COMPUTER SCIENCE & APPLICATIONS

SYLLABUS AND SAMPLE QUESTIONS

PAPER—II

1. Discrete Structures


Computability: Models of computation-Finite Automata, Pushdown Automata. Non-determinism and NFA, DPDA and PDAs and Languages accepted by these structures. Grammars, Languages, Non-computability and Examples of non-computable problems.


Groups: Finite fields and Error correcting/detecting codes.

2. Computer Arithmetic

Propositional (Boolean) Logic, Predicate Logic, Well-formed-formulae (WFF), Satisfiability and Tautology.


Representation of Integers: Octal, Hex, Decimal and Binary. 2’s complement and 1’s complement arithmetic, Floating point representation.

3. Programming in C and C++

Programming in C: Elements of C-Tokens, identitiers, data types in C. Control structures in C. Sequence, selection and iteration(s), Structured data types in C arrays, struct, union, string and pointers.

C++ Programming: Elements of C++-Tokens, identifiers, Variables and constants, Data types, Operators, Control statements, Functions parameter passing, Class and objects, Constructors and destructors, Overloading, Inheritance, Templates, Exception handling.

4. Relational Database Design and SQL
E R diagrams and their transformation to relational design, normalization-1NF, 2NF, 3NF, BCNF and 4NF. Limitations of 4NF and BCNF.
SQL: Data Definition language (DDL), Data Manipulation Language (DML), Data Control language (DCL) commands. Database objects like-Views, indexes, sequences, synonyms, data dictionary.

5. Data and File structures
Data, Information, Definition of data structure, Arrays, stacks, queues, linked lists, trees, graphs, priority queues and heaps.
File Structures: Fields, records and files, Sequential, direct, index-sequential and relative files, Hashing, inverted lists and multi-lists B trees and B+ trees.

6. Computer Networks
Network Fundamentals: Local Area Networks (LAN), Metropolitan Area Networks (MAN), Wide Area Networks (WAN), Wireless Networks, Inter Networks.
Reference Models: The OSI model, TCP/IP model.
Internetworking: Switch/Hub, Bridge, Router, Gateways, Concatenated virtual circuits, Tunnelling, Fragmentation, Firewalls.
Routing: Virtual circuits and datagrams, Routing algorithms, Conjestion control.
Network Security: Cryptography-public key, secret key, Domain Name System (DNS)-Electronic Mail and Worldwide Web (WWW), The DNS, Resource Records, Name servers, E-mail architecture and Serves.

7. System Software and Compilers
Loading, linking, relocation, program relocatability, Linkage editing.
Text editors, Programming Environments, Debuggers and program generators.
Compilation and Interpretation. Bootstrap compilers. Phases of compilation process. Lexical analysis. Lex package on Unix system.
Context free grammars, Parsing and parse trees, Representation of parse (derivation) trees as rightmost and left most derivations. Bottom up parsers-shift-reduce, operator precedence, and LR, YACC package on Unix system.


8. Operating Systems (with Case Study of Unix)
Main functions of operating systems. Multiprogramming, multiprocessing, and multitasking.

*Memory Management*: Virtual memory, paging, fragmentation.

*Concurrent Processing*: Mutual exclusion, Critical regions, lock and unlock.


*UNIX*

The Unix System: File system, process management, bourne shell shell variables, command line programming.

*Filters and Commands*: Pr, head, tail, cut, paste, sort, uniq, tr, join, etc., grep, egrep, fgrep, etc., sed, awk, etc.

*System Calls (like)*: Creat, open, close, read, write, isseek, link, unlink, stat, fstat, umask, chmod, exec, fork, wait, system.

9. Software Engineering

*System Development Life Cycle (SDLC)*: Steps, Water fall model, Prototypes, Spiral model.

*Software Metrics*: Software Project Management.

*Software Design*: System design, detailed design, function oriented design, object oriented design, user interface design. Design level metrics.

*Coding and testing*: Testing level metrics, Software quality and reliability, Clean room approach, software reengineering.

