

Course title	Hours	Description	Literature Used
Algorithms and Programming I	194.5	Basic computer literacy: terminology, system components and operation. Fundamentals of computer programming: top-down structured design, sequence, decision, repetition, syntax, compilation, debugging and maintenance, object-oriented programming with Java, objects classes, methods, parameters, arrays, layout and style. The emphasis is on an engineering “right-first-time” approach to solving large problems using computers.	Textbook: Big Java: Late Objects, Big Java Late Objects, Enhanced eText, 2nd Edition, 2016, Wiley [download]

Course title	Hours	Description	Literature Used
Algorithms and Programming II	195	Enhanced Object-Oriented Programming with Java. Inheritance and polymorphism, abstract classes and interfaces, graphical-user-interfaces, exceptions. Abstract data structures: lists, stacks, queues and trees. Recursion. Files. Searching and sorting. Hashing. Time and space considerations. Students undertake a large design project involving teamwork, independent learning, writing and presenting of requirements, user-interface design, and project documentation.	Textbook: Big Java (Late Objects) Enhanced eText 2nd edition., Cay S. Horstmann, 2016, Wiley

Course title	Hours	Description	Literature Used
Digital Design	200	<p>Number systems, Binary numbers, Logic levels, transistors, gates, Boolean expressions. Combinational logic: Boolean algebra, simplification of Boolean expressions. Logic minimization with Karnaugh maps, don't-care conditions. Introduction to System Verilog. Combinational building blocks, multiplexers, decoders, propagation delays, glitches. Verilog modeling. Sequential logic: SR latch, D-latch, D flip-flop, synchronous sequential circuits. Finite State Machine design, Moore and Mealy models, state encodings, timing of sequential circuits. Verilog modeling of sequential circuits. Signed numbers, Adders, ALU, comparators. Registers, register files. Counters, timers. High level state machines, RTL design, RAM, ROM. FPGA, programmable processors.</p>	<p>Textbook: Digital Design and Computer Architecture, David M. Harris, Sarah L. Harris, 2013 Second Edition, Morgan Kaufmann Text-book: Digital Design, with RTL Design ,VHDL and Verilog, Farank Vahid, 2011 2nd Edition, John Wiley</p>

Course title	Hours	Description	Literature Used
Computer Organization	189	MIPS instruction set and registers. Branching and procedure calls, addressing modes. Single cycle processor datapath. Single cycle control. Multicycle processor datapath. Multicycle control. Exceptions, interrupts. Pipelining. Pipelining hazards and stalls. Superscalar processor, out of order execution, Register renaming. IA-32 architecture. Memory system performance and hierarchy, caches. Memory system optimization, virtual memory. Memory mapped I/O.	Textbook: Digital Design and Computer Architecture , David Harris, Sarah Harris, 2012/2nd Edition, Morgan Kaufmann [download]

Course title	Hours	Description	Literature Used
Programming Languages	150	Language evaluation criteria. Describing syntax and semantics. Tools for constructing lexical and syntactical analyzers. Names, bindings, type checking, and scopes. Data types. Expressions and the assignment statement. Statement-level control structures. Subprograms. Abstract data types. Concurrency. Exception handling. Functional programming languages. Logic programming languages.	Textbook: Concepts of Programming Languages, Robert W. Sebesta, 11th Edition, Pearson [download]

Course title	Hours	Description	Literature Used
Object Oriented Software Engineering	195	Principles and stages of object-oriented software development. Overview of object-oriented software modeling with Unified Modeling Language and exposure to CASE tools for object-oriented development. Experience with such tools and environments through programming assignments and/or a term project.	Textbook: Object Oriented Software Engineering, Using UML, Patterns, and Java, Bernd Bruegge and Allen H. Dutoit, 2010/3rd, Pearson

Course title	Hours	Description	Literature Used
Operating Systems	196.5	Introduction to computer operating systems; processes, threads, interprocess communication, process scheduling, process synchronization, deadlocks, memory management and virtual memory, file systems - interface and implementation, mass-storage structure and management, input/output systems, examples from operating systems such as Linux and Windows.	Textbook: Operating System Concepts, Avi Silberschatz, Peter Baer Galvin, Greg Gagne, 2018 / 10th edition, Wiley [download]Textbook: The C Programming Language, B. Kernighan and D. Ritchie, 1998, Prentice Hall [download]

Course title	Hours	Description	Literature Used
Database Systems	154	Relational data model. Entity/Relationship model. Relational Algebra. Structured Query Language, SQL. Relational database design. Tree-structured and hash-based indexing. Query processing and optimization. Transaction management, concurrency control and recovery issues in database systems. Development of a relational database application as a term project.	Textbook: Database Management Systems, R. Ramakrishnan, J. Gehrke, 2003/3rd, McGraw Hill Textbook: Database System Concepts, A. Silberschatz; H. Korth; S. Sudarshan, 2011/6th, McGraw Hill Textbook: Fundamentals of Database Systems, R. Elmasri, S. B. Navathe, 2011/6th, Addison Wesley

