Course Syllabi
Department of Computer Science and Engineering

CSL101 COMPUTER PROGRAMMING
(3-0-2-8)

Contents:
Overview of a computer system, Block diagram and major parts of a computer, history of computer development, introduction to binary, octal, & hexadecimal numbers, ASCII code, different levels of programming languages – machine language, assembly language, high level language; need of operating system, tree structure of storage, introduction to assembler, compiler and interpreter.

Introduction: Flow charts, data types and storage classes, scope of variables, arithmetic operators, assignment, conditional, arithmetic expressions, enumerated data types, decision making, branching, looping, Switch concept, function and parameter passing, recursive functions, macros. Basic programming algorithms: Programs to illustrate basic language constructs in C like - Factorial, Sine/cosine and other mathematical series, Fibonacci series, calculating square-root of a number, calculating GCD of 2 integers (Euclid’s method and otherwise), Calculating LCM of 2 integers and similar such programs.

Arrays and applications: Introduction to one dimensional and 2-D array with examples. Representing a polynomial using 1-D array and polynomial operations, Use of 2-D array to represent a matrix and matrix operations. Character arrays (strings): String related functions (strlen, strcpy, strcat, strcmp, reverse etc.) and their function definitions. Searching and Sorting methods: Selection sort, Bubble sort, Insertion sort, Linear and binary search, partitioning an array, merging of 2 sorted arrays. Introduction to “Divide and Conquer” via Mergesort and Quicksort.

Structures and Unions: Basic concept, array of structures and its applications. Pointers: Introduction (declaration and initialization), pointers and arrays, concept of dynamic memory allocation, use of pointers to represent variable-sized 1-D and 2-D arrays, pointers to structures.

File Management in C: Open, close, read and write operations, Sequential and text files.

Text Books:

Reference Books:

CSL201 DATA STRUCTURES AND PROGRAM DESIGN (3-0-2-8)

Contents:
Types and operations, Iterative constructs and loop invariants, Structured programming and modular design, Illustrative examples, recursion, program stack and function invocations including recursion. Overview of arrays and array based algorithms - searching and sorting, Overview of Selection sort, bubble sort and insertion-sort, Divide and Conquer – Merge sort, Quicksort, Binary search, Introduction to Program complexity (Big Oh notation), Recurrence relations. Sparse matrices. Introduction to pointers, scope rules, parameter passing mechanisms – pass by value and pass-by-reference. Structures (Records) and array of structures (records). Database implementation using array of records. Dynamic memory allocation and de allocation. Dynamically allocated single and multi-dimensional arrays. Files, operations on them, examples of using file. Stack, Queues and its operations. Concept of an Abstract Data Type (ADT), Implementation of stacks and queues using both array-based and pointer-based structures. Uses of stacks in simulating recursive procedures/functions. Applications of stacks and queues. Lists – Self-referential structures, Singly-linked lists, doubly linked lists and circular linked lists. List traversal, insertion, deletion at different positions in the linked lists, concatenation, list-reversal etc. Merge sort for linked lists. Applications of lists in polynomial representation, multi-precision arithmetic, hash tables etc.

Multi linked structures and an example application like sparse matrices. Implementation of priority queues.Trees, binary trees, binary trees- basic algorithms and various traversals. Binary Search Trees (BSTs) and insertion, deletion in BSTs. Height-balanced (AVL) trees, insertion/deletion and rotations. Heaps and heap sort. Multi-way trees and external sorting - Introduction to B-trees and B+trees. Tries. Applications of the above mentioned trees. Generalisation of trees to graphs – Introduction to DFS, BFS and Topological sort.

Text Books:

Reference Books:

CSL202 COMPUTER ORGANIZATION (3-2-0-8)

Contents:
Addressing methods, their application in implementation of HLL constructs and data structures, instruction formats, expanding op-code method, subroutine linkage. Instruction sets of ARM, Intel and Motorola Processors. Processing unit, bus architecture, execution of a complete instruction, sequencing of control signals, micro programmed control, microinstruction format, microinstruction sequencing, bit slice concept. Arithmetic, number representations and their operations, design of fast address, signed multiplication, Booth’s Algorithm, bit-pair recording, division, floating point numbers and operations, guard bits and rounding.

Main memory organization, various technologies used in memory design, higher order memory design, multi module memories and interleaving, cache memory, concept of cache memory, mapping functions, replacement algorithms. Input-output organization, I/O mapped I/O and memory mapped I/O, Direct Memory Access, interrupt and interrupts handling mechanisms, device identification, vectored interrupts, interrupt nesting, I/O interfaces, synchronous vs. asynchronous data transfer, I/O channels. Computer peripherals, I/O devices such as video terminals, video displays, graphic input devices, printers, magnetic disk, magnetic tape, CDROM systems.