10. Current Trends and Technologies

The topics of current interest in Computer Science and Computer Applications shall be covered. The experts shall use their judgement from time to time to include the topics of popular interest, which are expected to be known for an application development software professional, currently, they include:

*Parallel Computing*

Parallel virtual machine (pvm) and message passing interface (mpi) libraries and calls. Advanced architectures. Today’s fastest computers.

*Mobile Computing*

Mobile connectivity-Casts, Framework, wireless delivery technology and switching methods, mobile information access devices, mobile data internetworking standards, cellular data communication protocols, mobile computing applications, Mobile databases-protocols, scope, tools and technology, M-business.
**E-Technologies**


Electronic Payment Systems: Digital Token, Smart Cards, Credit Cards, Risks in Electronic Payment System, Designing Electronic Payment Systems.


Main concepts in Geographical Information System (GIS), E-cash, E-Business, ERP packages.

Data Warehousing: Data Warehouse environment, architecture of a data warehouse methodology, analysis, design, construction and administration.

Data Mining: Extracting models and patterns from large databases, data mining techniques, classification, regression, clustering, summarization, dependency modelling, link analysis, sequencing analysis, mining scientific and business data.

**Windows Programming**

Introduction to Windows programming-Win32, Microsoft Foundation Classes (MFC), Documents and views, Resources, Message handling in windows.

**Simple Applications** (in windows)

Scrolling, splitting views, docking toolbars, status bars, common dialogs.

**Advanced Windows Programming**

Multiple Document Interface (MDI), Multithreading, Object linking and Embedding (OLE), Active X controls, Active Template Library (ATL), Network programming.

**PAPER—III (A)**

**(CORE GROUP)**

**Unit-I**

Combinational Circuit Design, Sequential Circuit Design, Hardwired and Microprogrammed processor design, Instruction formats, Addressing modes, Memory types and organisation, Interfacing peripheral devices, Interrupts.

Microprocessor architecture, Instruction set and Programming (8085, P-III/P-IV), Microprocessor applications.

**Unit—II**

Database Concepts, ER diagrams, Data Models, Design of Relational Database, Normalisation, SQL and QBE, Query Processing and Optimisation, Centralised and Distributed Database, Security, Concurrency and Recovery in Centralised and Distributed Database Systems, Object Oriented Database, Management Systems (Concepts, Composite objects, Integration with RDBMS applications), ORACLE.
Unit—III
Display systems, Input devices, 2D Geometry, Graphic operations, 3D Graphics, Animation,
Graphic standard, Applications.

Unit—IV
Programming language concepts, paradigms and models.
Data, Data types, Operators, Expressions, Assignment, Flow of Control-Control structures, I/O
statements, User-defined and built-in functions, Parameter passing.
Principles, classes, inheritance, class hierarchies, polymorphism, dynamic binding, reference
semantics and their implementation.
Principles, functions, lists, types and polymorphisms, higher order functions, lazy evaluation,
equations and pattern matching.
Principles, horn clauses and their execution, logical variables, relations, data structures,
controlling the search order, program development in prolog, implementation of prolog, example
programs in prolog.
Principles of parallelism, coroutines, communication and execution, Parallel Virtual Machine
(PVM) and Message Passing Interface (MPI) routines and calls. Parallel programs in PVM
paradigm as well as MPI paradigm for simple problems like matrix multiplication.
Preconditions, post-conditions, axiomatic approach for semantics, correctness, denotational
semantics.
Compiler structure, compiler construction tools, compilation phases.
Finite Automata, Pushdown Automata, Non-determinism and NFA, DPDA, and PDAs and
languages accepted by these structures. Grammars, Languages-types of grammars-type 0, type
1, type 2 and type 3. The relationship between types of grammars, and finite machines.
Pushdown automata and Context Free Grammars. Lexical Analysis-regular expressions and
regular languages, LEX package on Unix. Conversion of NFA to DFA. Minimizing the number
of states in a DFA. Compilation and Interpretation. Bootstrap compilers.
Context free grammars, Parsing and parse trees. Representation of parse (derivation) trees as
rightmost and leftmost derivations. Bottom up parsers-shift-reduce, operator precedence, and
LR, YACC package on Unix system. Topdown parsers-left recursion and its removal. Recursive
descent parser. