DETAILED OUTLINES OF COURSES

Level-1 Term-I B. Sc. Engineering

CSE-141 **Lectures: 3 hours/cycle**

Structured Programming **Credits: 3**

Structured Programming Language: Introduction: data types, operators, expressions; Input and output: standard input and output, formatted input and output; Control structures: branching, looping; Arrays: 1-D array, multidimensional array; Strings; Functions and program structure: parameter passing conventions, scope rules and storage classes, recursion; User defined data types: structures, unions, enumerations; File management; Error handling; Variable length argument list; Command line parameters; Header files; Preprocessor; Linking; Library functions.

Reference language: C

EE-181 **Lectures: 3 hours/cycle**

Basic Electrical Engineering **Credits: 3**

Direct current: voltage, current, resistance and power; Laws of electrical circuits and methods of network analysis; Laws of magnetic fields and methods of solving simple magnetic circuits;

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; Single and Polyphase A.C. circuit analysis; Resonance.

Math-141 **Lectures: 3 hours/cycle**

Differential and Integral Calculus **Credits: 3**

Differential Calculus:

Limit, Continuity and Differentiability, Significance of Derivatives and Differentials, Successive Differentiation, Leibnitz's Theorem, Indeterminate Forms and L'Hospital's Rule, Rolle's Theorem and The Mean Value Theorem, Taylor's Theorem, Geometrical Interpretation of the Theorems, Homogeneous Functions and Euler's Theorem, Partial Derivatives, Total Derivatives and Differentials, Geometrical Interpretation of Total and Partial Derivatives, Jacobian Transformation, Tangent and Normal in Cartesian and Polar Coordinates, Sub-tangent and Sub-normal in Cartesian and Polar Coordinates, Maximum and Minimum Values of the Functions of More Than One Variables with Applications.

Integral Calculus

Integration by Various Methods, Integration by the Method of Successive Reduction, Definite Integrals as the Limit of a Sum, Properties of Definite Integrals, Walli's Formula, More Reduction of Definite Integrals, Gamma and Beta Functions and Their Properties, Arc Length, Line Integrals of Scalar Functions, Area of the Region Enclosed by the Curves in Cartesian and Polar Coordinates, Area and Volume of a Surface of Revolution in Cartesian and Polar Coordinates, Differentiation Under the Sign of Integration and Its Application.

Phy-141 **Lectures: 3 hours/cycle**

Physics **Credits: 3**

Physical Optics: Theories of light; Interference of light, Young's double slit experiment, Interference in thin films: Interference by multiple reflections: constant and varying thickness, Newton's rings and its application.

Diffraction of light: Fresnel and Fraunhoffer diffraction. Diffraction by single slit, diffraction at double slit, diffraction grating;

Polarization of light: Production and analysis of polarized light, Brewster's law, Malus law, Polarization by double refraction, Retardation plates, Nicol prism, Optical activity, Polarimeters, Polaroid.

Modern Physics: Quantum effect, photo electric effect and Compton effect, de Broglie waves.

Quantum Mechanics: Uncertainty principle, Wave function and Schrodinger equation, Physical Significance of wave function.

Structure of Matter: Crystalline and non-crystalline solids, single crystal and polycrystalline solids, unit cell, Crystal systems, Coordinate number, Crystal planes and directions, NaC1 and CsC1 structure, Packing factor, Miller indices, Relation between inter-planar spacing and Miller indices, Bragg's Law. Defects in solids; point defects; Bonds in solids, Distinction between metal, insulator and semiconductor in terms of energy band

Waves & Oscillations: Differential equation of a Simple harmonic oscillator, Total energy and average energy, Combination of Simple Harmonic oscillations, Lissajous figures, Spring-mass system, Differential equation of a progressive wave, Power and intensity of wave motion, Stationary wave, Group velocity and Phase velocity.

LASER: Properties of LASER, Metastable state, Population inversion, Stimulated emission, Optical pumping, Principle of LASER, Ruby LASER, He-Ne gas LASER, Semiconductor LASER and application of LASERs.

Hum-141 **Lectures: 2hours/cycle**

English **Credit: 2**

Grammar: Sentence elements and basic sentence patterns, analysis and synthesis of sentences, rules of punctuation and capitalization, study of grammatical errors, word formation processes.

Writing: paragraph writing, principles of academic writing, structure and writing process of academic reports, research proposal writing.

Reading: Purposes of academic reading, types of academic reading, different reading skills and their application, SQ3R/4R approach to academic reading.

Speaking: aspects of effective oral presentation.

CSE-100 **Contact hour: 3/2 hours/cycle**

Computer Fundamentals and Ethics (Sessional) **Credits: 0.75**

Sessional based on following contents:

Introduction to Computers: Overview of Computer system, Types and generation of computers, Basic organization and functional units of computers.

Hardware: Operations and functions of processor, Memory, I/O devices.

Software: Overview of system and application software, Installation of different types of Operating Systems, Networking.

Ethics: Ethical issues of software, social media and IT Enabled Services (ITeS) usages; Safety and security issues in cyber world.

CSE-142 **Contact hour: 3 hours/cycle**

Structured Programming (Sessional) **Credits: 1.5**

Sessional based on CSE-141

EE-182 **Contact hour: 3 hours/cycle**

Basic Electrical Engineering (Sessional) **Credits: 1.5**

Sessional based on EE-181

Phy-142 **Contact hour: 3 hours/cycle**

Physics (Sessional) **Credits: 1.5**

Sessional based on Phy-141

Level-1 Term-II B. Sc. Engineering

CSE-111 **Lectures: 3 hours/cycle**

Discrete Mathematics **Credits: 3**

Set theory: sets, relations, and partial ordered sets; functions; Mathematical Logic: propositional calculus and predicate calculus; Mathematical reasoning and proof techniques; Counting, principles of inclusion and exclusion; Recurrence relations and recursive algorithms; Growth of functions; Graph Theory: graphs, paths, and trees; Algebraic structures: rings and groups.

CSE-143 **Lectures: 3 hours/cycle**

Object Oriented Programming **Credits: 3**

Concepts of object oriented programming, Classes, Friend functions: Objects, isomorphism, polymorphism, inheritance, parameterized constructors, multiple inheritance, passing object to functions, arrays of objects, pointer to objects.

Function and operator overloading, overloading constructor functions, references, virtual functions, Exception Handling, Template functions and classes, Streams, Dynamic allocation, Static class members, Multi-threaded programming.

Math-143 **Lectures: 3 hours/cycle**

Co-ordinate Geometry and Differential Equation **Credits: 3**

Coordinate Geometry:

Two Dimensional Geometry: Change of Axes, Pair of Straight Lines, General Equations of Second Degree and Their Reduction to Standard Forms.

Three Dimensional Geometry: Direction Cosines, Direction Ratios, Distance Between Two Points, Equation of Planes, Angle Between Two Planes, Condition of Parallelism and Perpendicularity of Two Planes.

Ordinary Differential Equations (ODE):

Definitions and Terminology, Formation of Differential Equations, Solutions of Various Types of First Order and First Degree ODE, Initial Value Problems, Solutions of Linear Differential Equations of Second and Higher Orders with Constant Coefficients, Method of Undetermined Coefficients, Solutions of Homogeneous Linear Equations (Cauchy-Euler Equations), Modeling with First Order ODE.

Partial Differential Equations (PDE):

Definition, Formation of PDE, Classification of PDE (Elliptic, Hyperbolic or Parabolic), Solutions of Higher Order PDE with Constant Coefficients, Solutions of Second Order Linear PDE by Separation of Variables (Heat, Wave, Laplace's and Telegraph Equations).

LEVEL 1 TERM II

EE-183 **Lectures: 3 hours/cycle**

Electronic Devices and Circuits **Credits: 3**

Introduction to semiconductors; Bipolar Junction Transistor (BJT): Bipolar Junction Transistor (BJT): principle of operation, I-V characteristics; Transistor circuit configurations (CE, CB, CC), BJT biasing, load lines; BJTs at low frequencies; Hybrid model, h parameters, simplified hybrid model; Small-signal analysis of single and multi-stage amplifiers, frequency response of BJT amplifier. Field Effect Transistors (FET): principle of operation of JFET and MOSFET; Depletion and enhancement type NMOS and PMOS; biasing of FETs; Low and high frequency models of FETs, Switching circuits using FETs; Introduction to CMOS; OPAMP: linear applications of OPAMPs, gain, input and output impedances, active filters, frequency response and noise, Non-linear applications of OP AMP; DAC-ADC: A/D and D/A converters with applications; Sample and hold circuit; LED-LCD: Introduction of LED and LCD with application; Oscillators; Silicon Controlled Rectifiers (SCR), TRIAC, DIAC and UJT: characteristics and applications; Introduction to IC fabrication processes. Stabilizer and UPS.

Wave shaping circuits: Linear wave shaping; Non-linear wave shaping; Diode wave shaping technique s, clipping and clamping circuits (Diode applications); regulated power supply using zener diode; comparator circuits; Multivibrators: monostable, bistable and astable multivibratiors; Schmitt trigger; blocking oscillators and time-base circuit; Timing circuits, Simple voltage sweeps, linear current sweeps.

Chem-141 **Lectures: 3 hours/cycle**

Chemistry **Credits: 3**

1. Chemistry of Semiconductor Materials: Definition, types and properties. Effect of temperature on Semiconductor. Physical and Chemical Properties of Boron, Silicon, Gallium, Germanium, Arsenic and Antimony. Preparation of Pure Silicon.

2. Nuclear Chemistry: Radioactivity of Nucleus, Definition, types, effect ad properties of radioactive elements. Nuclear stability, Mass defects, Nuclear binding energy. Energy released in radiation. Nuclear reaction, reactor and safety.

3. Chemical Bonding: Ionic Bond, Covalent Bond, Co-ordination Bond, Metallic Bond, Hydrogen Bond, Dipole Bond, Vander Waal's Forces, Hybridization, Resonance, Valence Bond Theory (VBT), Molecular Orbital Theory (MOT), Liner Combination of Atomic Orbital (LCAO) Method.

4. Conductivity of Electrolytic Solution: Type of Conductors, Conductance, Specific Conductance, Equivalent Conductance, Mechanism of Electrolytic Conductance, Factors Influencing Conductivity, Arrhenius Theory, Law of Independent Migration of Ions and its Applications, Determination of Transport Number, Abnormal Conductance, Conductometric Titration.

5. Electromotive Forces: Electrochemical Cell, Cell Reaction, Cell Potential, Cell Representation, Measurement of EMF of a Cell, Relation Between EMF and Free Energy, Electrode Potential, Electrochemical Series, Nernest's Equation, Different Types of Reference Electrodes and pH Measurement, Over Potential, Lithium Ion Battery, Fuel Cell its latest development.

6. Photochemistry: Photochemical Reactions, Laws of Photochemistry, Quantum Yield and its determination, Photosensitized reaction, Photo-physical Processes.

7. Polymer: Classification, Bonding in Polymer, Thermosetting and Thermoplastic Polymer, Synthesis, Properties and Uses of Some Polymers-Polyethylene, PVC, Bakelite, and Melamine etc.

8. Rubber: Importance, Latex, Cude Natural Rubber, Gitta-percha, Compounding and Vulcanization of Rubber, Synthesis and Properties of Neoprene Rubber, Buna-S Rubber, Nitrile Rubber and Silicon Rubber, Reclaimed Rubber.

CSE-144 **Contact hour: 3 hours/cycle**

Object Oriented Programming (Sessional) **Credits: 1.5**

Sessional based on CSE-143 with emphasize of the followings:

1.Familiarities with OOP languages

2.Conversion of structured programs into object oriented programs

3. Develop program to illustrate basic concept of OOP- class and object; constructor and destructor

4.Implementation of major object-oriented features- encapsulation, data abstraction, inheritance and polymorphism

5. Implementation of I/O Stream and file handling techniques in OOP

6. Implementation of advance features like temples and exception

7. Implementation of multithreaded programming

8.Develop real life/ engineering problem solving applications using object oriented programming

EE-184 **Contact hour: 3 hours/cycle**

Electronic Devices and Circuits (Sessional) **Credits: 1.5**

Sessional based on EE-183

Chem-142 **Contact hour: 3/2 hours/cycle**

Chemistry (Sessional) **Credit: 0.75**

Sessional based on Chem-141 with emphasize of the followings:

Preparation: Preparation of Standard Solutions like $Na_2C_2O_4$, $K_2Cr_2O_7$ Solution.

Standardization: Standardization of the solution of Secondary Standard Substances like $KMnO_4$, $Na_2S_2O_3$ Solution.

Analysis of Materials: Determination of Fe, Cu, Ca etc.

Hum-144 **Contact hour: 3 hours/cycle**

English Skill Development (Sessional) **Credits: 1.5**

Writing Skills: generating sentences to form paragraphs, practicing writing abstract, introduction, conclusion, paraphrasing and summarizing, quotations, referencing, description, narrative, definitions, exemplification, classification, comparison and contrast, cause and effect, generalization, qualification, caution, and practicing interpretation of data (charts, graphs, diagrams, tables etc).

Reading Skills: applying various approaches to reading (skimming, scanning, predicting, inferring, SQ3R/4R) in analyzing and interpreting variety of texts, and practicing comprehension from literary and nonliterary texts.

Listening Skills: listening to recorded texts, class lectures and various speeches and practicing to take useful notes based on listening.

Speaking Skills: communicative expressions for personal identification, life at home, giving advice and opinion, instructions and directions, requests, complaints, apologies, describing people and places, narrating events, self-introduction, introducing others, group discussion, dialogue, and practice speaking.

Level-2 Term-I B. Sc. Engineering

CSE-241 **Lectures: 3 hours/cycle**

Data Structures **Credits: 3**

Introduction to Data Structure

Data Management concepts, Data types: primitive and non-primitive, Types of Data Structures: linear and nonlinear data structures, Operations on Data Structures, Performance Analysis and Measurement: time and space analysis of algorithms-Average, best and worst case analysis, asymptotic notations

Linear Data Structure

Arrays: Representations of different types of arrays, operations on arrays, pointer arrays, types and operations on matrices

Linked Lists: Types linked lists, representation of linked lists, operations on linked lists, linked lists for representation of polynomials

Stacks: Definitions and concepts, Memory representation of stacks, Operations on stacks, Applications of stacks, Infix, prefix and postfix expressions, Recursion and use of stacks in recursion

Queues: Definitions and representation of queues, Types of queues, Operations on Queues, Circular Queue, Priority Queue, Array representation of Priority Queue, Double Ended Queue, Applications of Queues

Nonlinear Data Structure

Trees: Definitions and Concepts, Representation of trees, Tree traversal, Threaded binary tree, Conversion of General Trees to Binary Trees, 2-trees, balanced binary trees, Binary search trees, AVL trees, Red-black trees, M-way search trees, B-trees and B+-trees, Heaps

Graphs: Terminologies and representation of graphs, path matrix and strongly connected graph, operations on graphs, Graph traversals: BFS and DFS, topological sorting, minimum cost spanning trees

Sorting and Searching

Sorting: Bubble Sort, Selection Sort, Quick Sort, Merge, Heap sort, radix sort Sort

Searching: Linear Search, Binary Search, Ternary Search, Jump Search, Interpolation Search

Exponential Search, Fibonacci Search

Hashing and File Structures:

Hashing: The symbol table, Hashing Functions, Collision Resolution Techniques,

File Structure: Concepts of fields, records and files, Sequential, Indexed and Relative/Random File Organization, Indexing structure for index files, hashing for direct files, Multi-Key file organization and access methods.

CSE-221 **Lectures: 3 hours/cycle**

Digital Logic Design **Credits: 3**

Number systems & codes, representation of digital data in registers and memory; Digital logic: Boolean algebra, De Morgan's Theorems, logic gates and their truth tables, canonical forms, combinational logic circuits, minimization techniques; Arithmetic and data handling logic circuits, decoders and encoders, multiplexers and demultiplexers; Combinational circuit design; Flip-flops; race around problems; Counters: asynchronous and synchronous counters and their applications; Asynchronous and synchronous logic design: State diagram, Mealy and Moore machines; State minimizations and assignments; PLA and PAL design; Design using MSI and LSI components. Logic Families: RTL, TTL, IIL and CMOS logic with operation details; Basic ECL circuit, ECL OR/NOR gate, ECL characteristics, Propagation delay, product and noise immunity, fan-in and fan-out. Open collector and high impedance gates, Electronic circuits for flip-flops.

CSE-231 **Lectures: 3 hours/cycle**

Applied Statistics **Credits: 3**

Elementary probability theory, Axioms of probability, Repeated trial, Random Variables, Distribution and Density of Random Variables, Conditional Distribution, Function of One and Two Random Variables, Discrete and Continuous probability distributions; Expectation, Variance, Moments.

Binomial, Negative binomial, Geometric and Poisson Distributions.

Continuous probability distributions: Normal, Gaussian, Gamma and Exponential distributions.

Moment Generating functions (MGF);

Elementary Sampling Theory, Estimation, Hypothesis Testing.

Stochastic processes, Discrete time Markov Chain and continuous time Markov chain, birth death process in queuing. Random Walks.

Math-241 **Lectures: 3 hours/cycle**

Fourier Analysis and Laplace Transformation **Credits: 3**

Fourier Series: Fourier Series and Fourier Coefficients, Dirichlet's Conditions of the Convergence of Fourier Series, Exponential Form of Fourier Series, Fourier Series of Even and Odd Functions, Half-Range Fourier Series, Frequency Spectrum (or Line Spectrum) of Periodic Continuous Time Signals.

Fourier Integrals: Development of Fourier Integral from Fourier Series (Fourier's Integral Theorem), Fourier Integral, Fourier Sine and Cosine Integrals.

Fourier Transforms: Development of Fourier Transform and Inverse Fourier Transform from Fourier Integral, Fourier Transforms of Elementary Functions, Fourier Sine and Cosine Transforms and Their Applications in Boundary Value Problems.

Laplace Transforms: Definition of the Laplace Transform, Laplace Transforms of Elementary Functions, Inverse Transforms and Transforms of Derivatives, Translation on the s-Axis, Translation on the t-Axis and Unit Step Function, Derivatives of a Transform, Transforms of Integrals, Transform of a Periodic Function, The Dirac Delta Function, Solutions of Differential Equations by Laplace Transforms.

Hum-243 **Lectures: 3 hours/cycle**

Engineering Economics **Credits: 3**

Fundamental Economics: Definition and scope, demand and supply, market equilibrium, elasticity, utility analysis (consumer behavior), theory of production, theory of cost, and market structure (perfectly competitive market and monopoly), Economics and engineering.

Macroeconomics: National Income, circular flow of income, aggregate demand and, aggregate supply, inflation, devaluation , unemployment, consumption and saving function, investment function, IS and LM model, fiscal and monetary policy.

International Economics: The pure theory of international trade, foreign currency reserve of Bangladesh.

Cost-benefit analysis; payback period, net present value (NPV), internal rate of return (IRR); economic feasibility of engineering undertakings; Development Economics.

CSE-242 **Contact hour: 3 hours/cycle**

Data Structures (Sessional) **Credits: 1.5**

Sessional based on CSE-241 with emphasize of the followings:

-Implementation of large programs using array data structure
-Performing different operations on different variants of linked lists
-Implementations of stack and queues to solve real world problems
-Implementations of binary search trees, 2-D trees and heap
-Implementation of Warshall's algorithm, BFS, DFS and topological sorting
-Implementation of different sorting algorithms

CSE-222 **Contact hour: 3 hours/cycle**

Digital Logic Design (Sessional) **Credits: 1.5**

Sessional based on CSE-221

ME-246 **Contact hour: 3 hours/cycle**

Engineering Drawing & CAD (Sessional) **Credits: 1.5**

Introduction, First and third angle projections; Orthographic drawings; Isometric views; Missing lines and views; Sectional views and conventional practices; Auxiliary views, Auto CAD and drawing of engineering objects using Auto CAD.