Introduction to RISC philosophy, Pipelining, Basic concepts in pipelining.

Text Book:

Reference Books:

CSL203 CONCEPTS IN PROGRAMMING LANGUAGES (3-0-2-8)

Contents:
Definition of Programming language, Syntax, semantics, High-level languages. Implementation of high-level languages, Compilers and Software interpreters. Data elements, identifiers binding, binding time, binding identifiers to names, binding of attributes, importance of binding time. Concept of r-value and l-value. Effect of environment on a language, Language paradigms.

Data type, elementary data type, structured data type, elements of specification and implementation of data type. Implementation of elementary data types: int, integer, real, character, Boolean and pointer. Implementation of structured data types Vectors & arrays, records and files. Type checking, type conversion and initialization.

Evolution of data type concept. Abstract data type, encapsulation. Design and implementation of new data types through subprograms. Subprogram definition and activation, their implementation, parameter passing, generic subprograms. Sequence control structures used in expressions and their implementation. Sequence control structures used between statements or group of statements and their implementation.

Sequence control structures used between subprograms, recursive and non-recursive subprogram calls. Data control, referring environment dynamic and static scope, static chain implementation and display implementation.

Type definition as mechanism to create new abstract data types, type equivalence, type definitions with parameters. Defining new abstracts data types Storage management issues, like static and dynamic allocation, stack based allocation and management, Heap based allocation and management. Garbage collection. Introduction to exception handling.

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Text Book:

Reference Book:

CSL204 INTRODUCTION TO OBJECT ORIENTED METHODOLOGY (3-0-2-8)

Contents:
Object Oriented Programming, Features of object oriented programming languages like data encapsulation, inheritance, polymorphism and late binding. Concept of a class, Access control of members of a class, instantiating a class, static and non-static members, overloading a method. Deriving a class from another class, access control of members under derivation, different ways of class derivation, overriding of a method, run time polymorphism. Concept of an abstract class. Concept of an interface. Implementation of an interface. Exception and exception handling mechanisms. Study of exception handling mechanisms in object-oriented languages.

Text Books:

Reference Books:

CSL301 THEORY OF COMPUTATION (3-2-0-8)

Pre-requisite: CSL 201 Data Structures and Program Design SCL 401 Discrete Mathematics

Contents:
Preliminaries - Sets, operations, relations, transitive closure, countability and diagonalisation, induction and proof methods - pigeon-hole principle and simple applications - concept of language - grammars and production rules - Chomsky hierarchy. Regular grammars, deterministic finite automata - non determinism, conversion to deterministic automata-e-closures, regular expressions, finite automata, regular sets. Pump lemma for regular sets - closure properties of regular sets, decision properties for regular sets, minimization of automata.

Context-Free languages, parse trees and ambiguity, reduction of CFGs, Chomsky and Greibach normal forms, push - down Automata (PDA), non-determinism, acceptance by two methods and their equivalence, CFLs and PDAs - Pumping lemma for context free languages, Closure and decision properties of CFLs.

Timing machines - variants, recursively enumerable (r. e.) sets, recursive sets, TM as computer of function, decidability and solvability, Halting Problem, reductions, Post correspondence Problem (PCP) and insolvability of ambiguity problem of CFGs.


Text Book:

Reference Book:

CSL302 OPERATING SYSTEMS (3-0-2-8)

Pre-requisites: CSL 201 Data Structures and Program Design CSL 202 Computer Organization

Contents:
Introduction, basic h/w support necessary for modern operating systems - Services provided by OS, system programs and system calls - brief discussions of evolution of OS- real time and distributed systems: a brief overview of issues. File systems, user interface - disk space management and space allocation strategies - examples from UNIX, DOS, Windows etc - directory structures - disk each

Text Books:

Reference Books:

CSL303 COMPUTER NETWORKS (3-0-2-8)

Pre-requisite: CSL308 Analysis of Algorithms

Contents:

CN Lab:
Programs based on
1. Using TCP sockets or Network socket programming
2. Client-server application for chat
3. PC to PC file transfer using serial port
4. Implementation of Shortest path routing
5. Implementation of Sliding Window Protocol
6. Implementation of Address Resolution Protocol
Implementation of Open Shortest Path First Protocol
Using simple UDP.

