Undergraduate Course Calendar

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Department of Computer Science and Engineering
Bangladesh University of Engineering and Technology
ECE Building, West Palasi
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Contents

Chapter 1

Course Requirements for Undergraduate Computer Science and Engineering Students

Undergraduate students of the Department of Computer Science and Engineering have to follow a particular course schedule which is given in this chapter according to term-wise distribution of the courses.

Level-1 Term-I

Course Number	Course Title	Hours/Week		Credit	Pre-requisite
		Theory	Sessional		
CSE 101	Structured Programming Language	3.00	-	3.00	
CSE 102	Structured Programming Language Sessional	-	3.00	1.50	
CSE 103	Discrete Mathematics	3.00	-	3.00	
EEE 163	Introduction to Electrical Engineering	3.00	-	3.00	
EEE 164	Introduction to Electrical Engineering Sessional	-	3.00	1.50	
MATH 141	Calculus I	3.00	-	3.00	
PHY 129	Structure of Matter, Electricity & Magnetism, Wave Mechanics	3.00	-	3.00	
PHY 114	Physics sessional	-	3.00	1.50	
	Total	**15.00**	**9.00**	**19.50**	

Level-1 Term-II

Course Number	Course Title	Hours/Week		Credit	Pre-requisite
		Theory	Sessional		
CSE 107	Object Oriented Programming Language	3.00	-	3.00	CSE 101
CSE 108	Object Oriented Programming Language Sessional	-	3.00	1.50	
CSE 105	Data Structures and Algorithms I	3.00	-	3.00	CSE 101, CSE 103
CSE 106	Data Structures and Algorithms I Sessional	-	3.00	1.50	
CHEM 113	Chemistry	3.00	-	3.00	
CHEM 118	Chemistry Sessional	-	1.50	0.75	
MATH 143	Linear Algebra	3.00	-	3.00	
ME 165	Basic Mechanical Engineering	3.00	-	3.00	
ME 174	Mechanical Engineering Drawing and CAD	-	3.00	1.50	
	Total	**15.00**	**10.50**	**20.25**	

Level-2 Term-I

Course Number	Course Title	Hours/Week		Credit	Pre-requisite
		Theory	Sessional		
CSE 205	Digital Logic Design	3.00	-	3.00	
CSE 206	Digital Logic Design Sessional	-	3.00	1.50	
CSE 207	Data Structures and Algorithms II	3.00	-	3.00	CSE 105
CSE 208	Data Structures and Algorithms II Sessional	-	3.00	1.50	
CSE 215	Database	3.00	-	3.00	
CSE 216	Database Sessional	-	3.00	1.50	
EEE 263	Electronic Circuits	3.00	-	3.00	EEE 163
EEE 264	Electronic Circuits Sessional	-	3.00	1.50	
MATH 241	Advanced Calculus	3.00	-	3.00	MATH 141
	Total	**15.00**	**12.00**	**21.00**	

Level-2 Term-II

Course Number	Course Title	Hours/Week		Credit	Pre-requisite
		Theory	Sessional		
CSE 200	Technical Writing and Presentation	-	1.50	0.75	
CSE 209	Computer Architecture	3.00	-	3.00	CSE 205
CSE 210	Computer Architecture Sessional	-	1.50	0.75	
CSE 211	Theory of Computation	3.00	-	3.00	
CSE 213	Software Engineering	3.00	-	3.00	
CSE 214	Software Engineering Sessional	-	1.50	0.75	
CSE 219	Signals and Linear Systems	3.00	-	3.00	MATH 141
CSE 220	Signals and Linear Systems Sessional	-	3.00	1.50	
MATH 243	Probability and Statistics	3.00	-	3.00	
	Total	**15.00**	**7.50**	**18.75**	

Level-3 Term-I

Course Number	Course Title	Hours/Week		Credit	Pre-requisite
		Theory	Sessional		
CSE 301	Mathematics for Computing and Data Science	3.00	-	3.00	MATH 243
CSE 309	Compiler	3.00	-	3.00	CSE 211
CSE 310	Compiler Sessional	-	1.50	0.75	
CSE 313	Operating System	3.00	-	3.00	
CSE 314	Operating System Sessional	-	1.50	0.75	
CSE 315	Microprocessors, Microcontrollers, and Embedded Systems	3.00	-	3.00	CSE 205
CSE 316	Microprocessors, Microcontrollers, and Embedded Systems Sessional	-	1.50	0.75	
CSE 317	Artificial Intelligence	3.00	-	3.00	
CSE 318	Artificial Intelligence Sessional	-	1.50	0.75	
	Total	**15.00**	**6.00**	**18.00**	

Level-3 Term-II

Course Number	Course Title	Hours/Week		Credit	Pre-requisite
		Theory	Sessional		
CSE 311	Data Communication	3.00	-	3.00	CSE 219
CSE 321	Computer Networks	3.00	-	3.00	
CSE 322	Computer Networks Sessional	-	3.00	1.50	
CSE 325	Information Systems Development and Management	3.00	-	3.00	
CSE 326	Information Systems Development and Management Sessional	-	3.00	1.50	
CSE 329	Machine Learning	3.00	-	3.00	CSE 301, CSE 317
CSE 330	Machine Learning Sessional	-	3.00	1.50	
CSE 450	Capstone Project	-	3.00	1.50	
HUM 347	Ethics in Society and E-Governance	3.00	-	3.00	
	Total	**15.00**	**12.00**	**21.00**	

Level-4 Term-I

Course Number	Course Title	Hours/Week		Credit	Pre-requisite
		Theory	Sessional		
CSE 400	Project and Thesis	-	6.00	3.00	
CSE 401	Numerical Analysis, Simulation and Modeling	3.00	-	3.00	
CSE 402	Numerical Analysis, Simulation and Modeling Sessional	-	1.50	0.75	
CSE 405	Cyber Security	3.00	-	3.00	
CSE 406	Cyber Security Sessional	-	1.50	0.75	
	Option 1	3.00	-	3.00	
	Option 2	3.00	-	3.00	
CSE 450	Capstone Project	-	3.00	1.50	
HUM 475	Engineering Economics	3.00	-	3.00	
	Total	**15.00**	**12.00**	**21.00**	

Option 1 and 2

Course Number	Course Title	Hours/Week		Credit	Pre-requisite
		Theory	Sessional		
CSE 417	Cyber-Physical Systems	3.00	-	3.00	
CSE 419	Internet of Things (IoT)	3.00	-	3.00	
CSE 421	Basic Graph Theory	3.00	-	3.00	CSE 103
CSE 423	Fault Tolerant Systems	3.00	-	3.00	
CSE 425	Human Computer Interaction	3.00	-	3.00	
CSE 429	Deep Learning	3.00	-	3.00	CSE 329
CSE 435	Introduction to Quantum Computing	3.00	-	3.00	
CSE 441	Mobile Computing	3.00	-	3.00	
CSE 445	Data Mining and Information Retrieval	3.00	-	3.00	
CSE453	High Performance Database System	3.00	-	3.00	CSE 215
CSE455	Next Generation Wireless Networks	3.00	-	3.00	
CSE 457	Wireless Networks	3.00	-	3.00	CSE 321
CSE 459	Communication Systems	3.00	-	3.00	CSE 219
CSE 463	Bioinformatics	3.00	-	3.00	CSE 207
CSE 467	Software Architecture	3.00	-	3.00	
CSE 477	Cloud Computing	3.00	-	3.00	CSE 313, CSE 321
EEE 463	Optical Communications	3.00	-	3.00	
EEE 465	Telecommunication Systems	3.00	-	3.00	
MATH 441	Mathematical Optimization	3.00	-	3.00	
MATH 443	Game Theory	3.00	-	3.00	
PHY 405	Quantum Mechanics	3.00	-	3.00	PHY 129

Level-4 Term-II

Course Number	Course Title	Hours/Week		Credit	Pre-requisite
		Theory	Sessional		
CSE 400	Project and Thesis	-	6.00	3.00	
	Option 3	3.00	-	3.00	
	Option 3 Sessional	-	1.50	0.75	
	Option 4	3.00	-	3.00	
	Option 4 Sessional	-	1.50	0.75	
HUM 402	Professional Communication in English Sessional	-	3.00	1.50	
HUM 403	Communication in English	3.00	-	3.00	
HUM 429	Accounting and Entrepreneurship for IT Business	3.00	-	3.00	
IPE 493	Industrial Management	3.00	-	3.00	
	Total	**15.00**	**12.00**	**21.00**	

Options 3, 4, and Sessionals

Course Number	Course Title	Hours/Week		Credit	Pre-requisite
		Theory	Sess.		
CSE 409	Computer Graphics	3.00	-	3.00	
CSE 410	Computer Graphics Sessional	-	1.50	0.75	
CSE 411	Simulation and Modeling	3.00	-	3.00	
CSE 412	Simulation and Modeling Sessional	-	1.50	0.75	
CSE 413	High Performance Computing	3.00	-	3.00	CSE 209
CSE 414	High Performance Computing Sessional	-	1.50	0.75	
CSE 415	Real-time Embedded Systems	3.00	-	3.00	
CSE 416	Real-time Embedded Systems Sessional	-	1.50	0.75	
CSE 427	Network Security	3.00	-	3.00	CSE 321, CSE 405
CSE 428	Network Security Sessional	-	1.50	0.75	
CSE 431	Natural Language Processing	3.00	-	3.00	CSE 329
CSE 432	Natural Language Processing Sessional	-	1.50	0.75	
CSE 433	Image Processing and Computer Vision	3.00	-	3.00	CSE 329
CSE 434	Image Processing and Computer Vision Sessional	-	1.50	0.75	
CSE 437	Data Science and Big Data Analytics	3.00	-	3.00	CSE 329
CSE 438	Data Science and Big Data Analytics Sessional	-	1.50	0.75	
CSE 439	Functional Programming	3.00	-	3.00	
CSE 440	Functional Programming Sessional	-	1.50	0.75	
CSE 447	Introduction to Blockchain	3.00	-	3.00	
CSE 448	Introduction to Blockchain Sessional	-	1.50	0.75	
CSE 461	Algorithm Engineering	3.00	-	3.00	CSE 207
CSE 462	Algorithm Engineering Sessional	-	1.50	0.75	

CSE 469	Software Testing and Quality Assurance	3.00	-	3.00	
CSE 470	Software Testing and Quality Assurance Sessional	-	1.50	0.75	
CSE 475	Robotics	3.00	-	3.00	CSE 317
CSE 476	Robotics Sessional	-	1.50	0.75	
CSE 481	VLSI Design	3.00	-	3.00	CSE 205
CSE 482	VLSI Design Sessional	-	1.50	0.75	
CSE 483	Interfacing	3.00	-	3.00	CSE 205
CSE 484	Interfacing Sessional	-	1.50	0.75	
CSE 485	Digital Signal Processing	3.00	-	3.00	
CSE 486	Digital Signal Processing Sessional	-	1.50	0.75	
CSE 487	Mobile Applications Development	3.00	-	3.00	CSE 107
CSE 488	Mobile Applications Development Sessional	-	1.50	0.75	
EEE 469	Electrical Machines and Instrumentation	3.00	-	3.00	
EEE 470	Electrical Machines and Instrumentation Sessional	-	1.50	0.75	

Summary

Level Term	Hours/Week		Credit	No. of Theory Courses
	Theory	Sessional		
Level 1 Term I	15.00	9.00	22.00	5
Level 1 Term II	15.00	10.50	20.50	5
Level 2 Term I	15.00	12.00	19.50	5
Level 2 Term II	15.00	7.50	19.75	5
Level 3 Term I	15.00	6.00	19.50	5
Level 3 Term II	15.00	12.00	19.50	5
Level 4 Term I	15.00	12.00	20.25	5
Level 4 Term II	15.00	12.00	19.00	5
Total	**120.00**	**81.00**	**160.50**	**40**

Chapter 2

Detailed Outline of Courses

Level-1 Term-I

CSE 101 Structured Programming Language

3 hours in a week, 3.00 credits

Data type, variables, operators, expressions, type-casting; Control structure: if-else, switch-case, ternary operator, while/do-while/for loops, nested control structure, break and continue; Function: parameter passing, return type; One-dimensional array: searching and sorting with one-dimensional arrays; Character and string: basic string operations, string related library functions; Multi-dimensional array: matrix operations with multi-dimensional arrays; Recursion; Bitwise operations; User-defined data types: structure, union, bitfield, enumeration; Pointers: pointer to string, array, structure, and function, dynamic memory allocation; Input/Output (I/O): console I/O, formatted I/O, file I/O, command line arguments; Header files and preprocessors; Variable argument function; Error handling.

Reference language: C.

CSE 102 Structured Programming Language Sessional

3 hours in a week, 1.50 credits

Sessional based on CSE 101; A project work will be included.

CSE 103 Discrete Mathematics

3 hours in a week, 3.00 credits

Sets, functions, sequences, sums; Relations and partial ordered sets; Mathematical logic: propositional calculus and predicate calculus; Mathematical reasoning and proof techniques: induction; Counting: permutations, combinations, principles of inclusion and exclusion, generating functions; Discrete probability; Recurrence relations and recursive algorithms; Graph theory: graphs, paths, and trees; Introduction to number theory and algebraic structures.

EEE 163 Introduction to Electrical Engineering

3 hours in a week, 3.00 credits

Direct current: voltage, current, resistance and power; Laws of electrical circuits and methods of network analysis; Alternating current: instantaneous and RMS values of current, voltage and power, average power, for various combination of R, L and C circuits, phasor representation of sinusoidal quantities; Balanced three phase circuits; Introduction to filters.

EEE 164 Introduction to Electrical Engineering Sessional

3 hours in a week, 1.50 credits

Sessional based on EEE 163.

MATH 141 Calculus I

3 hours in a week, 3.00 credits

Differential Calculus: Continuity and differentiability; Successive differentiation: Leibnitz's forms; Maxima and minima of functions of single variable: Rolle's theorem, mean value theorem; Evaluation of indeterminate forms by L'Hospital's rule; Expansion of functions: Taylor's and Maclaurin's theorems, Lagrange's and Cauchy's forms of remainders; Partial differentiation, Euler's Theorem; Tangent, normal.

Integral Calculus: Definite integrals and its properties; Wallis' formula; Improper integrals; Beta function and Gamma function; Parametric equations and polar coordinates; Applications of integration: area under a plane curve, area of a region enclosed by two curves and arc

lengths in Cartesian and polar coordinates, volume and surface area of solids of revolution; Multiple integrals.

Ordinary Differential Equations (ODE): Definition. Formation of differential equations. Solution of first order differential equations by various methods with applications. Solution of general linear equations of second and higher orders with constant coefficient. Solution of Euler's homogeneous linear equations.

PHY 129 Structure of Matter, Electricity & Magnetism, Wave Mechanics

3 hours in a week, 3.00 credits

Structure of Matter: Crystalline and amorphous solids, crystal systems, crystal directions, Miller indices, co-ordinations number, packing factor, Bragg's law of X-ray diffraction, crystal structure analysis, defects in crystal, bonds in solids, cohesive energy and bonding energy, free electron theory of metals, band theory of solids, solid state devices.

Electricity and Magnetism: Electrostatics: electric field, Gauss's law and its applications for various charge distributions, electric potential and equipotential surface, dielectrics and electrostatic energy in capacitors; Magnetostatics: magnetic field and forces, Hall effect, application of Biot-Savart and Ampere's laws, electromagnetic induction and inductance, energy in a magnetic field, Electromagnetic oscillations: RC, LR, LC and LRC circuits, working principle of transformers, motors and generators, magnetic materials and its applications in a computing device.

Wave Mechanics: Failure of classical mechanics and historical origins of the quantum mechanics, wave particle duality, uncertainty principle, postulates of quantum mechanics, wave function, operators, Schrödinger equation, expectation value, Ehrenfest theorem, eigen function and eigen values, particle in a box, square well potential, linear harmonic oscillator.

PHY 114 Physics Sessional

3 hours in a week, 1.50 credits

Physics sessional based on the theory course PHY 129.

Level-1 Term-II

CSE 105 Data Structures and Algorithms I

3 hours in a week, 3.00 credits

Introduction to algorithms; Asymptotic analysis: growth of functions, O, Ω, θ, o, ω notations; Correctness proof of algorithms; Analysis of algorithms: Master theorem, etc.; Elementary data structures: arrays, linked lists, stacks, queues, trees and tree traversals, graphs and graph representations, heaps, binary search trees; Graph traversals: DFS, BFS, applications of DFS and BFS; Methods for the design of efficient algorithms: divide and conquer, greedy methods, dynamic programming; Sorting: sorting algorithms, sorting in linear time; Lower bound theory; Data structures for set operations.

CSE 106 Data Structures and Algorithms I Sessional

3 hours in a week, 1.50 credits

Sessional based on CSE 105.

CSE 107 Object Oriented Programming Language

3 hours in a week, 3.00 credits

Philosophy of object oriented programming (OOP); Basic principles of OOP: abstraction, encapsulation, polymorphism, inheritance; Advantages of OOP over structured programming;
C++: Classes and objects: specifying a class, access specifiers; Functions: inline functions, friend functions; Constructors and destructors; Operator overloading and type conversions; Inheritance: single inheritance, multilevel inheritance, multiple inheritance; Polymorphism: function overloading, virtual functions, pure virtual functions; Templates: class templates, function templates, introduction to the standard template library (STL);
Java: Nested and Inner classes; Local variable type inference; Strings: String, StringBuffer, StringBuilder; Inheritance: abstract class and anonymous subclasses, object class; Access protection with package; Interface; Exception; Thread: multithreading, Introduction to Java concurrency utilities; Generics and collections; Stream API and lambda expressions; Networking: ServerSocket, Socket.

CSE 108 Object Oriented Programming Language Sessional

3 hours in a week, 1.50 credits

Sessional based on CSE 107; A project work will be included.

CHEM 113 Chemistry

3 hours in a week, 3.00 credits

Quantum concept in atomic structure, VSEPRT; molecular geometry, Quantum concept in bonding; VBT and MOT, Frontier MOT and electronic transition, Silicon chemistry, Properties of solutions, Colloid and Nanochemsitry, Phase rule and phase diagram; Energy and chemistry, Electrochemistry; electrolytic conduction, corrosion, devices for energy storage, Chemistry of biodegradable and conductive polymer; LED, LCD/touch screen, Chemistry of proteins, nucleic acids (DNA, RNA), carbohydrates and lipids; Introduction to computational chemistry; Design of new molecules, materials and drug.

CHEM 118 Chemistry Sessional

3 hours in alternate weeks, 0.75 credits

Determination of the concentration of battery acid, study of redox system (iodometric study of copper determination), calorimetric determination of heat of reaction, Molecular geometry model based on VSEPRT, phase diagram.

MATH 143 Linear Algebra

3 hours in a week, 3.00 credits

Introduction to vectors, their products, matrices and systems of linear equations; Solving linear equations: Gaussian elimination, inverse and transpose of a matrix, factorization into $\mathbf{A} = \mathbf{LU}$; Vector spaces and subspaces: four fundamental subspaces, solving $\mathbf{Ax} = \mathbf{0}$ and $\mathbf{Ax} = \mathbf{b}$, independence, basis and dimension, dimensions of the four subspaces; Orthogonality: orthogonality of the four subspaces, projections, least squares, orthonormal bases and Gram-Schmidt; Determinants: properties, formulas, Cramer's rule, inverses and volumes; Eigenvalues and eigenvectors: eigendecomposition, systems of differential equations, symmetric and positive definite matrices; Singular value decomposition (SVD): bases and matrices in the SVD, geometry of the SVD; Linear transformations: the matrices of linear transformations; Complex vectors

and matrices: complex numbers, polar coordinates, Hermitian and unitary matrices; Applications of linear algebra in computer science and engineering.

ME 165 Basic Mechanical Engineering

3 hours in a week, 3.00 credits

Statics of particles and rigid bodies; Forces in trusses and frames; Relative motion; Kinematics of particles: Newton's Second Law of Motion; Kinematics of rigid bodies.
Introduction to Robotics; Plane, rotational and spatial motion with applications to manipulators; Geometric configurations: structural elements, linkage, arms and grippers; Motion characteristics.
Sources of energy: conventional and renewable; Introduction to IC engines, Refrigeration and Air conditioning systems.

ME 174 Mechanical Engineering Drawing and CAD

3 hours in a week, 1.50 credits

Introduction; Instruments and their uses; Third angle projection; Orthographic drawing; Isometric views; Sectional views; Introduction to computer graphic software: Computer aided design (CAD).

Level-2 Term-I

CSE 205 Digital Logic Design

3 hours in a week, 3.00 credits

Digital logic: Boolean algebra, theorems and properties, logic gates and their truth tables, canonical and standard forms, Boolean functions, minimization techniques; Combinational logic: arithmetic and data handling logic, decoder and encoders, multiplexer and demultiplexers; Asynchronous and synchronous logic design: flip-flops and latches, race around problems, modes of asynchronous sequential circuits, clocked sequential circuits, state diagram, Mealy and Moore machines; state minimizations and assignments; Registers; Counters: asynchronous and synchronous counters and their applications; Pulse mode logic; Fundamental mode design; Memory and Programmable logic: internal construction of RAM and ROM, address multiplexing, PLA design.

CSE 206 Digital Logic Design Sessional

3 hours in a week, 1.50 credits

Sessional based on CSE 205 including 4-bit ALU design and implementation.

CSE 207 Data Structures and Algorithms II

3 hours in a week, 3.00 credits

Graph algorithms: minimum spanning tree algorithms, shortest path algorithms, maximum flow and maximum bipartite matching; Advanced data Structures: balanced binary search trees (AVL trees, red-black trees, splay trees) skip list, advanced heaps (Fibonacci heaps, binomial heaps); Hashing; NP-completeness; NP-hard and NP-complete problems; Coping with hardness: backtracking, branch and bound, approximation algorithms; String matching algorithms.

CSE 208 Data Structures and Algorithms II Sessional

3 hours in a week, 1.50 credits

Sessional based on CSE 207.

CSE 215 Database

3 hours in a week, 3.00 credits

Concepts of database systems; Introduction to the relational model; Database design using the Entity-Relationship model; Query Languages: Relational algebra, SQL; Constraints, functions and procedures, triggers; Functional dependencies and normalization; Data storage architectures; Indexing: primary and secondary indices, B+ tree index, hash indices; Query processing and optimization; Transaction management; Concurrency control; Recovery system; Introduction to parallel and distributed databases; Introduction to Big data analytics; NoSQL databases.

CSE 216 Database Sessional

3 hours in a week, 1.50 credits

Sessional based on CSE 215; A project work will be included.

EEE 263 Electronic Circuits

3 hours in a week, 3.00 credits

Ideal device characteristics of Diode, Bipolar Junction Transistor (BJT), Metal-Oxide-Semiconductor Field Effect Transistor (MOSFET); Wave shaping circuits: Diode wave shaping techniques, clipping and clamping circuits, comparator circuits, switching circuits; Amplifiers: BJT and MOSFET amplifiers; Linear Integrated Circuits: Op-amps, linear applications of OpAmps; Oscillators: Timers (555), function generators.

EEE 264 Electronic Circuits Sessional

3 hours in a week, 1.50 credits

Sessional based on EEE 263.

MATH 241 Advanced Calculus

3 hours in a week, 3.00 credits

Vector Calculus: Vector and scalar fields; Differentiation and integration of vectors; Gradient of a scalar field: directional derivative; Divergence and curl of a vector field; Vector calculus identities: Jacobian, Hessian, Laplacian; Line integrals.

Complex Calculus: Functions of a complex variable; Limits and continuity of functions of complex variables; Complex differentiation: analytic functions, Cauchy-Riemann equations; Elementary complex functions: exponential, trigonometric, hyperbolic; Line integral of a complex function.

Partial Differential Equations (PDE): Introduction and formation of PDE; Solution of linear and non-linear PDE of order one; Second order linear PDE: classifications to standard forms; Parabolic, elliptic, hyperbolic; Solution of second order linear PDE by separation of variables.

Level-2 Term-II

CSE 200 Technical Writing and Presentation

3 hours in alternate weeks, 0.75 credits

Issues of technical writing and effective oral presentation in Computer Science and Engineering; Writing styles of definitions, propositions, theorems and proofs; Preparation of reports, research papers, theses

and books: abstract, preface, contents, bibliography and index; Writing of book reviews and referee reports; Writing tools: LaTeX, etc.; Diagram drawing software; presentation tools.

CSE 209 Computer Architecture

3 hours in a week, 3.00 credits

Information representation; Measuring computer performance; Instruction set architectures: MIPS/ ARM, operations and operands of computer hardware, representing Instructions in machine instructions; Computer Arithmetics: Integer and floating point operations; Processor design: single cycle datapath and control, pipelined datapath and control, Hazards, Exceptions; Instruction-Level Parallelism: multiple issue, speculation, superscalar and dynamic pipelining, out-of-order execution, register renaming; Memory organization: cache, cache performance, cache optimization techniques, virtual memory; Multiprocessors: introduction to SISD, MIMD, SIMD, SPMD, vector; Parallel architectures: data level parallelism, performance, GPU architecture.

CSE 210 Computer Architecture Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 209; Assignments, project work will be included such as the following: Booth Multiplier Design and Implementation, Small Microprocessor Design and Implementation, FPGA programming.

CSE 211 Theory of Computation

3 hours in a week, 3.00 credits

Regular languages; Finite automata: deterministic finite automata, nondeterministic finite automata, equivalence and conversion between deterministic and nondeterministic finite automata; Regular expressions: equivalence with finite automata; Nonregular languages: pumping lemma for regular languages; Context free languages: context free grammars, ambiguity, Chomsky normal form, pumping lemma for context free languages; Pushdown automata: equivalence with context-free grammar; Turing machines: basic machines, variants of Turing machines, computing with Turing machines; Computability: Church-Turing thesis, Hilbert's problems, diagonalization language; Decidability: decidable languages, undecidability, halting problem, reducibility; Complexity: time complexity,

class P, class NP, NP-completeness, Cook's theorem, space complexity, Savitch's theorem.

CSE 213 Software Engineering

3 hours in a week, 3.00 credits

Software engineering: professional software development, ethics; Software development life cycle; Requirements analysis: functional and non-functional requirements, requirement elicitation and specification, use cases, requirement validation; System modeling and design: unified modeling language (UML) diagrams, user interface design; Design patterns: creational, structural, and behavioral patterns; Development: code review and documentation, version control, code smell, code refactoring; Testing and debugging: unit testing, test doubles, integration testing, regression testing, white box and black box testing, performance and security testing, A/B testing, bug reporting.

CSE 214 Software Engineering Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on theory course; Sample topics include the following: use cases, UML, design pattern implementation, software testing, software documentation, version control, etc.

CSE 219 Signals and Linear Systems

3 hours in a week, 3.00 credits

Introduction to signals and systems: continuous and discrete-time signals, basic operation on signals, unit impulse and unit step function, systems and their properties; Linear time invariant (LTI) systems: continuous and discrete-time LTI systems, convolution integral and convolution sum, properties of LTI systems; Time domain analysis of LTI systems: differential and difference equations; Frequency domain analysis of LTI systems: Fourier series representation of continuous and discrete-time periodic signals, properties of continuous and discrete-time Fourier series, Fourier series and LTI systems; Continuous and discrete-time Fourier transform: representation of aperiodic signals, Fourier transform for periodic signals, properties, duality; Time and frequency characterization of signals and systems; Sampling: the sampling theorem, interpolation, aliasing; Laplace transform: properties, inverse Laplace transform, analysis

and characterization of LTI systems; Z-transform: properties, inverse Z-transform, analysis of LTI systems.

CSE 220 Signals and Linear Systems Sessional

3 hours in a week, 1.50 credits

Sessional based on CSE 219.

MATH 243 Probability and Statistics

3 hours in a week, 3.00 credits

Introduction to Statistics: variability in data, populations and samples, descriptive statistics, inferential statistics and probability, sampling procedures; Measures of location: mean, median; Measures of variability: standard deviation, variance; Higher moments: skewness, kurtosis; Graphical representation of data: scatter plot, stem and leaf plot, histogram, box plot; Probability: sample space and events, rules of probability, conditional probability, independence, Bayes' rule; Random variables: discrete and continuous probability distributions, joint probability distributions, marginal distributions and independence; Expectations, variance and covariance of random variables and their properties, Chebyshev's theorem; Discrete probability distributions: Bernoulli, binomial, multinomial, Poisson distributions and their properties; Continuous probability distributions: uniform, Gaussian (normal), chi-square distributions and their properties; Sampling distributions: sample mean, central limit theorem, sample variance, t-distribution, F-distribution, quantile and probability plots; Statistical inference: parameter estimation, confidence intervals; Hypothesis testing: null and alternative hypotheses, test statistic, P-values and significance levels, Z-test, t-test, goodness-of-fit test; Regression and correlation: least squares, coefficient of determination, correlation coefficient; Analysis of variance (ANOVA).

Level-3 Term-I

CSE 301 Mathematics for Computing and Data Science

3 hours in a week, 3.00 credits

Advanced counting and discrete probability: recurrences and sums, binomial coefficients, special numbers, generating functions, probability generating function; Random variables: discrete and continuous random variables, multivariate distributions, moment generating functions;

Conditional probability and conditional expectation; Probability bounds: Markov and Chebyshev inequalities, Chernoff bound, Cauchy-Schwarz and Jensen inequalities; Convergence of random variables: law of large numbers, central limit theorem; Statistical inference: parametric and nonparametric models, point estimation, confidence intervals, bootstrapping; Parametric inference: maximum likelihood estimation; Bayesian inference: maximum a posteriori estimation; Hypothesis testing: permutation test, likelihood ratio test, multiple testing; Stochastic processes: Poisson process, Gaussian process; Markov chains: discrete-time, continuous-time, birth-death process; Queuing theory: exponential models, open and closed queuing network, applications of queuing models.

CSE 309 Compiler

3 hours in a week, 3.00 credits

Basic issues, compiler structure, front end, optimizer, back end; Lexical Analysis: Tokens, patterns, and lexemes, transition diagrams, lexical-analyzer generator; Syntax Analysis: Top-down parsing, bottom-up parsing, LR parsing, parser generators; Syntax-Directed Translation: Syntax-directed definitions, dependency graphs, syntax trees, syntax-directed translation schemes; Intermediate-Code Generation: Directed acyclic graphs for expressions, three-address Code, quadruples, triples, static single-assignment form, types and declarations, type checking, control flow; Run-Time Environments: Storage organization, static versus dynamic storage allocation, activation trees, activation records, heap management and garbage collection; Code Generation: Basic blocks and flow graphs, optimization of basic blocks, peephole optimization, register allocation and assignment, instruction selection; Machine-independent optimizations: principal sources of optimization; Interprocedural Analysis: Call graphs, pointer analysis.

CSE 310 Compiler Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 309.

CSE 313 Operating System

3 hours in a week, 3.00 credits

Operating system concepts: its role in computer systems, operating system

structures, multiuser and multitasking OS; Process: process concepts, user and kernel threads, synchronization, inter-process communication, communication in client-server systems; CPU scheduling: scheduling criteria and algorithms, thread scheduling; Process synchronization: critical-section problem, semaphores, monitors; Deadlock: resource allocation and deadlock, deadlock detection, prevention and recovery; Memory management: swapping, paging, segmentation, virtual memory; Input/Output: hardware, software, disk, terminals, clocks; File Systems: files, directories, security, protection; Multi Processor System: Multiprocessor OS types, multiprocessor synchronization and scheduling, case study of a multiprocessor system; Case study of some operating systems.

CSE 314 Operating System Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 313.

CSE 315 Microprocessors, Microcontrollers, and Embedded Systems

3 hours in a week, 3.00 credits

Introduction to embedded systems: microprocessors and microcontrollers, applications; Microprocessors and computers: architecture, addressing modes, x86 instruction set, arithmetic co-processor, evolution of microprocessors, multitasking, virtual memory; Microcontrollers: architecture, ARM/AVR instruction set, single-board microcontrollers; Assembly language programming; Memory architectures: von Neuman and Harvard architecture, memory hierarchy, DMA; I/O modes: memory mapped I/O, general purpose I/O; Interfaces and peripherals; Interrupts and timers; Bus interfaces: UART, SPI, I2C, USB; Sampling and pulse width modulation (PWM); Interfacing with stepper motor, liquid-crystal display (LCD), analog-to-digital converter (ADC), digital-to-analog converter (DAC), sensors and actuators; Wireless communication; Embedded systems design: design flow, specifications and modeling; Power management; Distributed embedded systems and the Internet of Things (IoT); Embedded and real time OS.

CSE 316 Microprocessors, Microcontrollers, and Embedded Systems Sesssional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE315 including assembly language programming and experiments using microprocessors/microcontrollers.

CSE 317 Artificial Intelligence

3 hours in a week, 3.00 credits

Introduction to AI, intelligent agents; Solving problems by searching: informed search strategies, greedy best-first search, A* search, inadmissible heuristics and weighted A*, heuristic functions; Local search and optimization problems: hill-climbing search, simulated annealing, local beam search, evolutionary algorithms; Adversarial search and games: alpha-beta tree search, Monte Carlo tree search; Constraint satisfaction problems (CSP): backtracking and local search for CSPs; Knowledge, reasoning, and planning: logical agents, inference in first-order logic, knowledge representation, automated planning; Learning from examples: forms of learning, supervised learning, learning decision trees, model selection and optimization, theory of learning; Parametric models: linear regression and classification; Nonparametric models: nearest-neighbor models, support vector machines (SVM); Ensemble learning: bagging, random forests, stacking, boosting, gradient boosting, online learning; Markov decision process (MDP), partially observable MDP, learning from rewards, passive and active reinforcement learning, Q-learning, policy search; Robotics: robotic perception, planning and control, reinforcement learning in robotics; Ethics and future of AI.

CSE 318 Artificial Intelligence Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 317.

Level-3 Term-II

CSE 311 Data Communication

3 hours in a week, 3.00 credits

Introduction to analog and digital communication: bandwidth, signal-to-noise ratio, capacity; Analog modulation: amplitude modulation

(AM), DSB-SC, SSB, VSB, frequency modulation (FM), phase modulation (PM); Analog-to-digital conversion: sampling, quantization, pulse code modulation (PCM), DPCM, ADPCM, delta modulation, digital telephony and video compression; Line coding, pulse shaping, intersymbol interference; Digital modulation: amplitude shift keying (ASK), frequency shift keying (FSK), phase shift keying (PSK), differential, binary and M-ary PSK, quadrature AM (QAM), binary and M-ary FSK, minimum shift keying (MSK), Gaussian minimum shift keying (GMSK); Multiplexing and multiple access: time division multiplexing (TDM), frequency division multiplexing (FDM), orthogonal frequency domain multiplexing (OFDM), spread spectrum, code division multiple access (CDMA); Noise in communication, additive white Gaussian noise (AWGN), errors due to noise; Information theory: entropy, mutual information, Huffman and Lempel-Ziv source coding, Shannon's information capacity theorem; Error control coding: linear block codes, cyclic codes, convolutional codes, Viterbi decoding; Introduction to modern communication systems: cellular, satellite, optical fiber and power-line carrier communication.