CSE-200 **Contact hour: 3/2 hours/cycle**

Competitive Programming (Sessional) **Credits: 0.75**

Introduction to different online judges: LightOJ, UVa, Codeforces, Topcoder, Codechef; Understanding complexity; Coding skill improvement; Ensure participations in online contest; Take appropriate steps to improve problem solving skills of students; Solve 100+ problems (on different categories).

Number Theory: Prime generation, Sieve of Eratosthenes, Modular arithmetic's, Modular inverse, Big-mod; STL; Searching; Sorting; Graph theory; Tail-call recursion; Pattern matching: KMP, Z-algorithm; Basic Geometry; Advanced Geometry: Convex Hull.

Level-2 Term-II B. Sc. Engineering

CSE-223

Digital Signal Processing

Lectures: 3 hours/cycle

Credits: 3

Signals and systems: Continuous time and discrete time signals and systems; signal characteristics, properties of continuous time and discrete time systems; Linear time-invariant (LTI) systems: Continuous time and discrete time LTI systems, impulse response, convolution, properties of LTI systems; Fourier series representation of periodic signals: Continuous time and discrete time Fourier series; Fourier transform: Continuous time and discrete time Fourier transform; Z-transform, Signal flow graphs of discrete time systems, Discrete Fourier transform; Fast Fourier transform; Filter design techniques: Design of FIR filters and IIR filters, windowing, impulse invariance, optimum approximation; Applications of DSP; Multimodal signal processing.

CSE-243

Algorithms Design and Analysis

Lectures: 3 hours/cycle

Credits: 3

Efficient algorithm designing techniques: Divide-and-Conquer paradigm, Greedy method, Dynamic programming, Backtracking, Branch and bound; Flow algorithms; Approximation Algorithms; Introduction to parallel and randomized algorithms;

Search and traversal: Basic search and traversal technique, Shortest path problems, Topological sorting, Connected components, Spanning trees; Graph algorithms.

Analysis of algorithms: Complexity Analysis, Solving Recurrences, Correctness and loop invariants, Algebraic simplification and transformations, Lower bound theory, NP completeness, NP-hard and NP-complete problems;

CSE-251

Data Base Management Systems

Lectures: 3 hours/cycle

Credits: 3

Concepts of database systems; Data Models: Entity-Relationship model, Relational model; Query Languages: Relational algebra, SQL; Intermediate SQL: Join operations, Views; Advanced SQL: Constraints and triggers; Functional dependencies and normalization; File organization and data storage; Indexing: primary and secondary indexes, B+ trees, hash tables; Query optimization; Transaction management: Transaction concept, ACID Properties , Concurrent Executions, Serializability ; Recovery; Concurrency control: Lock-Based Protocols, Timestamp-Based Protocols, Multiple Granularity; Access control and security; Distributed Databases; Semi-structured database: XML, XPath, XQuery; Object oriented and object relational databases; Introduction to NoSQL database;

EE-283 **Lectures: 3 hours/cycle**

Electrical Drives and Instrumentation **Credits: 3**

DC Machines: Operation and performance characteristics of generators and motors. Starting and Speed control of DC motor/generator.

AC Machines: Basic principle, Characteristics of single/three phase induction motors. Working Principle of synchronous machines, method of synchronization and parallel operation of alternator. Speed control of AC machines.

Special Machines: Working principle and control of stepper motor. High-Speed Operation of Stepper-Motors, Basic operating principle of Servo Motor, types of servo motor and their working mechanism, Servo Control using microcontroller, Adriano and Raspberry Pi.

Measuring Instruments: voltage, current, and power measuring instruments. Computer aided measurements. Analog & digital data acquisition systems. Modern digital data acquisition system. AC to DC and DC to AC Converters.

Transducers: Classification of transducers. Factors affecting the choice of transducers. Piezoelectric, Hall Effect, Pressure, Temperature, Ultrasonic, Humidity and opto electronic transducers. Linear variable differential transformers (LVDT).

Special Topics: Smart grid operation, monitoring and control.

Math-243 **Lectures: 3 hours/cycle**

Vector Calculus, Linear Algebra and Complex Variables **Credits: 3**

Vector Calculus: Scalar and Vector Field; Gradient of Scalar Field, Divergence and Curl of Vector Field; Physical Significance of Gradient, Divergence and Curl; Line, Surface and Volume Integrals; Green's Theorem, Gauss' Divergence Theorem, Stokes' Theorem and Their Applications.

Linear Algebra: Matrices and Elementary Row Operations, Rank, The Inverse of a Square Matrix, Systems of Linear Equations and Their Applications in Network Flow and Electric Circuits, Vectors in IRn, Linear Combinations, Linear Dependence and Independence, Vector Spaces and Subspaces, Basis and Dimension, Linear Transformations, Kernel and Range, Matrix Representation of a Linear Transformation, Application of Linear Transformation in Computer Graphics, Eigenvalues and Eigenvectors, Diagonalization.

Complex Variables: Complex Functions, Complex Functions as Mappings, Linear Mappings, Limits and Continuity, Differentiability and Analyticity, Cauchy-Riemann Equations, Harmonic Functions, Line Integral of a Complex Function, Cauchy's Theorem, Cauchy's Two Integral Formulas, Taylor and Laurent Series, Zeros and Poles, Residues and Residue Theorem, Contour Integration (Evaluation of Real Trigonometric Integrals, Real Improper Integral, Integration Along a Branch Cut), Conformal Mappings, Linear Fractional Transformations.

CSE-224 **Contact hour: 3/2 hours/cycle**

Digital Signal Processing (Sessional) **Credits: 0.75**

Sessional based on CSE-224

CSE-244 **Contact hour: 3 hours/cycle**

Algorithms Design and Analysis (Sessional) **Credits: 1.5**

Sessional based on CSE-243

CSE-252 **Contact hour: 3 hours/cycle**

Data Base Management Systems (Sessional) **Credits: 1.5**

Sessional based on CSE-251

EE-284 **Contact hour: 3/2 hours/cycle**

Electrical Drives and Instrumentation (Sessional)
Credits: 0.75

Sessional based on EE-283

CSE-202 **Contact hour: 3 hours/cycle**

Software Development with JAVA (Sessional) **Credits: 1.5**

Introduction to JAVA and JAVA Development Kit (JDK); Fundamental programming with JAVA; Object Oriented Programming based project development with JAVA; Take appropriate steps to archive all the project goals.

CSE-313 **Lectures: 3 hours/cycle**

Data Communication **Credits: 3**

Modulation: AM, FM, and PM; Digital modulation: ASK, FSK, PSK, QPSK, MSK, OOK, Quantization, Constellation and PCM; Pulse modulation: PAM, PWM, PPM, PCM, companding, delta modulation, differential PCM; Concept of channel coding and capacity; Line coding, trunks, multiplexing; Synchronous and asynchronous communications; Communication mediums and their characteristics; Data communication interface; Data communication services: SONET, ISDN, SMDS and ATM; Circuit switching, Packet switching and Frame relay; Signaling System 7(SS7). Error detection and Correction, flow control and error control, Automatic repeat request (ARQ) protocols. Fiber optics communication: transmitters, receives, network components, WDM; VSAT: Satellite communication fundamentals.

CSE-331 **Lectures: 2 hours/cycle**

Theory of Computing **Credits: 2**

Central Concept of Automata Theory: Alphabets, Strings, Length of Strings, Power of Alphabets, Languages, Problems, Define language using set former. Finite Automata: Basic concepts of DFA & NFA, Designing DFA & NFA, Transition Diagram, Transition Table, NFA to DFA Conversion, Computation of ε-closure of states, ε-NFA, Equivalence of ε-NFA to NFA. Regular Expressions: Basic Concepts, Application of Regular Expressions, Conversion of Regular Expressions to NFA, Conversion of NFA/DFA to Regular Expressions. Context-free Grammars (CFGs): Definition/Properties of CFG, Designing CFG, Left-most Derivation, Right-most Derivation, Parse Tree, Equivalence of Derivation & Parse Tree, Ambiguity & Ambiguous CFGs, Conversion of Ambiguous CFGs to Unambiguous CFGs. Pushdown Automata (PDA): Basic concepts, Transition function, Transition Diagram, Designing PDA, Instantaneous Description of PDA, Languages of PDA & their conversion, Conversion of PDA to CFG & CFG to PDA, Chomsky Normal Form (CNF): Basic properties and conversion of CFG to CNF, Pumping Lemma. Turing Machines (TM): Basic Concepts, Configuration, Transition Functions, Transition Diagram, Instantaneous Description of TM, Computing & Designing Turing Machines, Halting Problem of TM, Programming Techniques for TM (Multi-track TM, Multi-tape TM, Multi-stack TM, Counter Machines), Simulating TM, Combining TM, Comparing the Running Times of Computers & TM, Undecidability: Basic Concepts, Decidable Languages, Reducibility, Codes of TM, Hilbert's problems.

CSE-333 **Lectures: 3 hours**

Microprocessors and Interfacing **Credits: 3**

Introduction to 8-bit, 16-bit, and 32-bit microprocessors: architectures, addressing modes, instruction sets, interrupts, assembly language programming, hardware specifications; Memory interface; Arithmetic Co-processors; Microcontrollers; An overview of Pentium and Multicore processors, RISC processors. Basic I/O interface; Programmable peripheral interfacing chip with interface to A/D and D/A converters; Interrupt controller; DMA controller; Serial communication interface; Bus interface: ISA, PCI, AGP, LPT, COM, USB, and GPIB standards; MIDI interface; Application of opto-coupler and relays; Interfacing with analog/digital world: stepper motors, sensors, transducers, DC motors, and high power devices.