Text Books:

Reference Books:

CSL304 SYSTEM PROGRAMMING (3-0-2-8)
Pre-requisites: CSL201 Data Structures and Program Design
CSL 202 Computer Organization

Contents:
Assembler, Macro processor - Concept of assembler, design of single pass and two pass assembler, forward reference, design of output file of assembler, concept of macro, macro call within macro, macro definition within macro, recursive macro calls, design of macro processor.
Linker and Loader - Concept of static and dynamic relocation, external symbols, design of linker, design of object file for different loading schemes.
Common Object file format - Structure of object file and executable file, section or segment headers, symbol table, concept of storage class, string various, data types line insert, character, arrays structures.
System utilities - Source code control system, make, link editor, symbolic debugger, pattern matching language like awk.
Device Drivers - Device programming, system drivers, non-system drivers, virtual drivers, Incorporation of driver routines, Basic device driver operation, character and block drivers.

Text Books:

CSL305 DATABASE MANAGEMENT SYSTEMS (3-0-2-8)
Pre-requisite: CSL302 Operating Systems

Contents:
Database system concepts and Architecture - concept of relational database, Relational data model, Relational algebra, SQL-the relational database standard, ER and EER model.
Database design theory - Functional dependencies and normalization, relational database design algorithms, practical database design and demoralization, Relational constants, programmatic ways for implementing constraints, triggers, Chase algorithm.
Physical database design - Concept of physical and logical hierarchy, storage structures like cluster, index organized table, partitions, various table storage parameters and block storage parameters, concept of index, B-trees, hash index, function index, bitmap index.
Process and memory management in database- Various types of tasks in database, database buffer management, log buffer management code reuse, concept of two tier and N-tier architecture, data dictionary and catalog information database recovery technique. Arier Algorithm for recovery.
Query optimization and performance tuning- Various techniques for query optimization, strong and weak equivalence, cost base optimization, Use of different storage structures in query optimization.
Transaction Processing - Transaction and system concepts, Desirable properties of transaction, Schedules and recoverability, serializability of schedules, concurrency control, lock base protocols and time stamp based protocols, read consistency.

Text Book:

Reference Books:

CSL306 LANGUAGE PROCESSORS (3-0-2-8)
Pre-requisites: CSL301 Theory of Computation

Contents:
Introduction to compilers,compilers and translators, phase structure of a typical compiler. Number of passes, ideas about lexical analysis, syntax analysis, code optimization and code generation, design of lexical analyzer.
Syntax specification of programming languages, Design of top-down parser, bottom up parsing technique, LR parsing algorithm, Design of SLR, LALR,LR parsers. Dealing with ambiguity of the grammar.
Study of syntax directed definitions and syntax directed translation schemes as notational frame work to specify the translations. Using syntax directed translation schemes for translation of expressions, controls structures, declarations, procedure calls.
Storage allocation and run time storage administration, symbol table management, Error detection and recovery, error recovery in LR parsing, error recovery in LL parsing, Automatic error recovery in YACC.
Introduction to Important code optimization techniques, loop optimization, control flow analysis, data flow analysis, setting up data flow equations to compute reaching definitions, available expressions, Live variables.Problems in code generation, simple code generator code generation from DAG, Peephole optimization.

Text Book:

References Books:

CSL307 SOFTWARE ENGINEERING (3-0-2-8)
Prerequisite: CSL204 Introduction to OO Methodologies

Contents:
Software Engineering Process & Management: Generic view, Capability Maturity Model, Process models- waterfall, evolutionary, incremental etc., unified process, agile view, project management, metrics estimation, project scheduling, risk management.
Software engineering Principles and Practice: Communication, planning and modeling practices, system engineering and modeling, business process engineering requirement analysis, system analysis- flow oriented and class oriented modeling using data modeling concepts.
Software Design Engineering: Design Concepts: Abstraction Architecture, pattern modularity, information hiding, design classes, refactoring etc., Design of web application, architectural design, component level design, user interface design.
Software Testing and Quality Management: Testing strategies, testing for object oriented software testing for web applications, validation testing etc. Black box testing, white box testing, Basis path testing. Testing for specialized environments, architectures and application. Quality concepts, quality assurance, software reviews, statistical quality assurance.
Software configuration management and advance topics : Elements of configuration management system, process configuration for web engineering, component-based development, clean room software engineering, formal methods, software reengineering, Software Maintenance.