CSE 321 Computer Networks

3 hours in a week, 3.00 credits

Introduction to computer networks; Protocol hierarchies; Data link control: Link layer and services; Multiple access protocol: Standards IEEE 802.*; Hubs, Bridges, and Switches, Fast Ethernet; Routing architecture and algorithms; IPV4, IPV6, ARP, RARP, DHCP, BGP; Introduction to transport layer: UDP,TCP; Principles of Reliable data transfer, Principles of congestion control, TCP, Congestion control; Application layer services: Web, HTTP, FTP, SMTP, DNS architecture; IoT fundamentals: edge devices, wireless communication, routing, IoT applications; IoT advanced: edge-cloud IoT platforms, load balancing, energy management, IoT security; Datacenter topology.

CSE 322 Computer Networks Sessional

3 hours in a week, 1.50 credits

Sessional based on CSE 321.

CSE 325 Information Systems Development and Management

3 hours in a week, 3.00 credits

Project management: risk management, stakeholder management, team

management, issue management; Project planning: software pricing, project scheduling, estimation techniques, COCOMO cost modeling; Software development methodologies: Agile, Waterfall; Agile software development: Scrum, Kanban; Software quality assurance: software measurement, metrics, static analysis; Delivery management: acceptance criteria, Software architecture: software as a service (SaaS), service oriented architecture (SOA), microservices, model-view-controller (MVC), n-tier; Deployment: deployment architecture, continuous integration and continuous delivery (CI/CD), containerization/virtualization; Monitoring and maintenance: metrics, APM (application performance monitoring).

CSE 326 Information Systems Development and Management Sessional

3 hours in a week, 1.50 credits

Sessional based on CSE 325; Sample topics include design, full stack development of a simple software and deployment in cloud, browser and mobile with UML modeling and Agile project management.

CSE 329 Machine Learning

3 hours in a week, 3.00 credits

Developing machine learning systems: problem formulation, data collection, manipulation and preprocessing, exploratory data analysis and visualization; Deep learning: linear regression as a neural network, simple feedforward networks, forward propagation, backward propagation, computation graphs, numerical stability and initialization; Optimization: batch and stochastic gradient descent (SGD); Convolutional neural networks (CNN): convolution, padding, stride, pooling, modern CNNs (AlexNet, VGG, GoogLeNet, ResNet), batch normalization; Recurrent neural networks (RNN): language modeling with RNNs, modern RNNs, long short-term memory (LSTM), gated recurrent units (GRU), recursive neural networks, sequence-to-sequence (seq2seq) models; Generalization in deep learning: designing neural network architectures, weight decay, dropout; Probabilistic modeling and reasoning: Bayesian networks, exact inference, variable elimination algorithm, approximate inference, direct sampling methods, inference by Markov chain simulation, Gibb's sampling; Probabilistic reasoning over time: inference in temporal models, hidden Markov model, Kalman filters; Learning probabilistic models: learning with complete data, Bayesian learning, naive Bayes models, generative and discriminative models, generalized linear model; Learning with

hidden variables: expectation–maximization (EM) algorithm, mixture models, learning mixtures of Gaussians, K-means clustering, learning hidden Markov models; Dimensionality reduction: principal component analysis (PCA); Recommender systems: collaborative filtering using matrix factorization.

CSE 330 Machine Learning Sessional

3 hours in a week, 1.50 credits

Sessional based on CSE 329.

CSE 450 Capstone Project

3 hours in a week, 1.50 credits

Solving complex engineering problems related to computer science and engineering.

HUM 347 Ethics in Society and E-Governance

3 hours in a week, 3.00 credits

Ethics and society: Ethics: approaches, ethical dimensions of technology, historical perspectives; Categorical imperative: motivation of action; Deviance, delinquency, morals, law, ethics; Ethics in social survey; Online communication: manifest and latent functions; Social group dynamics; Technology and inequality: class and gender issues; Social media: effect on individual autonomy, socialization, privacy, cyberbullying; Dramaturgy: presentation of self; Social interaction: distant learning, work from home; Value system, cultural ethics; Other social issues: individualism, community, minority; Digital Bangladesh and SDGs; Professional ethics: ACM code of ethics and professional conduct, responsibility, liability, loyalty, whistleblowing, trust and reliability in research and testing, conflict of interest; Intellectual property: licensing, copyrights, patents, trade secrets, plagiarism; Environmental impact: energy consumption by computing systems, electronic waste, repairing and recycling.

E-Governance: Defining government, institutional framework, democracy, leadership, bureaucracy, accountability and transparency in decision-making, concept of governance, citizen engagement in good governance, e-governance for good governance, e-government and public service delivery, public-private partnership for e-government

system, legal and ethical issues in e-government, e-government development index (EGDI), ICT policy and smart government.

Level-4 Term-I

CSE 400 Project and Thesis

6 hours in a week, 3.00 credits

Study of problems in the field of Computer Science and Engineering.

CSE 401 Numerical Analysis, Simulation and Modeling

3 hours in a week, 3.00 credits

Introduction to Numerical Analysis, approximations, round-off errors, truncation errors; Visualization and plotting; Root finding: bisection method, false position method, Newton-Raphson method, Bairstow's method; Solution of systems of equations: Gauss elimination method, Gauss-Jordan elimination method, LU decomposition; Eigenvalue decomposition: power method, QR method: Optimization: golden-section search, Newton's method, gradient methods, constrained optimization; Curve fitting, interpolation and approximation: least squares regression, linear interpolation, Lagrange polynomial interpolation, Newton's polynomial interpolation, spline interpolation; Numerical integration and differentiation: Newton-Cotes integration, trapezoidal rule, Simpson's rule, Romberg's integration, Richardson's extrapolation; Solution of ordinary differential equations: Euler's method, Runge-Kutta methods, finite difference methods; Modeling with linear and differential equations; Introduction to simulation and modeling, Discrete event simulation models; Steps in a simulation study; Model validation and verification; Random number generation; Monte Carlo methods: Metropolis-Hastings algorithm.

CSE 402 Numerical Analysis, Simulation and Modeling Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 401.

CSE 405 Cyber Security

3 hours in a week, 3.00 credits

Fundamental concepts: confidentiality, integrity and availability, assurance, authenticity and anonymity; threats and attacks, security principles,

Ethical issues in security; Cryptographic concepts: encryption, digital signatures, simple attacks on cryptosystems, cryptographic hash functions, digital certificates, Diffie-Hellman Key Exchange Algorithm; Cryptography: symmetric cryptography, public-key cryptography, cryptographic hash functions, digital signatures, details of AES and RSA cryptography; Security: Operating systems concepts, process security, memory and file system security, physical security, application program security, network security concepts, browser security, Security Attacks: buffer overflow and other vulnerabilities due to insecure programming, foot printing, social engineering, Trojans and backdoors, sniffing, denial of service, session hijacking, dictionary attack on password protected systems, threats on components like web servers, web applications, mobile platforms, wireless networks; Security Measures: Firewall, Intrusion detection and prevention.

CSE 406 Cyber Security Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 405.

CSE 450 Capstone Project

3 hours in alternate weeks, 0.75 credits

Solving complex engineering problems related to computer science and engineering.

CSE 417 Cyber-Physical Systems

3 hours in a week, 3.00 credits

Cyber-physical systems: tight integration of computing, control, and communication; Applications of cyber-physical systems: vehicle systems, smart buildings, mobile computing, and medical devices; Hardware platforms: processors, sensors, actuators, and networks; Software and control: RTOS, scheduling, optimization, optimal control, and algorithm development; Modeling: system modeling, model-based design, and timed-automata; Resource-constrained platforms; Security in cyber-physical systems.

CSE 419 Internet of Things (IoT)

3 hours in a week, 3.00 credits

Basics of the Internet of Things (IoT): IoT and its importance, elements of

an IoT ecosystem, IoT applications; Sensors and sensor nodes: sensing components and devices; Actuators; Connectivity and networks: wireless technologies for the IoT, edge connectivity and protocols, wireless sensor networks; Variants of IoT: low power embedded systems, distributed systems, cloud, and edge IoT systems, and real-time IoT systems; Basics of IoT security; Performance analysis of IoT systems; Analytics and applications: signal processing, real-time and local analytics, databases, and cloud analytics.

CSE 421 Basic Graph Theory

3 hours in a week, 3.00 credits

Graphs: simple graphs, digraphs, subgraphs, vertex-degrees, walks, paths and cycles; Trees, spanning trees in graphs, distance in graphs; Complementary graphs, cut-vertices, bridges and blocks, k-connected graphs; Euler tours, Hamiltonian cycles, Chinese Postman Problem, Traveling Salesman Problem; Chromatic number, chromatic polynomials, chromatic index, Vizing theorem, planar graphs, perfect graphs.

CSE 423 Fault Tolerant Systems

3 hours in a week, 3.00 credits

Introduction of Fault Tolerant Systems and architectures; Fault detection and location in combinational and sequential circuits; Fault test generation for combinational and sequential circuits; Digital simulation as a diagnostic tool; Automatic test pattern generator; Fault modeling; Automatic test equipment, faults in memory, memory test pattern and reliability; Performance monitoring, self checking circuits, burst error correction and triple modular redundancy; Maintenance processors.

CSE 425 Human Computer Interaction

3 hours in a week, 3.00 credits

Introduction to human-computer interaction; Interaction design: understanding users, cognitive and affective factors; Web interfaces; Introduction to interactive system design: data gathering and requirements analysis, interfaces design; UI design models: system model, interface model, user model; Usability: consistency, simplicity, learnability, efficiency, safety, ergonomics, aesthetics; Accessibility: kinds of impairments, assistive technology, universal design; Internationalization and localization: translation, text direction, sort order, formatting, color conventions, icons;

User research methods: experiments, experiment design techniques, field study, survey; Prototyping; Usability testing; Analytic evaluation; Design thinking; Participatory design; Contextual inquiry; Case studies.

CSE 429 Deep Learning

3 hours in a week, 3.00 credits

Modern practices in deep neural networks: hidden units, architectural design, back-propagation and automatic differentiation; Regularization: norm penalties, dataset augmentation, noise robustness, early stopping, parameter tying and parameter sharing; Optimization algorithms: adaptive gradient methods, approximate second-order methods; Linear factor models: probabilistic PCA, factor analysis, independent component analysis (ICA), sparse coding, manifold interpretation of PCA; Deep generative models: autoencoders, generative adversarial networks (GAN), variational autoencoder (VAE); Representation learning: transfer learning and domain adaptation, semi-supervised, self-supervised deep learning, contrastive learning; Deep recommender systems: neural collaborative filtering for personalized ranking, deep factorization machines; Deep learning on graphs; Deep reinforcement learning; Bayesian deep learning; Efficient neural networks: sparsity, parameter and compute efficient neural networks; Multi-task and meta learning, multi-modal learning; Energy-based models; Interpretability and analysis of deep neural networks; Causality and explainability in deep learning.

CSE 435 Introduction to Quantum Computing

3 hours in a week, 3.00 credits

Quantum computation: evolution and applications; Basics of quantum computing: qubit representation, measurement, and superposition; Multi-qubit operations; Quantum circuits: design and architecture; Bell state and Bell-basis; Quantum operations: entanglement and teleportation; Noise and error correction; Quantum hardware; Quantum algorithms; Quantum artificial intelligence; Quantum networking.

CSE 441 Mobile Computing

3 hours in a week, 3.00 credits

Mobile technologies: anatomy of a mobile device, survey of mobile devices, usability issues of mobile devices; Mobile application development: mobile operating systems and development environments/frameworks,

mobile SDKs, programming for smart-phones; Cellular communications: standards for cellular wireless networks, mobile IPv4 and mobile IPv6; Mobility in cellular networks: types of mobility, mobility management, mobility models, traffic models, channel allocation, interferences, handoffs, and location management; User interaction: user interface issues, the united look and feel paradigm, common human interface guidelines; Context aware mobile computing: types of context, modeling context information, collecting and disseminating context, applications development for changing context; Data and information management: mobile database, transactions, web services; Privacy and security issues.

CSE 445 Data Mining and Information Retrieval

3 hours in a week, 3.00 credits

Introduction to Data Mining; Finding similar items: applications of set similarity, shingling of documents, locality-sensitive hashing, distance measures, the theory of locality-sensitive functions, LSH families for other distance measures, applications of locality-sensitive hashing, methods for high degrees of similarity; Mining Data Streams: the stream data model, sampling, filtering, counting distinct elements, estimating moments, counting ones in a window, decaying windows; Link Analysis: PageRank algorithms, topic-sensitive PageRank, link spam, hubs and authorities; Frequent itemsets: the Market-Basket model, the A-Priori algorithm; Clustering: hierarchical clustering, K-means algorithms, the CURE algorithm, clustering in non-Euclidean spaces, clustering for streams and parallelism; Advertising on the Web: issues in on-line advertising, on-line algorithms, the matching problem, adwords, search engine optimization; Recommendation systems: content-based recommendations, collaborative filtering, UV-decomposition; Mining social-network: clustering of social-network graphs, discovery of communities, partitioning of graphs, finding overlapping communities, Simrank, counting triangles, neighborhood properties of graphs; Dimensionality reduction: principal component analysis (PCA), singular-value decomposition, CUR Decomposition.

CSE 453 High Performance Database System

3 hours in a week, 3.00 credits

Distributed DBMS: design issues, architectures; Distributed and parallel database design: data fragmentation, allocation; Data control: view management, access control, integrity control; Query processing: data localization, query optimization, cost model; Transaction processing:

concurrency control, reliability; Replication: consistency, update management, replication protocols; Multidatabase systems: integration; Parallel database systems: parallel architectures, load balancing, fault tolerance; Big Data databases: storage systems, processing frameworks; NoSQL systems: data models, system architectures; Hybrid data stores: NewSQL, multi-model NoSQL.

CSE 455 Next Generation Wireless Networks

3 hours in a week, 3.00 credits

5G architecture: interfaces and protocols; New radio (NR) architecture: physical channels and signals, frame structure, resource block, carrier aggregation, use of TDD; 5G core: 5G system architecture, function of each network and function of 5G core, 5G reference point architecture, 5G service based architecture; Network Function Virtualisation (NFV); Network Slicing; Multi Access Edge Computing (MEC); Quality of service in 5G: QoS architecture, QoS Flow, QoS Rule, QoS Profile, 5G numbering, addressing and identities, Dynamic spectrum sharing: coexistence of 5G NR with 4G LTE; Open radio access network (open RAN) and 5G: basic concept of traditional RAN, vRAN and open RAN, Centralised RAN, Cloud RAN; Network function virtualization and 5G: Concept of Softwarisation, Virtualization; Transmission requirement for 5G: backhaul , mid-haul and fronthaul for 5G; 5G Security: security enhancement in 5G, new challenges and its mitigation.

CSE 457 Wireless Networks

3 hours in a week, 3.00 credits

Cellular concepts: frequency reuse, handoff strategies, interference and system capacity, grade of service, improving capacity and coverage, call blocking probability; Propagation effects: outdoor propagation models, indoor propagation models, power control, Doppler's effect, small and large scale fades; Wireless LAN Technology; IEEE 802.11: standard, protocol architecture, physical layer and media access control; Mobile IP; Wireless Application Protocol; IEEE 802.16 Broadband Wireless Access; Brief review of 2nd and 3rd generation wireless: GSM, GPRS, CDMA; Cordless system; Wireless local loop; Bluetooth: overview and baseband specifications.

CSE 459 Communication Systems

3 hours in a week, 3.00 credits

Communication link engineering: Fundamental noise processes, Brightness and antenna noise, Polarization-wave and antenna, Wave propagation, Channel impairment effects, Receiver system noise, Receiver types and sub-assembly survey, Low noise antenna design; Signal power budgets and system design techniques; Interference and frequency reuse; System- and circuit-level design and implementation of communication hardware: mixers, RF amplifiers, filters, oscillators and frequency synthesizers, modulators and detectors, carrier and symbol timing recovery subsystems; Issues in software-defined radio transmitter and receiver implementation.

CSE 463 Bioinformatics

3 hours in a week, 3.00 credits

Molecular biology basics: DNA, RNA, genes, and proteins; Genome sequencing: graph-based assembly; Protein sequencing; Sequence alignment: dynamic programming, local and global alignment; Combinatorial pattern matching: rapid string matching, database search, BLAST; Genome rearrangements; Evolutionary trees and phylogenetics; Computational phylogenomics; Statistical and machine learning methods in bioinformatics: clustering and classification, gene expression analysis, protein classification and attribute prediction.

CSE 467 Software Architecture

3 hours in a week, 3.00 credits

Definition and overview; Architecture design: patterns, Attribute-Driven Design (ADD) method; Architecture influence cycle: what influences software architects and software architecture; Understanding and achieving quality attributes: Quality Attribute Workshop (QAW) method for identifying critical quality attributes; Documenting software architecture; Evaluating software architecture: Architecture Tradeoff Analysis Method (ATAM) for evaluating software architecture; Architecture reuse; Architecture review; Improving an existing architecture design; Software Architecture in Agile projects; Software Architecture in service oriented systems; Software Architecture in embedded and mobile systems.

CSE 477 Cloud Computing

3 hours in a week, 3.00 credits

Cloud computing paradigms: cluster computing, grid computing, parallel and distributed computing; Cloud computing service models: infrastructure as a service, platform as a service, software as a service; Distributed computation models: MapReduce, Spark, remote procedure call, message passing; Virtualization: consolidation, resource provisioning, cost/profit optimization, customer satisfaction optimization, virtual machine management; Cloud system architecture: high availability, horizontal/vertical scaling, thin client, disaster recovery, performance measurement and monitoring; Cloud computing models: federation/presence/identity/security/privacy in cloud computing, multi-party computation; Mobile cloud computing: architecture, applications, privacy and security; Green cloud computing: dynamic capacity provisioning, power saving policies, geographical load balancing.

EEE 463 Optical Communications

3 hours in a week, 3.00 credits

Introduction to optical communication; Guided and unguided optical communication system, Light propagation through guided medium; Optical Fibers: SMF and MMF, SI fibers and GI fibers; Transmission impairments: fiber loss, chromatic dispersion in a fiber, polarization mode dispersion (PMD); Different types of fibers: DSF, DCF, Dispersion compensation schemes, Fiber cabling process, Fiber joints/connectors and couplers; Optical transmitter: LED and laser, Operating principles and characteristics; Optical receivers: PN, PIN and APD detectors, Noise at the receiver, SNR and BER. IM/DD and Coherent communication systems; Nonlinear effects in optical fibers; Optical amplifiers, Optical modulators; Multichannel optical systems: Optical FDM, OTDM and WDM; Lightwave networks: WDMA, FDMA, TDMA and CDMA, Optical Access Network, Optical network access protocols, Optical link design.

EEE 465 Telecommunication Systems

3 hours in a week, 3.00 credits

Introduction: Principle, evolution and telecommunication networks; National and International regulatory bodies, Basic elements of Telecommunication, Message source and bandwidth; Transmission media: twisted pair cable, coaxial cable, wireless channel and electromagnetic spectrum,

satellite channel and fiber-optic cable, Transmission impairments, Noise and signal-to-noise ratio, Transmission capacity, Analog and digital transmission; Telephone apparatus, telephone exchanges, subscriber loop, supervisory tones, PSTN; Switching systems: Introduction to analogy system: Strowger and Crossbar switching systems, Stored program control (SPC) systems; Digital switching systems: space division switching, time division switching; Traffic analysis: Traffic characterization, grades of service, network blocking probabilities, delay system and queuing; Integrated services digital network (ISDN): N-ISDN and B-ISDN, architecture of ISDN, B-ISDN implementation; Digital subscriber loop (DSL), Wireless local loop (WLL), FTTx, PDH and SONET/SDH, WDM Network, IP telephony and VoIP, ATM network and Next Generation Network (NGN).

MATH 441 Mathematical Optimization

3 hours in a week, 3.00 credits

Introduction; Classical methods with single and multi variables; Basics of mathematical programming; Linear programming; Graphical method with mathematical definitions and theorems; Nonlinear programming: one dimensional problems by elimination and interpolation methods; Unconstrained and constrained techniques; Geometrical programming, stochastic programming; Calculus of variations; Optimality and relaxation, Lagrangian relaxation; Convexity and subgradient Optimization; Subgradient optimization for the Lagrangian dual.

MATH 443 Game Theory

3 hours in a week, 3.00 credits

Introduction to game theory and its applications; Solution concepts: dominant strategies, pure and mixed strategies, Nash equilibrium; Zero sum games: two-player zero-sum games, existence of Nash equilibria, computation by linear programming, multiplayer zero-sum games; Learning in games: fictitious play, multiplicative weights updates; Price of anarchy: congestion games, potential games, existence of equilibria; Market equilibria: Arrow-Debreu existence theorem; Mechanism design: Vickrey auction, social choice theory, Arrow's impossibility theorem, Vickrey-Clarke-Groves (VCG) mechanism, application of the VCG mechanism in routing, Myerson auction; Evolutionary game theory.

PHY 405 Quantum Mechanics

3 hours in a week, 3.00 credits

Introduction to quantum mechanics, Born's interpretation of wave function, Hilbert space, Schrödinger equation in one dimension.: potential step, potential barrier, tunneling and its applications in metal-oxide-semiconductor, field-effect transistor and other electronic devices, rectangular potential well, linear harmonic oscillator, Schrödinger equation in three-dimension: analytical solution of hydrogen atom, orbital angular momentum and spin angular momentum, addition of angular momenta, Time independent and time dependent perturbation theory, quantum confinement in semiconductors and its energy considerations, applications of quantum mechanics in quantum computation.

HUM 475 Engineering Economics

3 hours in a week, 3.00 credits

Economics and engineering; microeconomics and macroeconomics; theory of demand and supply and their elasticities; demand estimation; price determination; indifference curve technique; theory of production; theory of cost and cost estimation; market structure; national income accounting; depreciation; circular flow of income and expenditure; cost-benefit analysis; payback period, net present value (NPV), internal rate of return (IRR), inflation; economic feasibility of engineering undertakings; Development Economics.

Level-4 Term-II

CSE 400 Project and Thesis

6 hours in a week, 3.00 credits

Study of problems in the field of Computer Science and Engineering.

CSE 409 Computer Graphics

3 hours in a week, 3.00 credits

Basics of computer graphics and its applications; Raster graphics: images and colours; 3D rasterization pipeline: modelling, viewing, projection and viewport transformations; Visible surface detection and hidden surface removal methods: back-face detection, depth buffer method, scan-line algorithm, depth-sorting method, BSP trees method; Scan conversion and

antialiasing; Direct illumination; Global illumination: radiosity, shadows; Shading and textures; Ray casting and ray tracing; Fractals; 3D modeling: parametric curves and surfaces using B-spline and Bezier curves and surfaces, polygonal meshes; Graphics hardware and computer games; Computer animation and computer-generated imagery (CGI).

CSE 410 Computer Graphics Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 409.

CSE 411 Simulation and Modeling

3 hours in a week, 3.00 credits

Systems, models, and simulation: the nature of simulation, discrete and continuous systems, simulation software, areas of application, advantages and disadvantages of simulation; Agent-based simulation and system dynamics, Spreadsheet simulation; Input modeling: selecting input probability distributions; Generating random variates: inverse-transform method, acceptance-rejection, composition, convolution; Output analysis; Variance-reduction techniques: Experimental design and optimization; Building valid, credible, and appropriately detailed simulation models; Analysis and modeling of some practical systems.

CSE 412 Simulation and Modeling Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 411.

CSE 413 High Performance Computing

3 hours in a week, 3.00 credits

Introduction to high performance computing: motivation, applications, challenges; Multi-processor computer organization: architecture, memory hierarchy, and pipelines; Performance measures and analysis: speedup, efficiency and scalability; Program optimization and vectorization; Parallelization strategies: task parallelism, data parallelism, and work sharing techniques; Parallel algorithms: algorithmic techniques, problem decomposition, partitioning and load balancing; High performance parallel programming: shared memory and message passing models, OpenMP and MPI programming; High performance computing with graphics

processing unit (GPU): GPU architecture, GPU programming model, GPU languages; High performance cloud and cluster computing: MapReduce programming model, Apache Hadoop.

CSE 414 High Performance Computing Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 413.

CSE 415 Real-time Embedded Systems

3 hours in a week, 3.00 credits

Embedded architectures: 16/32/64-bit embedded processors; Interaction with devices: buses, memory architectures, memory management, device drivers; Concurrency: software and hardware interrupt, timers; Real-time principles: synchronization, scheduling, multi-tasking; Real-time task scheduling: schedulability analysis, rate, and deadline monotonic scheduling, fixed and dynamic priority scheduling; Feedback control theory and application; Profiling and code optimization; Embedded software systems: exception handling, loading, mode-switching, programming embedded systems.

CSE 416 Real-time Embedded Systems Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 415.

CSE 427 Network Security

3 hours in a week, 3.00 credits

Network security policies, strategies and guidelines; Network security assessments and matrices; Security at Transport layer: SSL, TLS, SSH; Security on Network layer: IPSec; Security for wireless network protocols: WEP, WPA, WPA2; Security protocols for Ad-hoc network; Security protocols for Sensor network; Security for communication protocols; Security for operating system and mobile agents; Security for LAN and WAN; Switching and routing security; Network security applications: AAA standards, e-mail securities, PGP, S/MIME; PKI smart cards; Sandboxing; Firewalls and Proxy server.

CSE 428 Network Security Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 427.

CSE 431 Natural Language Processing

3 hours in a week, 3.00 credits

Introduction to Natural Language Processing (NLP): NLP tasks and applications; Language Models: The role of language models, Simple N-gram models, Estimating parameters and smoothing, Evaluating language models; Sequence Labeling; Topic modeling: TF-IDF, LSI, LDA; Deep Learning for NLP: word embeddings, RNNs, LSTMs, sequence-to-sequence models; Self-attention and Transformers; Parsing: semantic parsing, dependency parsing, constituency parsing; NLP for information extraction and information retrieval; Transfer learning and pre-trained language models: ELMo, GPT, BERT, T5; NLP for social media; Interpretability and analysis of language models; Advanced topics in NLP.

CSE 432 Natural Language Processing Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 431.

CSE 433 Image Processing and Computer Vision

3 hours in a week, 3.00 credits

Introduction; Digitization of images and its properties; Data structures for image analysis; Image processing; Segmentation: detection of discontinuities, edge linking and boundary detection, thresholding, region-oriented segmentation, use of motion in segmentation; Image transforms: Z-transform, 2D Fourier transform, discrete cosine transform; Image compression: run-length coding, transform coding, standards.
Introduction to computer vision; Image classification using convolutional neural networks; CNN architectures; image augmentation; semantic segmentation, object detection, and instance segmentation with RCNN and YOLO networks, Deep generative models: variational autoencoders (VAE) and generative adversarial networks (GAN) for computer vision; Image style transfer; Computer vision for multi-modal and video data; Advanced topics in computer vision.

CSE 434 Image Processing and Computer Vision Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 433.

CSE 437 Data Science and Big Data Analytics

3 hours in a week, 3.00 credits

Introduction to data science and big data: business intelligence, application domains; Data analytics life cycle: discovery, data preparation, model planning, model building, communicating results & operationalize; Exploratory data analysis and statistical evaluation using R; Data wrangling and visualization: feature extraction, handling missing values, dimensionality reduction, PCA, t-SNE, UMAP, plotting with ggplot2, visualization with Tableau; Machine learning: libraries and platforms for classification, regression, clustering, association rules, recommendations and ranking; Time series analysis: Box-Jenkins method, ARIMA; Text analysis: TF/IDF, LDA, topic modeling; Streaming, spatial, audio, video and graph data analytics; Advanced data analytics using deep learning; Data engineering: extract, transform, and load (ETL), database, parallel database, data warehouse, data lake, OLAP, JSON, XML, NoSQL; Big data analytics: characteristics of big data, analytics using MapReduce, Hadoop, Spark, managing big data, HDFS, Hive, MongoDB, Cassandra; Data provenance, privacy, security and ethics; Applications in financial technology (Fintech), cybersecurity,governance, social media, smart city, healthcare, bioinformatics, physical sciences, environmental and climates sciences.

CSE 438 Data Science and Big Data Analytics Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 437.

CSE 439 Functional Programming

3 hours in a week, 3.00 credits

Fundamental theories of programming languages: lambda-calculus and programming computable functions (PCF); Functional and imperative languages; Functional programming: types, pattern matching, functions, recursion, higher-order functions, modules, custom types and type classes, input and output, applicative functors, monads; Functional data structures;

Concurrent programming and parallelism; Program analysis, formal verification and abstraction using functional programming.
Reference language: Haskell/Kotlin.

CSE 440 Functional Programming Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 439.

CSE 447 Introduction to Blockchain

3 hours in a week, 3.00 credits

Basics of Blockchain: P2P networks, hashing, cryptography, digital signature, key exchange, checksum, blocks, and bitcoin; Distributed ledger systems; Miners; Block creation; Security on Blockchain; Categories of Blockchain; Consensus in Blockchain; Ethereum and Hyperledger; Applications of Blockchain.

CSE 448 Introduction to Blockchain Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 447.

CSE 461 Algorithm Engineering

3 hours in a week, 3.00 credits

Computational complexity; Exact Algorithms; Parameterized complexity; Practical computing and heuristics; Approximation algorithms; LP based approximation algorithms; Randomized algorithms; On-line algorithms; Experimental algorithmics; Contemporary and state-of-the-art.

CSE 462 Algorithm Engineering Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 461.

CSE 469 Software Testing and Quality Assurance

3 hours in a week, 3.00 credits

Objectives of software testing, Software Testing Life Cycle (STLC), Test Driven Development, Software Testing Terminology and Methodology; Test

Plan, Testcase design and Testdata generation, Equivalence Partitioning, Boundary Value Analysis, Test Coverage; Review of Common testing methods: Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Alpha and Beta Testing, White box and black box testing; GUI Testing, API Testing; Code Review; Performance testing: Load and Stress Testing, Volume Testing, Capacity Testing; Software Security: Concept of software security, Common Vulnerabilities and their mitigation, Buffer Overflow, SQLinjection, Cross-site Scripting, Automated Security Testing, Fuzz Testing; Testing tools and Test Automation : Open source and commercial software testing tools; Automatic Bug Detection, Automated Program Repair Techniques; Software Quality, Quality Control and Quality Assurance, Software Quality Metrics.

CSE 470 Software Testing and Quality Assurance Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 469.

CSE 475 Robotics

3 hours in a week, 3.00 credits

Introduction: what is a robot, types of robots, robotics and AI; Automation & autonomy architectures; Introduction to Robot Operating System (ROS); Robot hardware: sensors and effectors; Localization: Markov localization, particle filter, Kalman filter, extended Kalman filter, and multi-object localization; Mapping; Simultaneous localization and mapping (SLAM); Navigation and path planning; Locomotion and manipulation; Robot Kinematics: forward and inverse kinematics; Robot dynamics: dynamics of a Rigid Body, Newton-Euler Formula, and Euler-Lagrange Formula; Human-robot interaction; Control system of robots; Image processing and analysis with vision systems; Robotics and multi-agent systems.

CSE 476 Robotics Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 475.

CSE 481 VLSI Design

3 hours in a week, 3.00 credits

VLSI design methodology: PLA, FPGA, cell-based and full custom design

methods, System-on-chip design, Design Partitioning: structural and behavioral design with HDL, Physical design, Introduction to CMOS technology: characteristics and performance, CMOS processing technology, CMOS building blocks: inverters and basic gates, adder, multiplier, data path and memory structures, CMOS layout design rules, Design robustness: Variability, Reliability and Scaling, Testing, Debugging and Verification. VLSI Design Automation and Optimization: partitioning, floor-planning, channel routing, data-path synthesis.

CSE 482 VLSI Design Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 481.

CSE 483 Interfacing

3 hours in a week, 3.00 credits

Interfacing with floppy and hard-disk controller; serial communication interface; Barcode reader; Sound card; MIDI interface; Printer interface; ISA, PCI, AGP, PS/2 and USB interfaces; Interfacing with stepper motors, controlling semiconductor power switches - BJT, MOSFET, SCR and Triac, Application of Opto-coupler and relays, Embedded Processors, Embedded Computing Platform, Real Time Embedded Systems, Real Time Operating Systems, Embedded Systems Programming, Mapping between languages and hardware, Embedded Communication Systems, Embedded Computer Security.

CSE 484 Interfacing Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 483.

CSE 485 Digital Signal Processing

3 hours in a week, 3.00 credits

Discrete time signals and systems: Fourier and Z transforms, DFT, 2-dimensional versions; Linear time invariant discrete time systems; Digital signal processing topics: flow graphs, realizations, FFT, quantization effects, linear prediction; Digital filter design methods: windowing, frequency sampling, S-to-Z methods, frequency-transformation methods,

optimization methods, 2-dimensional filter design; Quantization of signals and filter coefficients; Oversampling techniques for ADC and DAC.

CSE 486 Digital Signal Processing Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 485.

CSE 487 Mobile Applications Development

3 hours in a week, 3.00 credits

Mobile platforms: anatomy of mobile devices, mobile OS (e.g., Android, iOS), mobile programming (e.g., Java, Swift); Android programming basics: SDKs, activities, life cycles, views, intent, resource, storage, UIs; Android advanced programming: SQLite, networking, maps, multimedia; iOS programming basics: Swift, SDKs, views, view controllers, gestures, storage; iOS advanced programming: memory management, data management, networking, graphics, location technologies; Web-based mobile applications (e.g., HTML5); Best practices to develop secure mobile app.

CSE 488 Mobile Applications Development Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on CSE 487.

EEE 469 Electrical Machines and Instrumentation

3 hours in a week, 3.00 credits

Introduction to conversion of energy; Single phase transformer - equivalent circuit and laboratory testing, introduction to three phase transformers; Principles of operation of DC, synchronous, induction, universal, and stepper motors; Introduction to Alternators; Measurement and instrumentation: applications, functional elements of a measurement system and classification of instruments; Measurement of electrical quantities; Transducers: mechanical, electrical and optical; Measurement of non-electrical quantities; Instrumentation amplifier, source of noise, noise reduction; Recording and display devices; Data acquisition systems.

EEE 470 Electrical Machines and Instrumentation Sessional

3 hours in alternate weeks, 0.75 credits

Sessional based on EEE 469.

HUM 403 Communication in English

3 hours in a week, 3.00 credits

Communication in society: forms of communication, communication for specific purposes, communication in the digital age, communicating across cultures, linguistic barriers; Grammar: construction of correct sentences; Paragraph; Composition; Vocabulary enrichment: techniques of enriching stock of words for global communication; Phonetics: places and manners of articulation of sounds; Summarizing and expansion of ideas; Reading: analysing literary and non-literary texts; Business communication: anticipating the audience, organizing messages, communicating in internal and client meetings, digital media, positive, neutral, negative and persuasive messages; Report writing: types and layouts of reports, information collection through research, usage of graphics and charts; Business presentations: creating effective business presentations; Employment communication: job search, resumes, cover letters, interviewing and following up.

HUM 402 Professional Communication in English Sessional

3 hours in a week, 1.50 credits

Communication basics: level of appropriateness, colloquial and standard, informal and formal, correct pronunciation and grammar in professional communication; Vocabulary building: correct and precise diction, affixes; Communication today: communication over digital media, communication at meetings, internal and client meetings; Improving reading skills: analyzing, interpreting and understanding text varieties, practicing comprehension, study of literary and non-literary texts; Improving listening skills: overcoming barriers to effective listening, building powerful listening skills; Written communication: sentence variety, generating sentences, clarity and correctness of sentences, linking sentences to form paragraphs, writing paragraph and composition; Writing reports and proposals; Business presentations: organizing content, connecting to audience, preparing engaging multimedia presentations; Employment communication: interviewing and following up.

HUM 429 Accounting and Entrepreneurship for IT Business

3 hours in a week, 3.00 credits

Accounting: Basic accounting concepts; Accounting as information systems; Conceptual framework of accounting; Double entry mechanism; Accounting equation; The recording process: journal, ledger and trial balance; Adjusting entries, preparing an adjusted trial balance; Financial statements preparation: statement of financial position, statement of comprehensive income, statement of owners' equity and statement of cash flows; Financial statements analysis and interpretation; Some applications of accounting in excel; Cost concepts: cost classifications and cost functions; Cost Behavior: analysis and use; Job order costing and preparing job cost sheet; Cost allocation; Standard costing; Working capital management.

Entrepreneurship for IT Business: Foundations of entrepreneurship; Inside the entrepreneurial mind, from ideas to reality: creativity and innovation; Rewards and challenges of entrepreneurship: ethics and social responsibility; Entrepreneurial process: conducting a feasibility analysis, designing a competitive business model, crafting a business plan and building a strategic plan; Forms of business ownership: buying an existing business; Building a marketing plan; Building a financial plan; Building an operational plan; Global aspects of entrepreneurship; Planning for the future: exit strategies.

IPE 493 Industrial Management

3 hours in a week, 3.00 credits

Introduction, evolution, management function, organization and Environment; Organization: Theory and structure; Coordination; Span of control; Authority delegation; Groups; Committee and task force; Manpower Planning; Personnel Management: Scope; Importance; Need hierarchy; Motivation; Job redesign; Leadership; Participative management; Training; Performance Appraisal; Wages and incentives; Informal groups; Organizational change and conflict; Cost and Financial Management: Elements of costs of products depreciation; Break-even analysis; Investment analysis; Benefit cost analysis. Management Accounting: Cost planning and control; Budget and budgetary control; Development planning process. Marketing Management: Concepts; Strategy; Sales promotion; Patent Laws; Technology Management: Management of innovation and changes; Technology life cycle; Case studies.

Chapter 3

Courses Offered to Other Departments

3.1 Courses Offered to the Department of Electrical and Electronic Engineering (EEE)

3.1.1 Course List

Course Number	Course Title	Hours/Week		Credit	Level/ Term
		Theory	Sessional		
CSE 109	Computer Programming	3.00	-	3.00	1/I
CSE 110	Computer Programming Sessional	-	3.00	1.50	1/I
CSE 451	Computer Networks	3.00	-	3.00	4/I
CSE 452	Computer Networks Sessional	-	3.00	1.50	4/I

3.1.2 Course Details

CSE 109 Computer Programming

3 hours in a week, 3.00 credits

Introduction to digital computers. Programming languages, algorithms and flow charts. Structured Programming using C: Variables and constants, operators, expressions, control statements, functions, arrays, pointers, structure unions, user defined data types, input-output and files. Object-oriented Programming using C++: introduction, classes and objects; polyorphism; function and operator overloading; inheritance.

CSE 110 Computer Programming Sessional

3 hours in a week, 1.50 credits

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in CSE 109. In the second part, students will learn program design.

CSE 451 Computer Networks

3 hours in a week, 3.00 credits

Switching and multiplexing; ISO, TCP-IP and ATM reference models. Different Data Communication Services: Physical Layer- wired and wireless transmission media, Cellular Radio: Communication satellites; Data Link Layer: Elementary protocols, sliding window protocols. Error detection and correction, HDLC, DLL of internet, DLL of ATM; Multiple Access protocols, IEEE.802 Protocols for LANs and MANs, Switches, Hubs and Bridges; High speed LAN; Network layer: Routing, Congestion control, Internetworking, Network layer in internet: IP protocol, IP addresses, ARP; NI in ATM transport layer: transmission control protocol. UDP, AT M adaptation layer; Application layer: Network security; Email, Domain Name System; Simple Network Management Protocol; HTTP and World Wide Web.

CSE 452 Computer Networks Sessional

3 hours in a week, 1.50 credits

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in CSE 451. In the second part, students will design systems using the principles learned in CSE 451.

3.2 Courses Offered to the Department of Biomedical Engineering (BME)

3.2.1 Course List

Course Number	Course Title	Hours/Week		Credit	Level/ Term
		Theory	Sessional		
CSE 281	Computer Programming	3.00	-	3.00	2/I
CSE 282	Computer Programming Sessional	-	3.00	1.50	2/I
CSE 283	Digital Techniques	3.00	-	3.00	2/II
CSE 284	Digital Techniques Sessional	-	3.00	1.50	2/II
CSE 391	Embedded Systems and Interfacing	3.00	-	3.00	3/I
CSE 392	Embedded Systems and Interfacing Sessional	-	3.00	1.50	3/I
CSE 493	Medical Informatics	3.00	-	3.00	4/I
CSE 495	Bioinformatics	3.00	-	3.00	4/I

3.2.2 Course Details

CSE 281 Computer Programming

3 hours in a week, 3.00 credits

Introduction to digital computers; Programming languages, algorithms and flow charts; Structured Programming using C: Variables and constants, operators, expressions, control statements, functions, arrays, pointers, structure unions, user defined data types, input-output and files; Object-oriented Programming using C++: introduction; classes and objects; polymorphism; function and operator overloading; inheritance.

CSE 282 Computer Programming Sessional

3 hours in a week, 1.50 credits

This course consists of two parts. In the first par t, students will perform experiments to verify practically the theories and concepts learned in CSE 281 In the second part, students will learn program design.

CSE 283 Digital Techniques

3 hours in a week, 3.00 credits

Digital Logic Design: Boolean algebra, logic gates and their truth tables, canonical forms, combinatorial logic circuits; Arithmetic and data handling

logic circuits, decoders and encoders, multiplexers and demultiplextures; Flip-flops, Counters, Registers; Sequential logic circuits. Digital Electronics: Diod logic gates, transistor gates, MOS gates; Logic Families: TTL, ECL, IIL and CMOS logic with operation details; Electronic circuits for flip-flops; A/D and D/A converters with applications; OP AMPs; Timing circuits.

CSE 284 Digital Techniques Sessional

3 hours in a week, 1.50 credits

Experiments based on CSE 283.

CSE 391 Embedded Systems and Interfacing

3 hours in a week, 3.00 credits

Introduction to embedded systems with applications: Overview of the design flow, Embedded system specification and modeling; Introduction to embedded processors and microcontrollers: types of processors, architecture, addressing modes, instruction sets, interrupts, parallelism; Memory architectures: memory technologies, memory hierarchy, memory models; memory interface; Bus interface; I/O hardware and interface; Integrating microcontrollers with interfacing chips; Programmable peripheral interfacing chip with interface to A/D and D/A converter; Programmable interrupt controller, DMA controller; Sensor and Actuators: models of sensors and actuators, common sensors, actuators; Interfacing to the external world through sensors and actuators.

CSE 392 Embedded Systems and Interfacing Sessional

3 hours in a week, 1.50 credits

Sessional based on CSE 391.

CSE 493 Medical Informatics

3 hours in a week, 3.00 credits

Integration of Information technology and Biomedical Engineering. Introduction to networking, communications, and information infrastructures in medical environment. Exposure to basic concepts related to networking at several levels: low-level (TCP/IP, services), medium-level (network topologies), and high-level (distributed computing, Web-based services) implementations. Commonly used medical communication protocols (HL7, DICOM) and current medical information systems (HIS, RIS, PACS).

Advances in networking, such as wireless health systems, peer-to-peer topologies, grid/cloud computing. Introduction to security and encryption in networked environments.

CSE 495 Bioinformatics

3 hours in a week, 3.00 credits

Introduction to algorithms and computational complexity; Basic graph theoretic terminologies; Graph algorithms: DNA sequencing, DNA fragment assembly, Spectrum graphs; Sequence similarity; Suffix Tree and variants with applications; Genome Alignment: maximum unique match, LCS, mutation sensitive alignments; Database search: Smith-Waterman algorithm, Fast A, BLAST and its variations, Locality sensitive hashing; Multiple sequence alignment; Phylogeny reconstruction; Phylogeny comparison: similarity and dissimilarity measurements, consensus tree problem; Genome rearrangement: types of genome rearrangements, sorting by reversal and other operations; Motif finding; RNA secondary structure prediction; Peptide sequencing; Population genetics.

3.3 Courses Offered to the Department of Industrial and Production Engineering (IPE)

3.3.1 Course List

Course Number	Course Title	Hours/Week		Credit	Level/ Term
		Theory	Sessional		
CSE 295	Computer Programming Techniques	3.00	-	3.00	2/I
CSE 296	Computer Programming Techniques Sessional	-	3.00	1.50	2/I

3.3.2 Course Details

CSE 295 Computer Programming Techniques

3 hours in a week, 3.00 credits

Introduction to number system: binary, octal, hexadecimal, binary arithmetic, basic programming concepts, program development stages: flow charts, pseudo codes, programming constructs: data types, operators, expressions, statement, control statements, single dimensional arrays, functions and program structure: parameter passing conventions, scope rules, recursion, library functions, pointers, strings, multidimensional

arrays, user defined data types: structures, unions, enumerations, input and output: standard input and output, formatted input and output, file access, command line parameters.

CSE 296 Computer Programming Techniques Sessional

3 hours in a week, 1.50 credits

Sessional work based on course CSE 295 using C programming language.

3.4 Courses Offered to the Department of Materials and Metallurgical Engineering (MME)

3.4.1 Course List

Course Number	Course Title	Hours/Week		Credit	Level/ Term
		Theory	Sessional		
CSE 287	Computer Programming	3.00	-	3.00	2/I
CSE 288	Computer Programming Techniques Sessional	-	3.00	1.50	2/I

3.4.2 Course Details

CSE 287 Computer Programming

3 hours in a week, 3.00 credits

Introduction to digitai computers; Programming languages, algorithms and flow charts; Structured programming using C: variables and constants, operators, expressions, control statements, functions, arrays, pointers, structures, unions, user defined data types, input-output and files; Object-Oriented programming using C++: introduction, classes and objects, polymorphism, function and operator overloading, inheritance.

CSE 288 Computer Programming Sessional

3 hours in a week, 1.50 credits

This course consists of two parts. In thè first part, students will solve programming problems to verify practically thè theories and concepts leamed in CSE 287. In thè second part, students will leam program design.

3.5 Courses Offered to the Department of Nanomaterials and Ceramic Engineering (NCE)

3.5.1 Course List

Course Number	Course Title	Hours/Week		Credit	Level/ Term
		Theory	Sessional		
CSE 273	Computer Programming and Numerical Analysis for Materials Modeling	3.00	-	3.00	2/I
CSE 274	Computer Programming and Numerical Analysis for Materials Modeling Sessional	-	3.00	1.50	2/I

3.5.2 Course Details

CSE 273 Computer Programming and Numerical Analysis for Materials Modeling

3 hours in a week, 3.00 credits

Introduction to digital computers. Structured Programming using C: Variables and constants, data types, operators, expressions, control statements, functions, arrays, structure, input and output: standard input and output, formatted input and output, file access. Applications of C/C++ programming in problems relevant for material modeling: numerical integration, differentiation, solving ordinary differential equations, curve fitting, finding roots of equations.

CSE 274 Computer Programming and Numerical Analysis for Materials Modeling Sessional

3 hours in a week, 1.50 credits

Laboratory course based on the theory course.