CSE-353 **Lectures: 3 hours/cycle**

System Analysis and Design **Credits: 3**

System analysis fundamentals: systems, roles, and development methodologies; Understanding and modeling organizational system; Project management; Information requirements analysis: Interactive methods; Information gathering: Unobtrusive methods; agile modeling and prototyping; The analysis process: Using data flow diagrams; Analyzing systems using data dictionaries; Process specifications and structured decisions; Object oriented systems analysis and design using UML(Use case); The essentials of design: Designing effective output, Designing effective input; Designing databases; Quality assurance: Designing accurate data entry procedures; Quality assurance and implementation.

CSE-335 **Lectures: 3 hours/cycle**

Operating Systems **Credits: 3**

Operating system: its role in computer systems; multitasking, multiuser, multiprocessing OS; Operating system structures; Process: process concept and scheduling, inter-process communication, communication in client-server systems; CPU scheduling: scheduling criteria and algorithms, thread scheduling, multiple-processor scheduling; Process synchronization: critical-section problem, semaphores, Classic synchronization problems, monitors; Deadlock: resource allocation and deadlock, deadlock detection, prevention and recovery; Memory management: swapping, paging, segmentation, virtual memory, Page replacement algorithms; Input/ Output: hardware, software, disk, terminals, clocks; File Systems: files, directories, security, protection; Case study of some operating systems.

CSE-314 **Contact hour: 3/2 hours/cycle**

Data Communication (Sessional) **Credits: 0.75**

Sessional based on CSE-313

CSE-334 **Contact hour: 3 hours/cycle**

Microprocessors and Interfacing (Sessional) **Credits: 1.5**

Sessional based on CSE-333 with emphasis on Assembly Language Programming

CSE-354 **Contact hour: 3/2 hours/cycle**

System Analysis and Design (Sessional) **Credits: 0.75**

Sessional based on CSE-353

CSE-336 **Contact hour: 3 hours/cycle**

Operating Systems (Sessional) **Credits: 1.5**

Sessional based on CSE-335

CSE-326 **Contact hour: 3 hours/cycle**

Internet Programming (Sessional) **Credits: 1.5**

Introduction: What is website, Types of website, Technology used in web site development, Different between web design and development, Domain and Hosting. **HTML:** HTML Basics, Tags, Use of tag, Properties and Element, Implementation of html tag, properties and element., Setting Background and Text Colors, Adding Local and Remote Links, Adding Internal Links with the Named Anchor Tag, Linking and Embedding Graphics, Creating Lists and Nested Lists, Creating and Modifying Tables. **XML and XHTML:** XML basics; XHTML: Document Structure, Basic Tags, Text Formatting, Character Entities, Lists, Links, Images, Color, Tables, Forms, Image Maps, Meta tags, Framesets. **CSS:** CSS Introduction, CSS Syntax, Classification, Font, Text Color & background, Padding, Border, Margin, Positioning. **JavaScript:** Introduction, Control Structures, Functions, Arrays, and Objects, Web APIs with JavaScript (example: Google Ajax API), jQuery Basics, Using selectors and events. Server-Side Technology: LAMP, Web application frameworks (example: Silverlight, Adobe Flex, Laravel), Web 2.0 and Web APIs, MVC framework. PHP : Basics of About PHP, PHP Installation, PHP Syntax & PHP Variable, PHP Variable, PHP show/print output, PHP Operators, if (...else) statement, Switch statements, For statement, While statement, Do While statement, Arrays, File, File Upload, Cookies, Session, PHP Date, PHP Socketing. **Database:** Database Basics, Types of Database, Usage of Database, Database Schema. **MySQL Database:** MySQL Database Basics, Features of MySQL Database, Database create and use, Table data type, Create table and view, Insert, Update, delete, Logical Query, Constraint, Joining, Aggregate Functions, Have and group by clause, Complex Query of PHP and MySQL. PHP and MySQL: Host Connection, Database Connection, Inserting into table, Update Data from Table, View Data from Table, Delete Data from Table, Joining Data, Report Generation, Report Print, Session Authorization, Log in and Log out, Hashing Password. **E-commerce:** Introduction to E-business, Future of E-commerce

CSE-311 **Lectures: 3 hours/cycle**

Computer Networks **Credits: 3**

Introduction: Definition of internet, Network access and physical media, ISPs and internet backbones, Client server and peer-to-peer network model, Packet-switched and circuit-switched networks, Protocol hierarchies and their service models Physical and Data Link Layer: Physical and data link layer services, Error detection and correction techniques, Flow control, Multiple access protocols, CSMA, CSMA/CD, ALOHA and Slotted ALOHA, Network topology, Token ring and FDDI, Hub, Bridge and switch, STP, LAN Protocols and Standards IEEE 802.*, PPP, HDLC, ARP and RARP, Ethernet, Fast Ethernet, Gigabit Ethernet, ATM and Frame relay, Wi-Fi and WLAN architecture, Bluetooth, MPLS, Virtualization. Network Layer: Network layer services, Internet Protocol: IPv4, IPv6, IP addressing, sub-netting, and VLSM, ICMP, DHCP and NAT, Routing principles, Routing techniques: Distance vector and link state routing algorithms, Hierarchical routing, Multicast routing, Router architecture, Fragmentation and reassembly, Congestion control, Mobile IP Internetworking, WAN technologies and protocols, introduction to 5G and next generation networks. Transport Layer: Transport layer services, Multiplexing and demultiplexing, Connectionless transport and UDP, Principles of reliable data transfer, Connection oriented transport and TCP, Connection and Timer management, Principles of congestion control, Congestion and flow controls with TCP. Application Layer: Principles of application layer protocols, Web and HTTP, File transfer protocol (FTP), Electronic mail, SMTP, POP3, IMAP, DNS, SNMP, Socket programming with TCP and UDP. Security in Computer Networks: Security issues in computer networks, Principles of cryptography, Symmetric key cryptography and public key encryption, DES, RSA, IDEA, MD5, SSH, Message integrity and digital signatures, End-point authentication, Diffie-Hellman key exchange algorithm, Access-control list (ACL), Gateway, Firewalls and intrusion detection systems, Blockchain.

CSE-321 **Lectures: 3 hours/cycle**

Computer Architecture **Credits: 3**

Information representation, Measuring performance; Instructions and data access methods: operations and operands of computer hardware, representing instruction, addressing styles, Arithmetic Logic Unit (ALU): arithmetic and logical operations, floating point operations, designing ALU; Status register, Data paths: single cycle and multicycle implementations; Control Unit/Logic design: Control organization, Design of hardwire and software control; Micro-program sequencer, Overview of Computer Design; Hazards: Structural, Data and Control hazards; Exceptions, Pipeline:

pipelined data path and control, superscalar and dynamic pipelining, Memory organization: cache, , Multiprocessors: types of multiprocessors, SISD, SIMD, and MIMD architectures, single bus multiprocessors, multiprocessors connected by network, clusters, Parallel processing, Introduction to RISC and CISC machines, Introduction to supercomputers.

CSE-355 **Lectures: 3 hours/cycle**

Software Engineering **Credits: 3**

Fundamentals of Software Development: Nature of Software and Software Engineering, Software process models, Requirement engineering, Use Case, UML diagrams, Design and Analysis: Object-oriented analysis and models, SRS documentation, Design concepts and principles, Architectural design, Object-oriented design, Component-level Design, User Interface Design, Pattern-Based Design, Software case tools. Software Review, Testing & Quality Assurance: Review Metrics, Informal & Formal Reviews, Software Testing Techniques and Strategies: White box and Black box testing, Basis path testing, Cyclomatic complexity, Unit testing, Mutation, Regression, Integration, System testing, Error seeding, Stress testing, Behavior driven test, Test automation, Debugging approaches. Reliability metrics, Growth modeling, Software Quality, Quality management system, Release Planning and deployment, Tools for software release, ISO 9001, SEI CMM. Security: Disaster, Recovery and ethics in system development. Project Management & Estimation: Cost estimation techniques, Algorithmic cost modeling, COCOMO-II. Software Metrics: Function-oriented metrics, Size-oriented metrics. Risk analysis and management, Software maintenance.

CSE-345 **Lectures: 3 hours/cycle**

Artificial intelligence **Credits: 3**

Introduction to old and new AI techniques; Intelligent agents; Search techniques in AI; Constraint satisfaction problems; Game playing; Knowledge representation and reasoning; Propositional and first order logic, inference in first order logic; Planning; Uncertainty; Probabilistic reasoning; Learning in symbolic and non-symbolic representation; Expert systems and knowledge engineering; Natural language processing; Computer vision; Robotics;

CSE-347 **Lectures: 3 hours/cycle**

Introduction to Mathematical Programming **Credits: 3**

Concepts of linear programming, preliminary theory and geometry of linear programming, basic feasible solution, complexity of linear programming; Simplex method, variants of simplex method, and revised simplex method, complexity of simplex method; Duality and its principles, interpretation of dual variables, dual simplex method, primal-dual method; Linear integer programs and their

applications in real decision making problems; Sensitivity analysis; Large scale optimization; Transportation problems, Assignment problems, Network maximum flow problems; The ellipsoid method; Interior point methods; Integer programming methods; Nonlinear programming; Lagrange multipliers; Linear optimization; Discrete optimization; Dynamic programming; Engineering applications of optimization; Queuing models: M/M/1, M/M/C, M/G/1, M/D/1, G/M/1 solution of network of queue-closed queuing models, approximate solution methods, Application of queuing models in Computer Science.

Contact hour: 3 hours/cycle

CSE-312

Computer Networks (Sessional) **Credits: 1.50**

Sessional based on CSE-311 (Experiment with physical devices and simulation using network simulators) and

UNIX/Linux based server configuration.

Contact hour: 3 hours/cycle

CSE-356

Software Engineering (Sessional) **Credits: 0.75**

Sessional based on CSE-355

Development of requirements specification, Object-oriented design using UML, Test case design. Use of appropriate CASE tools and other tools such as configuration management tools, program analysis tools in the software life cycle.

CSE-346 **Contact hour: 3 hours/cycle**

Artificial intelligence (Sessional) **Credits: 1.5**

Sessional based on CSE-345 with emphasis on Python Programming

CSE-300 **Contact hour: 3/2 hours/cycle**

S/W Development Project (Sessional) **Credits: 0.75**

Multimedia Application, Example: Animation, Learning Apps, DVD Apps; Network/ Internet Application, Example: Yahoo, Skype, PC^2, email client; Mobile Apps; OS: Android/IOS/Windows; Take appropriate steps to complete all the projects and keep tracks to maintain the originality of the projects; Writing project reports by following the standard technical writing practice.

CSE- 302 **Contact hour: 3/2 hours/cycle**

Technical Writing and Presentation (Sessional) **Credits: 0.75**

Issues of technical writing, Effective oral presentation, Criteria for good technical writing, Writing style: report, scientific articles, thesis and books, An overview of research methodology: quantitative and qualitative research, Writing tools: LATEX, Diagram drawing software, Presentation tools.

CSE-437 **Lectures: 3 hours/cycle**

Fundamentals of Internet of Things **Credits: 3**

Introduction to IoT and its elements; technological trends of IoT; Design and modeling IoT systems; applications of IoT: concept of smart homes, smart cities, smart manufacturing and automotive domains, M2M, Cyber-physical systems; Sensors and actuators; IoT communication Protocols: HTTP, UPnp, CoAP, MQTT, XMPP, IoT Service as a Platform, IoT Security and Interoperability, IoT system management. IoT platforms design methodology.

IoT physical devices and endpoints: Embedded system and its components, Introduction to Adriano and Raspberry pi, interactions of embedded systems with the physical world; connect Raspberry Pi to the Internet, networking socket interface, Raspberry Pi interact with online services, interfacing with various sensors and actuators, the design and development of sensor and actuator nodes; Programming Raspberry Pi, Configuring Raspberry Pi with Linux Commands, Raspberry Pi Programming interfaces in Python. Raspberry Pi Interfaces: UART, GPIO, I2C, Pulse Width Modulation, SPI for Camera, interaction between software and hardware in an IoT device, Python-based IDE (integrated development environments) for the Raspberry Pi. IoT web and cloud services, designing IoT Web API.

CSE-435 **Lectures: 3 hours/cycle**

Information Security **Credits: 3**

Concept and applications of cryptography; Techniques of designing efficient Cryptosystems: Symmetric key encryption-Stream ciphers, Block ciphers; Message authentication codes; Hash function; Digital signature; Asymmetric key encryption-Diffie-Hellman protocol, Trapdoor functions, RSA, Merkel puzzles, El-Gammal cryptosystems; Linear and differential cryptanalysis; Mathematics of cryptography; Lightweight cryptographic protocols; Steganography.

Fundamental properties and terminology of information security; System security management, analysis and control; Physical and logical security; Types of attacks; Database security; Network security threats; WSN security; Fundamental of Cybersecurity; IoT network and IoT device security; Blockchain; Secure Cloud computing; Computer abuse; Legal and Ethical issues.

CSE-445 **Lectures: 3 hours/cycle**

Machine Learning **Credits: 3**

Introduction to machine learning; Regression analysis: Logistic regression, linear regression; Classification techniques: Supervised and unsupervised classification; Neural networks; Support vector machines; Classification trees; Rule based learning; Instance based learning; Reinforcement learning; Ensemble learning; Negative correlation learning; Evolutionary algorithms; Genetic algorithm, Statistical performance evaluation techniques of learning algorithms: bias-variance tradeoff; Practical applications of machine learning.

CSE-438 **Contact hour: 3/2 hours/cycle**

Fundamentals of Internet of Things (Sessional) **Credits: 0.75**

Sessional based on CSE-437

CSE-436 **Contact hour: 3/2 hours/cycle**

Information Security (Sessional) **Credits: 0.75**

Sessional based on CSE-435

CSE-446 **Contact hour: 3 hours/cycle**

Machine Learning (Sessional) **Credits: 1.5**

Sessional based on CSE-445

CSE-400 (Sessional) **Contact hour: 2 hours/cycle**

Project and Thesis **Credits: 1.0**

Goal:

- Learn to access, interpret and apply existing knowledge in Computer Science & Engineering.
- Gain experience in computing research by formulation and answering original questions, ultimately creating new scholarly results in Computer Science & Engineering
- Submit a proposal report on student's own proposed idea.
- Demonstrate a command of new and existing knowledge by being able to express conclusion both orally and in writing.

Guidelines:

- Student will be assigned a supervisor and external
- Supervisor will set clear parameters with respect to expectation of the project / thesis.
- Project/thesis topic should be grounded in completed course work in Computer Science & Engineering program.
- Student should spent average of 2 hours per cycle to fix project/ thesis title, study the background, develop a methodology etc.
- Completed project/thesis proposal report must be signed by supervisor and handed in before proposal presentation date.

N.B. The project/thesis topic selected in this course is to be continued in the CSE 400 course of L-4, T-II.

CSE-402 **Contact hour: 2 hours/cycle**

Industrial Attachment (Sessional) **Credits: 1.0**

Purpose

- To develop the practical and communication skills/competencies of students
- To provide real life experience in the industry of Computer Science and Engineering
- To strengthen industrial-institutional partnership
- To develop students personality and understanding of individuals
- To be able to work in group or team of .
- To provide students background information and experience in career choice.

Performance Assessment:

A formal and final performance assessment is expected to be carried out on the basis of the learning outcomes. Students are required to give a presentation and a report on

– Organization structure of the host company/Organization

– Operational practice with in the organization

– Things they have learned

List of Optional Courses: CSE Optional-I should be selected from the following courses:

CSE-441 **Lectures: 3 hours/cycle**

Simulation and Modeling **Credits: 3**

Simulation methods, Model building, Classification of simulation models, random number generator, Statistical analysis of results, validation and verification techniques, Digital simulation of continuous systems, Combined discrete-continuous models, Monte Carlo simulation, Simulation of queuing systems.

Simulation and analytical methods for analysis of computer systems and practical problems in business and practice, Introduction to the development of simulation packages.

CSE-463 **Lectures: 3 hours/cycle**

Multimedia Theory **Credits: 3**

Fundamentals: Media and data streams, Sound/audio, Image, Graphics, Video and animation, Color science and color models. Data Compression: Coding requirements, Source, Entropy and hybrid coding, Lossless and lossy compression, JPEG, H.261, MPEG, MP3 and etc. Computer Technology Issues: Communication architecture, Multimedia workstations, cache systems, Storage systems and optical storage. Multimedia OS: Real-time operations, Resource management, Process management, file systems and multimedia networking. Multimedia Synchronization: Presentation requirements, Reference model and synchronization techniques. Multimedia Database: Data organization, indexing and retrieval. Web Technologies Issues: Elements of web styling, Usability, Accessibility and information architecture and Content Management Systems (CMS). Multimedia Applications: Digital libraries, System software, Toolkits, Conferencing paradigms, Structured interaction support and examples from video/audio/graphics conferencing. VOIP, Virtual Reality; Telemedicine.

CSE-447 **Lectures: 3 hours/cycle**

Neural Networks and Fuzzy Logic **Credits: 3**

Introductory Concept: Introduction Human Brain Mechanism, Neural Machine Intelligence. Fundamental concept of Neural Network: Basic models of artificial neuron, activation function, network architecture, neural network viewed as directed graph, Basic learning rules, overview of perceptrons, Single layer of perceptrons, mathematical model of single layer perceptrons, perceptrons learning algorithm, Delta learning rule, Multi-layer perceptrons, Back propagation learning algorithm, mathematical model of MLP network. Function Approximation: Basis function network, Radial Basis function networks (RBF), MLP vs. RBF networks, Support vector machine (SVM). Competitive Network and Associative memory network: Adaptive Resonance Theory (ART), ART-1 architecture and algorithm, Kohonen Self-organizing Maps (SOMs), Linear Feed-forward Associative memory network, Recurrent associative memory network, Bidirectional Associative memory network (BAM), Hopfield networks. Fuzzy System: Introduction to Fuzzy system, Fuzzy relations, fuzzy numbers, Linguistic description and their analytical form, fuzzy control

CSE-449 **Lectures: 3 hours/cycle**

Human Computer Interaction **Credits: 3**

Introduction to Human-computer interaction (HCI), human information processing systems, Models of interaction, Approaches to HCI ; User interface development: iterative design, rapid prototyping, low fidelity interactive prototyping, comparative evaluation of multiple interfaces, evaluation of user interface, heuristic evaluation; 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, accessibility APIs; Internationalization and Localization: translation, text direction, sort order, formatting, color conventions, icons; User research methods: experiments, experiment design techniques, field study, survey; Multimodal signal processing: recognize human emotions through combination of spoken language, gestures, facial expressions; Case studies.

CSE-487 **Lectures: 3 hours/cycle**

Communication Engineering **Credits: 3**

Information and Entropy: Measuring information and entropy; Overview of communication system; Introduction to signals and systems; Communication channels; Random process and its relationship with communication engineering. Traffic analysis: Traffic characterization, quality of service analysis, network blocking probabilities, delay system and queuing. Switching system: Introduction to analog system, digital switching systems, internet telephony and intelligent networks. Satellite communications: Frequency bands and characteristics, types of satellites, multiple

access techniques, radio system design, broadband technologies, FTTx networks. Introduction to cellular systems and wireless communications: Frequency reuse, trunking and grade of services, sectoring and cell splitting, coverage and capacity, Mobile radio channels, Multiplexing/multiple-access Techniques: FDM, TDM, OFDM and NOMA, GSM and CDMA, Communication over Fading channels: characterization of fading channels, diversity techniques, equalization, Spread-Spectrum Techniques, MIMO system; Signal detection in noise: The Matched Filter; Error Rate Due to Noise, Sampling theorem; Inter symbol Interference, Optimum Linear Receiver, Adaptive Equalization; Geometric Representation of Signals, Conversion of the Continuous AWGN Channel into a Vector Channel, Multichannel and multicarrier modulation, spread spectrum modulation, correlator receiver; maximum likelihood receiver and error probability; Signal Space Analysis; Union Bound on the probability of error; coherent and non-coherent communication systems; Channel capacity and coding, MLDC codes, convolution codes, Viterbi Algorithm; Turbo codes, Trellis code modulation, Modulation vs. Coding trade – off ; Modern network architecture paradigms: Internet of Things, Named Data Networking, mobile edge computing, information centric networking, and data center networking. Emerging technologies including 4G, 5G, and infrastructureless networks: Mobile adhoc/vehicular adhoc networks (MANET and VANET), sensor networks, low-rate wireless personal area networks (IEEE 802.15) including Bluetooth, Zigbee, LoRA, and others, 4G/5G/6G network architectures and technologies, Ultra-Reliable Low-Latency Communication (URLLC), Massive Machine Type Communication (mMTC) for Virtual Reality (AR) and Augmented Reality (AR) applications.

CSE-453 **Lectures: 3 hours/cycle**

Digital Image Processing **Credits: 3**

Digital Image Fundamentals – Introduction, Image acquisition, Sampling, Quantization. Binary Image Analysis – Thresholding, Histogram, Otsu Method, Neighborhood, Connected Component Labeling, Recursive Labeling, Morphological Processing - Erosion, Dilation, Opening, Closing.Edge & Corner Detection – Edges, Origins, Canny edge algorithm, Susan, Harris, KLT Corner Detector. Color Model – RGB, CMY, CMYK, HSI, Operations on Color image. Image Transformation – 2D Fourier, DCT, Hadamard, Slant, DWT, SVD. Image Enhancement – Histogram Equalization – Global, Local. Image Restoration – Noise Models, noise reduction - Mean, Median, Max, Weiner, Midpoint, Adaptive filters. Image Segmentation– Region based, Region growing and shrinking, Histogram Thresholding, Clustering. Image Compression – Lossy, Lossless, Huffman coding, Run length coding, Bit plane coding, JPEG compression.

CSE-451 **Lectures: 3 hours/cycle**

Data Mining **Credits: 3**

Introduction: Kinds of data and patterns to be mined, Basic statistical description of data. Data Preprocessing: Data objects and attributes Data similarity and dissimilarity, Data cleaning, Data integration, Data reduction, Data transformation and discretization. Data Warehousing: Data warehouse modeling, Design issue, Implementation and usage, Data mining, Associations, Correlations, Mining methods, Pattern evaluation. Data Classification: Decision tree induction, Classification methods, Evaluation and selection of classification, Classification accuracy. Cluster Analysis: Partitioning, Hierarchy, Density and grid based clustering methods, evaluation of clustering methods, Cluster quality. Outlier Detection: Outlier detection methods, Statistical approaches, Proximity based approaches, Clustering and classification based approaches.

CSE-455 **Lectures: 3 hours/cycle**

Embedded System Design **Credits: 3**

Overview of Embedded Systems and Their Specific Requirements: (e.g. Robust design, Temporal constraints, Technological constraints, Developmental constraints), Embedded Processing – Evolution, Issues and Challenges,The product design cycle, Evaluation and justification of the available levels of system integration (Custom chip design through to turnkey-systems) and technological choice, Overview of the software and hardware design tools/techniques applicable to such systems such as UML, VHDL, Verilog, etc. Software Issues: Real time operating systems, Software design methodologies pertinent to real-time embedded systems, Designing, implementing and testing software for embedded systems including multiprocessor and system-on-chip (SoC) devices. Hardware Issues: Choice of: processor, Memory, I/O, Level(s) of integration, Development environments, Hardware acceleration devices such as DSPs and FPGAs, Interfacing to commonly used I/O devices, Types of interconnection, Sensors for measuring physical phenomena, Output devices such as power actuators and motors. Software/Hardware Co-design Issues: Design, Implementation and verification considerations for the simultaneous design of both hardware and software. Performance Analysis and Optimization: Speed, Power and Area Optimization; Testing of Embedded Systems System Design Examples using Microcontrollers, PLC, and FPGA.

CSE-469 **Lectures: 3 hours/cycle**

High Performance Computing **Credits: 3**

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, algorithmic techniques, instruction level optimizations; Parallelization strategies: task parallelism, data parallelism, and work sharing techniques; Parallel algorithms: problem decomposition, partitioning and load balancing;

High performance parallel programming: shared memory and message passing models, OpenMP and MPI programming; High performance cloud and cluster computing: MapReduce programming model, Apache Hadoop, Hadoop distributed file system (HDFS), Apache Spark, Apache Cassandra.

CSE-473 **Lectures: 3 hours/cycle**

Algorithm Engineering **Credits: 3**

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

CSE-475 **Lectures: 3 hours/cycle**

Mobile Applications Development **Credits: 3**

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

CSE-497 **Lectures: 3 hours/cycle**

Numerical Analysis **Credits: 3**

Introduction; Errors in numerical calculations, Approximations and round-off errors, Truncation errors; Solution of algebraic and transcendental equations: method of iteration, False Position method, Newton-Rhapson method, Bisection method, Secant method; Solution of simultaneous linear equations: Cramers's rule, Gauss Elimination method, Gauss-Jordan method, Factorization method, Iteration method, Jacobi method, Gauss-Seidel method, Choleski's process; Interpolation; diagonal and horizontal difference, differences of a polynomial, Newton's formula for forward and backward interpolation, Spline interpolation, Integration: General quadrature formula, Trapezoidal rule, Simposon's rule, Weddle's rule, Solution of ordinary differential equations: Euler's method, Picard's method, Milne's method, Taylor's series method, Runge-Kutta method, Least squares approximation of functions: linear and polynomial regression, fitting exponential and trigonometric functions.

CSE-442 **Contact hour: 3/2 hours/cycle**

Simulation and Modeling (Sessional) **Credits: 0.75**

Sessional based on CSE-441

CSE-464 **Contact hour: 3/2 hours/cycle**
Multimedia Theory (Sessional) **Credits: 0.75**
Sessional based on CSE-463

CSE-448 **Contact hour: 3/2 hours/cycle**
Neural Networks and Fuzzy Logic (Sessional) **Credits: 0.75**
Sessional based on CSE-447

CSE-450 **Contact hour: 3/2 hours/cycle**
Human Computer Interaction (Sessional) **Credits: 0.75**
Sessional based on CSE-449

CSE-488 **Contact hour: 3/2 hours/cycle**
Communication Engineering (Sessional) **Credits: 0.75**
Sessional based on CSE-487

CSE-454 **Contact hour: 3/2 hours/cycle**
Digital Image Processing (Sessional) **Credits: 0.75**
Sessional based on CSE-453

CSE-452 **Contact hour: 3/2 hours/cycle**
Data Mining (Sessional) **Credits: 0.75**
Sessional based on CSE-451

CSE-456 **Contact hour: 3/2 hours/cycle**
Embedded System Design (Sessional) **Credits: 0.75**
Sessional based on CSE-455

CSE-470 **Contact hour: 3/2 hours/cycle**
High Performance Computing (Sessional) **Credits: 0.75**
Sessional based on CSE-469

CSE-474 **Contact hour: 3/2 hours/cycle**
Algorithm Engineering (Sessional) **Credits: 0.75**
Sessional based on CSE-473

CSE-476 **Contact hour: 3/2 hours/cycle**
Mobile Applications Development (Sessional) **Credits: 0.75**
Sessional based on CSE-475

CSE-498 **Contact hour: 3/2 hours/cycle**
Numerical Analysis (Sessional) **Credits: 0.75**
Sessional based on CSE-497

List of Optional Courses: Hum Optional-I should be selected from the following courses:

Hum-411 **Lectures: 2 hours/cycle**
Business Law **Credits: 2**
Principles of law of contract; Company Law: law regarding

formation, incorporation, management and winding up of companies; Labor Law: law in relation to wages hours, health, safety and other condition to work; The trade union legislation arbitration, the policy of the state in relation to labor; Bangladesh Labour Act, 2006; International Labour Law; The Factory Act (1965); Law of compensation (1965).

Lectures: 2 hours/cycle

Hum-413

Credits: 2

Sociology for Science and Technology

Society, Science and Technology; Social Research: Methods, Social Impact Assessment (SIA); Culture, civilization and professional ethics; Socialization and leadership development; Social stratification and social mobility; Globalization, mass media and technology; Deviance, crime, and juvenile delinquency; Social groups and organizations; Population and society: concepts and theories; Environment and Urbanization; Social change and technology

Lectures: 2 hours/cycle

Hum-415

Credits: 2

Government

Basic concepts of government and politics: form of government, organs of government, democracy; socialism, bureaucracy, good governance, e-government; Government and Politics of Bangladesh: major amendments to the constitution, local government, NGOs, public policies, managing development project, constitutional bodies: EC, PSC; Foreign policy of Bangladesh; International Organization: UNO

Lectures: 2 hours/cycle

Hum-417

Credits: 2

Entrepreneurship for IT Business

The foundations of entrepreneurship; Inside the entrepreneurship mind: from ideas to reality; The rewards and challenges of entrepreneurship: driving forces behind small business, ethics and social responsibility, creativity and innovation; New business planning process: conducting a feasibility analysis, designing a competitive business model, building a solid strategic plan and crafting a winning business plan; Forms of business ownership: franchising and the entrepreneur, buying an existing business; Building a marketing plan: building a bootstrap marketing plan, creative use of advertising and promotion, pricing and credit strategies, global marketing strategies, e-commerce; Building a financial plan: creating a successful financial plan, managing cash-flow, sources of financing-equity and debt; Building an operational plan: location, layout and physical facilities, supply chain management, managing inventory, staffing and leading a growing company; Legal aspects of small business: succession, ethics, business law and government regulation; Strategic plan and risk management; Global aspects of entrepreneurship; Building a new venture team and planning for the next generation.

Level-4 Term-II B. Sc. Engineering

CSE-431 **Lectures: 3 hours/cycle**

Compiler Design **Credits: 3**

Basic issues, compiler structure, front end, back end; Lexical analysis: Tokens, patterns, and lexemes, input buffering, transition diagrams, lexical-analyzer generator; Syntax analysis: Elimination of left recursion, left factoring, FIRST and FOLLOW, LL(1) grammars, non-recursive predictive parsing, parser generators; Syntax-directed translation: Syntax directed definitions, inherited and synthesized attributes, dependency graphs, syntax-directed translation schemes; Semantic analysis: Type expressions, type equivalence, type-checking; Run-time environments: Storage organization, static versus dynamic storage allocation, activation trees, activation records; Intermediate code generation: Directed acyclic graphs for expressions, three-address code, quadruples, triples, static single-assignment form; Code generation; Code optimization: Basic blocks and flow graphs, next-use information, optimization of basic blocks.

CSE-457 **Lectures: 3 hours/cycle**

Computer Graphics **Credits: 3**

Graphics hardware: display devices, input devices etc; Basic raster graphics algorithms for drawing 2D primitives; Two-dimensional and three dimensional viewing, clipping and transformations; Three-dimensional object representations: polygon surface, B-Spline curves and surfaces, BSP trees, Octrees, Fractal-Geometry methods; Visible surface detection methods; Z-buffer method, BSP tree method, Ray casting method; Illumination models; Surface rendering methods: Polygon rendering, ray tracing, terrain visualization with height mapping, modeling surface details with texture mapping; Color models; Computer animation.

Hum-445 **Lectures: 2 hours/cycle**

Engineering Management **Credits: 2**

Management: Definition, Evolution, Functions, levels, Principles, Roles of a Manager, Applications & Scope of Engineering Management, MBO, Different schools of Thoughts, Management Vs. Administration. Organization: Definition, Principles, Organization structure, Organization design & Factors affecting Organization design, Organization Chart, Span of control &Factors affecting Span of control, Formal Organisation Vs. Informal Organization, Authority & Responsibility Planning & Controlling: Planning (Definition, Nature, Types, Steps), Controlling (Definition, Steps, Techniques) Leadership: Definition, Features, Leader Vs. Manager,

Ingredients of Leadership, Traits of Charismatic Leader. Motivation: Definition, Need-Want-Satisfaction chain, Theories of Motivation. Human Resources Management Process: Selection, Recruitment, training, Development, Job Evaluation & Enrichment, Merit Rating Industrial Law: Provisions regarding Health, Safety, Welfare, Payment of wages, Trade Union, CBA Material Handling & Maintenance: Material Management, Types of inventory, Material Requirement Planning (MRP), Types& Objectives of Maintenance, Considerations in Preventive Maintenance. Technology Management: Management of innovation and changes; Technology life cycle;

Hum-447 **Lectures: 2 hours/cycle**

Financial, Cost and Managerial Accounting **Credits: 2**

Financial Accounting: Definition, Accounting concepts & Conventions, GAAP, Bookkeeping & Accounting ,Accounting Cycle, Transactions, Double Entry System, Accounting Equation, Journal, Ledger, Trial Balance ,Adjusting Entry, Financial Statement, analysis of Financial Statement. Cost Accounting: Introduction, Methods & techniques, Cost Classification, Statement of Cost, Overhead allocation, Store Ledger. Managerial Accounting: Introduction, CVP Analysis (Meaning, Break-Even analysis, contribution margin technique), Relevant Cost analysis.

CSE-432 **Contact hour: 3 hours/cycle**

Compiler Design (Sessional) **Credits: 1.5**

Sessional based on CSE-431

CSE-458 **Contact hour: 3/2 hours/cycle**

Computer Graphics (Sessional) **Credits: 0.75**

Sessional based on CSE-457

CSE-400 **Sessional: 6 hours/cycle**

Project and Thesis **Credits: 3**

Continuation of project/thesis topic undertaken in CSE 400.

Guidelines:

- Student should spend up to 6 hours per cycle finishing the project/thesis, writing the project/thesis report and most importantly revising the report with the consultation of assigned supervisor.
- Student should give a final presentation and submit a project/thesis report in their project/thesis.
- Completed project/thesis report must be approved and signed by supervisor and external and handed in before final presentation date.
- Student should expect to make changes after board give feedback on presentation and report.

List of Optional Courses: CSE Option –II should be selected from the following courses:

CSE-415 **Lectures: 3 hours/cycle**

Network Planning **Credits: 3**

Introduction: Network components, Theoretical network, Real world networks. Network Architectural Design: Designing the LAN, Configuring the network server and client, Network administration, Remote access, Expanding the network, Wide area network troubleshooting, Major protocol suites.Network Simulation: Network simulation and optimization, Network operations, control and maintenance, Network administration, Network management database and tools, Capacity planning. Network Optimization: Network security and integrity, Linear programming and network algorithms for planning, Reliability theory and network planning.

CSE-425 **Lectures: 3 hours/cycle**

Knowledge Engineering **Credits: 3**

Introduction: Key concepts of knowledge Representation and Reasoning, Language of first order Logic, Syntax, Semantics Pragmatics, Expressing Knowledge, Levels of Representation, Knowledge Acquisition and Sharing, Sharing Ontologies, Language Ontologies, Language Patterns, Tools for Knowledge Acquisition. Resolution and Reasoning: Proportional Case, Handling Variables and Qualifies, Dealing with Intractability, Reasoning with Horn Clauses, Procedural Control of Reasoning, Rules in Production, Description Logic, Vivid Knowledge, Beyond Vivid. Representation: Object Oriented Representations, Frame Formalism, Structured Descriptions, Meaning and Entailment, Taxonomies and Classification, Inheritance, Networks, Strategies for defensible Inheritance, Formal Account of Inheritance Networks. Defaults, Uncertainty and Expressiveness: Closed World Reasoning, Circumscription, Default Logic Limitations of Logic, Fuzzy Logic, Non-monotonic Logic, Theories and World, Semiotics, Auto epistemic Logic, Vagueness, Uncertainty and Degrees of Belief, Non-categorical Reasoning, Objective and Subjective Probability. Actions and Planning: Explanation and Diagnosis, Syntax, Semantics of Context, First Order Reasoning, Modal Reasoning in Context, Encapsulating Objects in Context, Agents, Actions, Situational Calculus, Frame Problem, Complex Actions, Planning, Strips, Planning as Reasoning, Hierarchical and Conditional Planning.

CSE-443 **Lectures: 3 hours/cycle**

Parallel and Distributed Processing **Credits: 3**

Motivation for Parallelism: Parallel Computing, Speed up, Moore's law, Grand challenge problems, Trends, The status and future of massively parallel processing. Parallel and Distributed Computers: Flynn's taxonomy, Distributed memory multicomputer, Shared memory multiprocessors, Networks of workstations, Cluster and grid computing, PRAMs, Interconnection networks. Performance Measures: Granularity, Speed up, Efficiency, Cost, Amdahl's law,

Gustafson's law, Isoefficiency, Optical computing, Quantum computing. Interconnection Networks: Interconnection networks for inter-processor communication, Permutation routing, Non uniform routing, Deadlock free routing and multicasting, Mapping and Embedding. Distributed Processing: Distributed models and systems, Real time distributed systems. Applications: Sorting, Searching, Matrix algorithms, Fourier transform, Finding the maximum, Image processing.

CSE-459 **Lectures: 3 hours/cycle**

Decision Support System **Credits: 3**

Introduction to Decision Support System: DSS Characteristics, Applications of Decision Support Systems, Capabilities of Decision Support Systems, Components of Decision Support Systems, Benefits of Using DSS Systems. Making Decisions in the Decision Support Systems Environment: Activities in the decision support systems environment, The Decision Making Process, Information use for strategic management, Making Decisions in the Decision Support Systems. Environment: Strategic analysis for the organization, Types of Problems in the Decision Making Process. Developing Decision Support System: Approaches to DSS development, DSS Software Tools, DSS Hardware and Operating system platforms, Building and Implementing Decision Support Systems. Decision Support Systems in Detail: Types of decision support systems, DSS Models, Data mining, Group decision, support systems, Executive Information Systems (EIS). Artificial Intelligence and Expert Systems, Systems Integration and the future of DSS: Brainstorming.

CSE-419 **Lectures: 3 hours/cycle**

VLSI Design **Credits: 3**

VLSI design methodology: top-down design approach, technology trends. NMOS, CMOS inverters, pass transistor and pass gates: dc and transient characteristics. Brief overview of fabrication process: NMOS, CMOS, Bi-CMOS process, NMOS and CMOS layout, stick diagram and design rules CMOS circuit characteristics and performance estimation: resistance and capacitance, rise and fall time, power estimation. Buffer circuit design, Introduction to Bi-CMOS circuits. Complex CMOS gates, CMOS building block: multiplexer, barrel shifter, crossbar switch, adder, counter, parity generator, multipliers: Data Path and memory structures, Sub-System Design Processes and Layout, Design of an ALU Sub-System, Design style: FPGA and PLDs. Introduction to HDL; basic digital design using VHDL.

CSE-427 **Lectures: 3 hours/cycle**

Fault Tolerant Systems **Credits: 3**

Introduction: background and motivation, dependability attributes, probability distributions; Reliability modeling: combinational modeling, state-space modeling; System view of high availability design; Defects: defect avoidance, shielding and hardening, defect

circumvention, yield enhancement; Faults: fault testing, design for testability, fault masking, replication with voting; Errors: error detection, self-checking modules, error correction, redundant disk arrays; Hardware redundancy: basic approaches, static and dynamic, voting, fault tolerant interconnection networks; Software redundancy: software reliability models, software aging, N-version programming; Degradation allowance: perform ability of a fail-soft system, check pointing and rollback.

CSE-439 **Lectures: 3 hours/cycle**

Computational Geometry **Credits: 3**

Algorithm and complexity of fundamental geometric objects: polygon triangulations and art gallery theorem, polygon partitioning, convex hulls in 2-dimension. Proximity: Voronoi diagrams and Delaunary triangulations. Graph Drawing: drawing styles and applications, drawing of rooted trees, straight line drawing of planar graphs.