Text Books:

References Book:
CSL308: ANALYSIS OF ALGORITHMS (3-2-0-8)
Pre-requisite: CSL 201 Data Structures and Program Design

Contents:
Mathematical foundations, summation of arithmetic and geometric series, $\sum n$, $\sum n^2$, Bounding summations using integration, recurrence relations, solutions of recurrence relations using technique of characteristic equation and generating functions.
Asymptotic notations of analysis of algorithms, analyzing control structures, worst case and average case analysis, amortized analysis, sorting algorithms such as selection sort, insertion sort, bubble sort, heap sort, lower bound proof, elementary and advanced data structures with operations on them and their time complexity. Divide and conquer basic strategy, binary search, quick sort, merge sort, Fast Fourier Transform etc. Greedy method - basic strategy, application to job sequencing with deadlines problem, minimum cost spanning trees, single source shortest path etc.
Dynamic Programming basic strategy, multitage graphs, all pairs shortest path, single source shortest paths, optimal binary search trees, traveling salesman problem.
Basic Traversal and Search Techniques, breadth first search and depth first search, connected components. Backtracking basic strategy, 8-Queen's problem, graph coloring, Hamiltonian cycles etc. NP-hard and NP-complete problems, basic concepts, nondeterministic algorithms, NP-hard and NP-complete, Cook's Theorem, decision and optimization problems, polynomial reduction.

Text Books:

Reference Book:

CSL309 NEURO-FUZZY TECHNIQUES (3-0-2-8)

Contents:

Text Books:

CSL310 COMPUTER GRAPHICS (3-0-2-8)
Pre-requisite: CSL 201 Data Structures and Program Design

Contents:

Text Book:

CSL311 INTERNET TECHNOLOGIES (3-0-2-8)

Contents:

Text Book:

Reference Books:

CSL312 TOPICS IN GRAPH THEORY (3-2-0-8)
Pre-requisite: SCL401 Discrete Mathematics

Contents:
Advanced topics: Perfect Graphs, the Perfect Graph Theorem, Imperfect Graphs, the Strong Perfect Graph Conjecture. Matroids, Hereditary Systems and Examples, The Span Function and Duality, Ramsey Theory, Ramsey’s Theorem, Graph Ramsey Theory, More Extremal Problems, Branching and Gossip, Partitions Using Paths and Cycles, Random Graphs, Connectivity, Cliques, and Coloring, Eigenvalues of Graphs, Graph Pebbling.

Electrical Network Analysis and Operations Research, Applications in Switching and Coding Theory.

**Text Book:**

**Reference Books:**

**CSL401 REAL-TIME SYSTEMS (3-0-2-8)**
Pre-requisite: CSL302 Operating Systems

**Contents:**

Real time Operating systems: Overview, Tim Services and Scheduling Mechanisms, Basic Operating System Functions, Processor Reserves and Resource Kernel, Open System Architecture, Capabilities of Commercial RTOS.

**Text Book:**

**Reference Book:**

**CSL402 ARTIFICIAL INTELLIGENCE (3-0-2-8)**
Pre-requisite: CSL308 Analysis of Algorithms

**Contents:**

**Text Book:**

**Reference Books:**

**CSL403 FUNDAMENTAL ALGORITHMS IN COMPUTATIONAL BIOLOGY (3-0-2-8)**

**Contents:**
DNA and Sequence Alignment – KMP-algorithm, BLAST and FASTA, Sorting by Reversals, Biological Databases – formats, downloading and using data, Phylogeny – Distance based algorithms (Hamming / Euclidian distance), Suffix Trees, Prediction of RNA secondary structure, Gene Prediction using Bayesian Methods and Markov Chains/HMMs, Modeling-Based on Cellular Automata, Based on Agent Based Modeling Techniques, Based on Partial Differential Equations, Single Nucleotide Polymorphism and algorithms for their identification, Microarray Data and Clustering – Hierarchical/K-Means, Pathway Data and their analysis, Protein Folding and Docking based on Entropy calculation.

**Text Books:**

**Reference Books:**
2. Course Website of Ron Shamir, Tel Aviv University (http://www.cs.tau.ac.il/~r-shamir/algmb/algmb-archive.htm).

**CSL404 NETWORK SECURITY (3-0-2-8)**
Pre-requisites: CSL 303 Computer Networks CSL 302 Operating Systems SCL 401 Discrete Mathematics

**Contents:**

**Text Books:**

**Reference Books:**

**CSL405 DATA MINING AND DATA WAREHOUSING (3-0-2-8)**
Pre-requisite: CSL305 Database Management Systems

**Contents:**
Introduction to Datawarehousing- Application of Data warehousing and mining, Data warehouse development life cycle, Data warehouse analysis, CUBE, ROLL UP and STAR queries.
Data warehouse Architecture, OLAP,ROLAP and MOLAP, Concepts of Fact and Dimension table.

Space Management in Datawarehouse- Schemas for storing data in warehouse using different storage structures, B-tree index, hash index, clusters, Bitmap index functional index, domain index, Data partitions. Performance and Tuning- Query optimization, memory management, process management, I/O management for Data warehouse.