Course title	Hours	Description	Literature Used
Computer Networks	148.5	<p>Introduction to computer networks and the Internet.</p> <p>Application layer: HTTP, FTP, SMTP, DNS. Socket programming; client/server model; peer-to-peer networking.</p> <p>Transport layer protocols: TCP, UDP. Congestion control and congestion control in TCP.</p> <p>Network layer protocols: IP. Internet routing.</p> <p>Link layer: error control, multiple access. Data link layer protocols: Ethernet. Local area networks.</p>	<p>Textbook: Computer Networks, A.S. Tanenbaum, 2003, Prentice Hall</p> <p>Textbook: Computer Networking, J.F. Kurose and K.W. Ross, 2010, Addison Wesley</p> <p>Textbook: Computer Networks, L.L. Peterson and B.S.Davie, 2007, Morgan Kaufman</p>

Course title	Hours	Description	Literature Used
Cloud Computing	152	<p>Hands-on introduction to cloud computing and its applications. Cloud computing services and infrastructures (virtualization, data center networking, wide-area storage/replication, distributed file systems), development tools, fundamental tradeoffs and algorithms (CAP theorem, NoSQL systems) and applications (big-data analysis, real-time data systems, large-scale web-services).</p> <p>Hands-on exploration of using cloud services (via Google Cloud Computing) and a term project that includes programming to develop applications with backend components running on the cloud.</p>	

Course title	Hours	Description	Literature Used
Software Verification and Validation	151.5	Introduction and motivation for verification and validation; software testing overview, fundamentals of test process, general principles of testing, definitions and concepts, testing in software development life cycle, types of testing, levels of testing, test metrics; software inspection and code reviews, technical reviews, pair programming; specification-based testing, input-based partitioning, equivalence class partitioning, boundary value analysis, state transition test, decision table technique, used case testing; structural testing, graph coverage, logic coverage, syntax-based testing, statement coverage, branch coverage, condition coverage, path coverage, instrumentation and tool support; system, acceptance, and regression testing; model-based testing; run-time verification; model-checking,	Textbook: Software Testing and Analysis: Process, Principles and Techniques, Wiley, ISBN 0471455938., Mauro Pezzè, Michal Young, 2008, Wiley [down-load]Textbook: Foundations of Software Testing (2nd Edition),, Aditya P. Mathur, 2013, PearsonTextbook: Software Engineering And Testing: An Introduction (Computer Science), B.B. Agarwal, M. Gupta, S.P. Tayal, Jones & BartlettTextbook: Software Engineering, “A practitioner’s Approach” 8th Edition, Roger S. Pressman, Bruce R. Maxim, 2015, McGraw Hill International EditionTextbook: Software Engineering, Ian Sommerville, 2011, Addison Wesley

Course title	Hours	Description	Literature Used
Algorithms I	145	Asymptotic notation. Divide and conquer approach. Solving recurrences: substitution method, master method. Bounding summations. Analysis of randomized quicksort. Medians and order statistics. Heaps: heapsort, priority queues. Sorting in linear time. Dynamic programming. Greedy algorithms. Amortized analysis: aggregate, accounting and potential methods, dynamic tables. Elementary graph algorithms: breadth-/depth-first search, topological sort, strongly connected components.	Textbook: Introduction to Algorithms, T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, 2009/3rd Ed, Mit Press and McGraw Hill

Course title	Hours	Description	Literature Used
Automata Theory and Formal Languages	147	Finite automata, regular expressions, regular languages and their properties, the pumping lemma. Context free grammars and languages, normal forms, pushdown automata, the pumping lemma for the CFLs. Turing machines and their properties. Decidability and undecidable languages. Complexity theory, NP-completeness.	Textbook: Introduction to the Theory of Computation, Michael Sipser , 3, Cengage Learning

Course title	Hours	Description	Literature Used
Computational Geometry	156.5	<p>Introduction: algorithmic background, data structures, geometric preliminaries, models of computation. Geometric searching: point-location problems, range-searching problems. Convex hulls: problem statement and lower bounds, convex hull algorithms in the plane, Graham's scan, Jarvis's march, Quickhull techniques, divide-and-conquer algorithms, dynamic convex hull, convex hull in 3D. Proximity: a collection of problems, a computational prototype: element uniqueness, lower bounds, the closest-pair problem: a divide-and-conquer approach, the Voronoi diagram, proximity problems solved by the Voronoi diagram.</p> <p>Triangulation: planar triangulations, Delaunay triangulation. Intersections: application areas, planar applications:</p>	<p>Textbook: Computational Geometry: An Introduction, F. P. Preparata and M.I. Shamos, 1985, Springer Verlag [download]Textbook: Computational Geometry: Algorithms and Applications, M. de Berg, M. van Kreveld, M. Overmars, O. Schwarzkopf, 2000/2, Springer Verlag [download]Textbook: Computational Geometry in C, Joseph O'Rourke, 2/1998, Cambridge University Press [download]Software: Computational Geometry Pages, Jeff Erickson, 1999 [download]</p>

Course title	Hours	Description	Literature Used
Senior Research Project	150	Introduction to research techniques in computer engineering and science. Working on a research topic as an independent study, under the supervision of a faculty member. Preparation of academic papers to present the results of the study.	
Senior Design Project I	197	Capstone design project. Technical and innovative group project emphasizing engineering design principles on a specific topic in any field of computer science and engineering. Documentation on the specifications, analysis and the high level design of the project.	