CSE-417 **Lectures: 3 hours/cycle**

Mobile and Wireless Networking **Credits: 3**

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-477 **Lectures: 3 hours/cycle**

Basic Graph Theory **Credits: 3**

Graphs and their applications; Basic graph terminologies; Basic operations on graphs; Graph representations; Degree sequence and graphic sequence; Paths, cycles and connectivity; Trees and counting of trees; Distance in graphs and trees; Euler tours; Hamiltonian cycles; Ear decomposition; Graph labeling; Matching and covering; Planar graphs; Graph coloring; Special classes of graphs.

CSE-479 **Lectures: 3 hours/cycle**

High Performance Database **Credits: 3**

High performance database systems: client-server databases, parallel and distributed databases, cloud databases; Transaction oriented computing: transaction models, flat transactions, nested transactions, distributed transactions, long-lived transactions, transaction processing monitors; Concurrency control: isolation theorems, locking, nested transaction locking, scheduling and deadlock, deadlock detection and management; Failure and recovery; Replica management, Transactional and tuple oriented file system; Transaction and database performance bench marks; NoSQL systems: data models, system architecture, transactions, elasticity, and optimizations.

CSE-483 **Lectures: 3 hours/cycle**

Introduction to Bioinformatics **Credits: 3**

Molecular biology basics: DNA, RNA, genes, and proteins; Gene mere arrangements; DNA sequence alignments; Gene prediction; Dynamic Programming, Local and Global Alignment; DNA sequencing, genome sequencing, protein sequencing, spectrum graphs; Combinatorial pattern matching: Database Search, Rapid String Matching, BLAST, FASTA; Genome Assembly: Consensus-alignment-overlap, Graph-based assembly; Expression Analysis, Clustering and classification; Evolutionary trees and Phylogenetic; Statistical and machine Learning Methods in Bioinformatics.

CSE-485 **Lectures: 3 hours/cycle**

Semantics of Programming Languages **Credits: 3**

Fundamentals: semantics of a programming language, static vs. dynamic semantics; Approaches: operational, denotational and axiomatic semantics of imperative program constructs; program verification; semantics of data structures; inductive and recursive definitions; fixed point operators and constructions; selected topics like non-determinism, parallelism, semantics and models of concurrency.

CSE-489 **Lectures: 3 hours/cycle**

Software Architecture **Credits: 3**

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 use; 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

EE-481 **Lectures: 3 hours/cycle**

Control System Engineering **Credits: 3**

Introduction to control systems, Dynamic systems modeling, Mathematical description of systems: taxonomy of systems, linear time invariant systems, discrete-time systems, Basic elements in control systems – open and closed loop systems, Block diagram and signal flow graph models, Transfer functions of linear systems, Mason's gain formula, Reduction of parameter variation and effects of disturbance by using negative feedback, Analysis and synthesis of continuous and sample data linear feedback control systems, properties and advantages of feedback systems, Time domain and frequency domain performance measures, Stability and degree of stability of linear feedback systems, Frequency response methods and nyquist stability, Root locus method, Compensation techniques.

CSE-443

Lectures: 3 hours/cycle

Pattern Recognition

Credits: 3

Introduction to Pattern Recognition; Statistical and Neural Pattern Recognition; Bayesian decision theory; Linear classifiers; Nonlinear classifiers; Parametric Estimation Techniques; Non-Parametric Estimation Techniques; Template matching techniques; Context dependent classification; Hidden Markov Models; Syntactic Pattern Recognition; Clustering algorithms; Principal Component Analysis.

CSE-499

Lectures: 3 hours/cycle

Cyber Security and Forensics

Credits: 3

Introduction to Cybersecurity, Cyber Security Vulnerabilities, Emerging threats in cybersecurity, Types of cyber-attacks, cybersecurity incidents, Malware, Distributed Denial-of-service, Zero-day attack, Data Breaches, Security Risks Associated with Integrating Systems, Cyber Crimes, Threat analysis and Cyber Risk mitigation strategies, Security policy making, Security Information Management, Intrusion Solutions and Defense strategies, Security Technology, Intrusion detection approaches, Knowledge-based techniques, Misuse based techniques, Anomaly-based techniques, Statistics-based techniques, Hybrid techniques, Firewall, Rule-based access control, Phishing and other social engineering methods, Securing a cyber system, Blockchain technology, Intrusion data sources, Cybersecurity data analysis, Cyberthreat Intelligence, AI-based security systems, Cyber Forensics, Legal aspects of forensics, Forensic Technology and Practices, Network Forensics, Applications.

CSE-465

Lectures: 3 hours/cycle

Data Science

Credits: 3

Overview of Data Science, Data Visualization, Decision Making and Predictive Analysis, Data Modeling and Optimization: modeling uncertainty and risk, optimization and modeling simultaneous decisions, Data Clustering: K-Means, K- Nearest Neighbors, Maxi-min, Association Rules Mining: AIS, SETM, Apriori, Aprioritid, Apriorihybrid, FP-growth, Dimensionality Reduction: need for dimensionality reduction, Principal Component Analysis (PCA), Singular Value Decomposition (SVD), Deep Learning: Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM), Gated recurrent units (GRUs), Big Data: What, Why, Where and How?

CSE-491

Lectures: 3 hours/cycle

Natural Language Processing

Introduction-Human languages, Phases in natural language processing; Word categories and parts of speech; Linguistics Resources- Introduction to corpus, elements in balanced corpus, TreeBank, PropBank, WordNet, VerbNet etc. Resource management with XML, Management of linguistic data with the help of GATE, NLTK; Syntactic representations of natural language; Context-free/Context-sensitive grammars & Parsing; Part of Speech tagging- Stochastic POS tagging, HMM, Transformation

based tagging (TBL), Handling of unknown words, named entities, multi word expressions; Treebank and parsing evaluation; Probabilistic Context Free Grammars and Statistical Parsing, Lexical Semantics, NLP Systems: Spell-checker, Summarization, Question answering, Document categorization, Machine Translation: Syntactic translation, Transfer rules, Translation divergences.

CSE-467 **Lectures: 3 hours/cycle**

Robotics Science and System

Overview of Robotics Science & Systems; System Identification & Filtering; Sensors and Actuators; Cameras, Images, and Low-Level Robot Vision; Robot Operating System; Robot Control Architectures and Sensing; Path & Motion Planning; State Estimation & Kalman Filter; Local Navigation and Error Analysis; Localization: Fundamentals & Grid Localization, Particle Filters; Manipulation: Mechanisms, Grasping, and Inverse Kinematics; Mapping, SLAM; Machine Learning for Robot Control; Aerial Robots; Swarm Robots; Social Robots; Robotics in Healthcare Applications.

CSE-493 **Lectures: 3 hours/cycle**

Distributed Systems and Cloud Computing

Systems Modeling, Clustering, and Virtualization: Introduction to Recent trends in Computing, Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing, Distributed System Models and Enabling Technologies, Inter-process Communication, Computer Clusters for Scalable Parallel Computing, Virtual Machines and Virtualization of Clusters and Data centers, Historical Perspective of Data Centers, Datacenter Components: IT Equipment and Facilities, Virtualization (CPU, Memory, I/O) Case Study: Amazon EC2, Community Clouds and Ecosystems, P2P and Overlay Networks/systems, IoT and Social Networks, Mobile and Ubiquitous Computing, Relevant emerging technologies (e.g. edge computing). Cloud Computing Models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS) and emerging XaaS, cloud computing networks and API, data storage, cloud interfaces, Distributed transaction and Concurrency Control, Data replication and availability in Cloud environments, Dynamic provisioning (elastic computing) and scaling.Types of Cloud Computing: Public cloud, private cloud and hybrid clouds, Cloud OSs and platforms. Cloud Architectures: Architectural design of Cloud computing, Interaction among infrastructure provider, business providers and the customers, roles of cloud broker, Tradeoffs between costs and customer satisfactions, Federated Clouds, Client-server computing, Sockets and remote procedure call. VM Resource Provisioning: Static and dynamic resource provisioning approaches, Capacity provisioning approaches, container and hypervisor based VM Cloud Storage: Cloud Storage Concepts, Distributed File Systems (HDFS, Ceph FS), Cloud Databases (HBase, MongoDB, Cassandra, DynamoDB), Cloud Object Storage (Amazon S3, OpenStack Swift, Ceph). Batch cloud computing: Map-reduce and Hadoop, Domain-specific languages for cloud data processing:

Pig and Hive, Parallel Programming in the Cloud. Scalability and Fault Tolerant Issues: Failure models and failure detectors, Scalable computing, energy optimization vs. fault tolerant service platforms, Performance, QoS, Power management in Cloud Computing data centers, Principles of Virtualization platforms: VMWare ESX Memory Management, Security and Privacy issues in the Cloud, cloud access authentication and authorization, SLA Management in Cloud Computing, Performance Prediction for HPC on Clouds, Building Content Delivery networks using Clouds, Resource Cloud Mashups, Service Management in Cloud Computing; Introduction to Mobile Cloud Computing: Architecture and applications of MCC, Code partitioning, Code offloading and VM migration techniques, advanced machine learning techniques in MCC. Programming Models: Distributed Programming for the Cloud Data-Parallel Analytics with Hadoop MapReduce (YARN), Iterative Data-Parallel Analytics with Apache Spark Graph-Parallel Analytics with GraphLab 2.0 (PowerGraph), Case Study on Open Source & Commercial Clouds Eucalyptus, Microsoft Azure.

CSE-495 **Lectures: 3 hours/cycle**

Credits: 3

Big Data

Overview of Big Data, Big Data Stack: data source layer, ingestion layer, source layer, security layer, visualization layer, visualization approaches etc, Technologies for Handling Big Data, NoSQL Data Management: document databases, relationships, graph databases, schema less databases, CAP Theorem etc.