Appendix A

Equivalence Table

Old Course			New Course		
Course No.	**Course Title**	**Cr.**	**Course No.**	**Course Title**	**Cr.**
CHEM 113	Chemistry	3.00	CHEM 113	Chemistry	3.00
CHEM 114	Inorganic Quantitative Analysis	1.50	CHEM 118	Chemistry Sessional	0.75
CSE 101	Structured Programming Language	3.00	CSE 101	Structured Programming Language	3.00
CSE 102	Structured Programming Language Sessional	1.50	CSE 102	Structured Programming Language Sessional	1.50
CSE 103	Discrete Mathematics	3.00	CSE 103	Discrete Mathematics	3.00
CSE 107	Object Oriented Programming Language	3.00	CSE 107	Object Oriented Programming Language	3.00
CSE 108	Object Oriented Programming Language Sessional	1.50	CSE 108	Object Oriented Programming Language Sessional	1.50
CSE 203	Data Structures and Algorithms I	3.00	CSE 105	Data Structures and Algorithms I	3.00
CSE 204	Data Structures and Algorithms I Sessional	1.50	CSE 106	Data Structures and Algorithms I Sessional	1.50

Old Course			New Course		
CSE 205	Digital Logic Design	3.00	CSE 205	Digital Logic Design	3.00
CSE 206	Digital Logic Design Sessional	1.50	CSE 206	Digital Logic Design Sessional	1.50
CSE 207	Data Structures and Algorithms II	3.00	CSE 207	Data Structures and Algorithms II	3.00
CSE 208	Data Structures and Algorithms II Sessional	1.50	CSE 208	Data Structures and Algorithms II Sessional	1.50
CSE 211	Theory of Computation	3.00	CSE 211	Theory of Computation	3.00
CSE 215	Database	3.00	CSE 215	Database	3.00
CSE 216	Database Sessional	1.50	CSE 216	Database Sessional	1.50
CSE 317 (2006 syllabus)	Numerical Methods	3.00	CSE 401	Numerical Analysis, Simulation and Modeling	3.00
CSE 218	Numerical Methods	2.00	-	-	-
CSE 300	Technical Writing and Presentation	0.75	CSE 200	Technical Writing and Presentation	0.75
CSE 301	Mathematical Analysis for Computer Science	3.00	CSE 301	Mathematics for Computing and Data Science	3.00
CSE 305	Computer Architecture	3.00	CSE 209	Computer Architecture	3.00
CSE 306	Computer Architecture Sessional	0.75	CSE 210	Computer Architecture Sessional	0.75
CSE 307	Software Engineering	3.00	CSE 213	Software Engineering	3.00
CSE 308	Software Engineering Sessional	0.75	CSE 214	Software Engineering Sessional	0.75
CSE 309	Compiler	3.00	CSE 309	Compiler	3.00
CSE 310	Compiler Sessional	0.75	CSE 310	Compiler Sessional	0.75
CSE 311	Data Communication	3.00	CSE 311	Data Communication	3.00
CSE 313	Operating System	3.00	CSE 313	Operating System	3.00
CSE 314	Operating System Sessional	1.50	CSE 314	Operating System Sessional	0.75

Old Course			New Course		
CSE 315	Microprocessors, Microcontrollers, and Embedded Systems	3.00	CSE 315	Microprocessors, Microcontrollers, and Embedded Systems	3.00
CSE 316	Microprocessors, Microcontrollers, and Embedded Systems Sessional	1.50	CSE 316	Microprocessors, Microcontrollers, and Embedded Systems Sessional	0.75
CSE 317	Artificial Intelligence	3.00	CSE 317	Artificial Intelligence	3.00
CSE 318	Artificial Intelligence Sessional	0.75	CSE 318	Artificial Intelligence Sessional	0.75
CSE 321	Computer Networks	3.00	CSE 321	Computer Networks	3.00
CSE 322	Computer Networks Sessional	1.50	CSE 322	Computer Networks Sessional	1.50
CSE 325	Information System Design	3.00	CSE 325	Information Systems Development and Management	3.00
CSE 326	Information System Design Sessional	0.75	CSE 326	Information Systems Development and Management Sessional	1.50
CSE 400	Project and Thesis	3.00	CSE 400	Project and Thesis	3.00
CSE 405	Computer Security	3.00	CSE 405	Computer Security	3.00
CSE 406	Computer Security Sessional	0.75	CSE 406	Computer Security Sessional	0.75
CSE 408	Software Development Sessional	1.50	-	-	-
CSE 409	Computer Graphics	3.00	CSE 409	Computer Graphics	3.00
CSE 410	Computer Graphics Sessional	0.75	CSE 410	Computer Graphics Sessional	0.75
CSE 411	Simulation and Modeling	3.00	CSE 411	Simulation and Modeling	3.00
CSE 412	Simulation and Modeling Sessional	0.75	CSE 412	Simulation and Modeling Sessional	0.75
CSE 413	High Performance Computing	3.00	CSE 413	High Performance Computing	3.00
CSE 414	High Performance Computing Sessional	0.75	CSE 414	High Performance Computing Sessional	0.75

Old Course			New Course		
CSE 415	Real-time Embedded Systems	3.00	CSE 415	Real-time Embedded Systems	3.00
CSE 416	Real-time Embedded Systems Sessional	0.75	CSE 416	Real-time Embedded Systems Sessional	0.75
CSE 421	Basic Graph Theory	3.00	CSE 421	Basic Graph Theory	3.00
CSE 423	Fault Tolerant Systems	3.00	CSE 423	Fault Tolerant Systems	3.00
CSE 425	Human Computer Interaction	3.00	CSE 425	Human Computer Interaction	3.00
CSE 453	High Performance Database System	3.00	CSE 453	High Performance Database System	3.00
CSE 457	Wireless Networks	3.00	CSE 457	Wireless Networks	3.00
CSE 459	Communication Systems	3.00	CSE 459	Communication Systems	3.00
CSE 461	Algorithm Engineering	3.00	CSE 461	Algorithm Engineering	3.00
CSE 462	Algorithm Engineering Sessional	0.75	CSE 462	Algorithm Engineering Sessional	0.75
CSE 463	Introduction to Bioinformatics	3.00	CSE 463	Bioinformatics	3.00
CSE 465	Semantics of Programming Languages	3.00	-	-	-
CSE 467	Software Architecture	3.00	CSE 467	Software Architecture	3.00
CSE 471	Machine Learning	3.00	CSE 329	Machine Learning	3.00
CSE 472	Machine Learning Sessional	0.75	CSE 330	Machine Learning Sessional	1.50
CSE 473	Pattern Recognition	3.00	-	-	-
CSE 474	Pattern Recognition Sessional	0.75	-	-	-
CSE 475	Robotics	3.00	CSE 475	Robotics	3.00
CSE 476	Robotics Sessional	0.75	CSE 476	Robotics Sessional	0.75
CSE 481	VLSI Design	3.00	CSE 481	VLSI Design	3.00
CSE 482	VLSI Design Sessional	0.75	CSE 482	VLSI Design Sessional	0.75
CSE 483	Interfacing	3.00	CSE 483	Interfacing	3.00

Old Course			New Course		
CSE 484	Interfacing Sessional	0.75	CSE 484	Interfacing Sessional	0.75
CSE 485	Digital Signal Processing	3.00	CSE 485	Digital Signal Processing	3.00
CSE 486	Digital Signal Processing Sessional	0.75	CSE 486	Digital Signal Processing Sessional	0.75
CSE 487	Mobile Applications Development	3.00	CSE 487	Mobile Applications Development	3.00
CSE 488	Mobile Applications Development Sessional	0.75	CSE 488	Mobile Applications Development Sessional	0.75
EEE 163	Introduction to Electrical Engineering	3.00	EEE 163	Introduction to Electrical Engineering	3.00
EEE 164	Introduction to Electrical Engineering Sessional	1.50	EEE 164	Introduction to Electrical Engineering Sessional	1.50
EEE 263	Electronic Circuits	4.00	EEE 263	Electronic Circuits	3.00
EEE 264	Electronic Circuits Sessional	1.50	EEE 264	Electronic Circuits Sessional	1.50
EEE 269	Electrical Drives and Instrumentation	3.00	EEE 469	Electrical Machines and Instrumentation	3.00
EEE 270	Electrical Drives and Instrumentation Sessional	1.50	EEE 470	Electrical Machines and Instrumentation Sessional	0.75
EEE 463	Optical Communications	3.00	EEE 463	Optical Communications	3.00
EEE 465	Telecommunication Systems	3.00	EEE 465	Telecommunication Systems	3.00
HUM 172	Developing English Skills Sessional	1.50	HUM 402	Professional Communication in English Sessional	1.50
HUM 183	English	3.00	HUM 403	Communication in English	3.00
HUM 411	Business Law	2.00	-	-	-
HUM 475	Engineering Economics	3.00	HUM 475	Engineering Economics	3.00
HUM 477	Sociology for Science and Technology	2.00	-	-	-
HUM 479	Government	2.00	-	-	-

Old Course			New Course		
HUM 473 + HUM 481	Financial, Cost, and Managerial Accounting + Entrepreneurship for IT Business	2.00 + 2.00	HUM 429	Accounting and Entrepreneurship for IT Business	3.00
IPE 493	Industrial Management	3.00	IPE 493	Industrial Management	3.00
MATH 145	Differential Calculus, Integral Calculus, and Coordinate Geometry	3.00	MATH 141	Calculus I	3.00
MATH 147 + MATH 245	Ordinary Differential Equations (ODE), Partial Differential Equations (PDE) and Vector Calculus + Complex Variable and Statistics	4.00 + 3.00	MATH 241 + MATH 243	Advanced Calculus + Probability and Statistics	3.00 + 3.00
MATH 247	Linear Algebra, Laplace Transformation and Fourier Analysis	4.00	-	-	-
ME 165	Basic Mechanical Engineering	3.00	ME 165	Basic Mechanical Engineering	3.00
ME 174	Mechanical Engineering Drawing and CAD	1.50	ME 174	Mechanical Engineering Drawing and CAD	1.50
PHY 102	Physics sessional	1.50	PHY 114	Physics sessional	1.50
PHY 109	Heat & Thermodynamics, Electricity & Magnetism, Waves & Oscillations and Mechanics	4.00	PHY 129	Structure of Matter, Electricity & Magnetism, Wave Mechanics	3.00
-	-	-	CSE 219	Signals and Linear Systems	3.00

Old Course			New Course		
-	-	-	CSE 220	Signals and Linear Systems Sessional	1.50
-	-	-	CSE 402	Numerical Analysis, Simulation and Modeling Sessional	0.75
-	-	-	CSE 450	Capstone Project	1.50 + 1.50
-	-	-	CSE 417	Cyber-Physical Systems	3.00
-	-	-	CSE 419	Internet of Things (IoT)	3.00
-	-	-	CSE 427	Network Security	3.00
-	-	-	CSE 428	Network Security Sessional	0.75
-	-	-	CSE 429	Deep Learning	3.00
-	-	-	CSE 431	Natural Language Processing	3.00
-	-	-	CSE 432	Natural Language Processing Sessional	0.75
-	-	-	CSE 433	Image Processing and Computer Vision	3.00
-	-	-	CSE 434	Image Processing and Computer Vision Sessional	0.75
-	-	-	CSE 435	Introduction to Quantum Computing	3.00
-	-	-	CSE 437	Data Science and Big Data Analytics	3.00
-	-	-	CSE 438	Data Science and Big Data Analytics Sessional	0.75
-	-	-	CSE 439	Functional Programming	3.00
-	-	-	CSE 440	Functional Programming Sessional	0.75
-	-	-	CSE 441	Mobile Computing	3.00

Old Course			New Course		
-	-	-	CSE 445	Data Mining and Information Retrieval	3.00
-	-	-	CSE 447	Introduction to Blockchain	3.00
-	-	-	CSE 448	Introduction to Blockchain Sessional	0.75
-	-	-	CSE 455	Next Generation Wireless Networks	3.00
-	-	-	CSE 469	Software Testing and Quality Assurance	3.00
-	-	-	CSE 470	Software Testing and Quality Assurance Sessional	0.75
-	-	-	CSE 477	Cloud Computing	3.00
-	-	-	HUM 347	Ethics in Society and E-Governance	3.00
-	-	-	MATH 143	Linear Algebra	3.00
-	-	-	MATH 441	Mathematical Optimization	3.00
-	-	-	MATH 443	Game Theory	3.00
-	-	-	PHY 405	Quantum Mechanics	3.00

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