Text Books:

CSL406 ADVANCED COMPUTER ARCHITECTURE (3-0-2-8)

Pre-requisites: CSL202 Computer Organization

Contents:
Classes of computers, Trends in technology, power and costs, dependability, quantitative principles of computer design, Amdahl’s Law, Introduction to computing models. Pipeline and superscalar techniques, linear pipeline processors, reservation and latency analysis, collision free scheduling, pipeline schedule optimization, instruction pipeline design, arithmetic pipeline design, super scalar and super pipeline design. Principles of scalable performance, performance metrics and measures, speedup performance laws, advanced processor technology, superscalar and VLIW processors. Elementary theory about dependence analysis, techniques for extraction of parallelism, branch prediction, dynamic scheduling, multiple issue and speculation, limits on instruction level parallelism. Memory hierarchy, cache performance, protection and examples of virtual memory.


Text Book:

Reference Books:

CSL407 DISTRIBUTED SYSTEMS (3-0-2-8)

Pre-requisite: CSL 302 Operating Systems

CSL 303 Computer Networks

Contents:
Motivation and goals, broad overview and advantages of distributed systems, main characteristics absence of global clock and state and possibility of large network delays. Issues in distributed systems such as transparency, scalability, security etc. Middlewares such as sockets, RPC, RMI etc. Distributed file systems- design issues- case studies with emphasis on NFS- distributed shared memory-coherence and coherence protocols- design issues and case studies, clock synchronization. Theoretical foundations- Lamport’s clocks-Chandy-Lamport Global State recording algorithm- termination detection, leader election. Distributed mutual exclusion- Lamport, Ricart - Agrawal non-token based algorithm- token based algorithms- comparative performance analysis. Distributed deadlock detection issues- central and distributed detection algorithm- agreement protocols- model of processor failures- Byzantine agreement and other problems- solutions and applications. Distributed scheduling- issues, load distributing algorithms- load sharing policies and case studies- task migration and issues Recovery: introduction and basic concepts - backward and forward error recovery, Checkpointing: synchronous and asynchronous- atomic actions and commit protocols- voting protocols- reliable communication.

Text Books:

Reference Book:

CSL408 INFORMATION RETRIEVAL (3-0-2-8)

Contents:
Boolean retrieval, the term vocabulary and postings lists, Dictionaries and tolerant retrieval, Introduction to index- construction and index-compression. Scoring, term weighting and the vector space model, Computing scores in a complete search system, Evaluation in information retrieval, Introduction to Relevance feedback and query expansion. Probabilistic information retrieval, review of basic probability theory, the probability ranking principle, the binary independence model Language models for information retrieval, Language modeling versus other approaches to IR, Text classification and Naïve Bayes, Bayesian Network approaches to IR, Vector space classification, Support vector machines and machine learning on documents, Flat clustering, Hierarchical clustering, Matrix decomposition and latent semantic indexing. Introduction to Web search basics, Web crawling and indexes, Link analysis.

Text Books:

Reference Books:

CSP401 SOFTWARE LAB (0-0-2-2)

Contents:
Main theme- Use of open source tools.
Advanced use of Apache Web server: Installing and using Apache Web server in load sharing manner (Configuration of 2 or more server hosting a common website, Advanced use of MySQL server: Installing and using mysql servers in load sharing manner (Configuration of 2 MySQL instances in master-slave mode). Database operations via programs written in C/C++ or Java. Java Native Interface (JNI): Calling C/C++ code from Java and vice versa. Automatic testing tools – Junit, NUnit, Advanced use of open source cloud platforms: Integration of mail with google calendar – from gmail you should be able to schedule an appointment with all the recipients of the mail. Creating a website on Salesforce cloud for tracking inventory from east, west, north, south regions in India separately. Accessing google-map via google-map APIs, Downloading and Installing Hadoop on 3 to 4 machines and writing a distributed sorting program on the same. Creating web-services using Axis-2 (Java) or gSoap library (C/C++) Introduction to SSL. Use digital certificates to encrypt/ decrypt data in transfers Notes- Keytool in Java allows to create/store/ (Java) or gSoap library (C/C++) Introduction to SSL. Use digital certificates to encrypt/ decrypt data in transfers Notes- Keytool in Java allows to create/store/ manipulate certificates Also, refer www.thawte.com for free download/creation of a certificate Introduction to Android Platform and APIs/libraries provided. A sample game/application on Android. Learning software engineering tools, Design tools – Rational Rose/visio, Memory leaks - Purify /Code Coverage tools, Testing tools– Loadrunner, Winrunner.