swap gate, Toffoli gate, Universal quantum gates. Quantum Algorithms and Applications: The quantum search algorithm, Quantum search as a quantum simulation, Quantum counting, Speeding up the solution of NP complete problem, Quantum search of an unstructured database, Optimality of the search algorithm.

Michael. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum information, Cambridge University Press 2000.

Bellac Michel Le, "A short introduction to quantum information and quantum computation", Cambridge University Press, 2006

Vishal Sahni, "Quantum Computing", Tata McGrawHill, 2007.

Richard L. Liboff, Introductory Quantum Mechanics, Pearson, Fourth Edition (2003).

QISKIT textbook: https://qiskit.org/textbook/content/ch-ex/.

IT470 CORNERSTONE/CAPSTONE PROJECT   4

For details refer to clause 3.2 (f) under Regulations specific to Undergraduate Programmes.

IT499 MAJOR PROJECT – II   (0-0-6) 4

The student has to select a project based on a topic of interest before starting of VII semester. This project work will be commencing in VII semester and continued in VIII semester, at the end of each semester, the project work will be evaluated internally and externally as per the evaluation criteria decided by the DUGC.