SCS 4009 Selected Topics in Theoretical Computing

Credits: 3

Prerequisites: discrete mathematics, linear algebra, probability theory, basic programming skills,

Learning Objectives: The course covers four distinct areas of theoretical computing: automata theory, computability and complexity, information and coding theory, and concurrency theory. With the knowledge in these areas student is well equipped to proceed to mathematical analysis of computational and communication processes.

Course contents:
Automata theory: finite automata, non deterministic automata, regular expressions, context free grammars
Computability and complexity: Turing machines, extension of TM's, Church-Turing thesis, decidability and undecidabilty, halting problem, diagonalisation, universal TM's, time bounded computations (P time, classes P and NP), NP completeness in graphs, numerical, Hamiltonian, 3 SAT problems, Space bound computations (PSPACE), relationship between complexity classes
Information and Coding theory: concept of self information, entropy, conditional entropy, ergodic Markov sources, entropy of a Markov source, source coding theorem, instantaneous codes, compact codes, cyclic codes, BCH codes, communication channels: BSC and BEC, channel coding theorem, maximum likelihood decoding, Hamming codes
Concurrency theory: formal specification of sequential programs, process algebras, Lambda calculus for functional programming, a calculus for concurrent processes (CCS), concurrency with pi calculus, program equivalence, labeled transition systems, bisimulation.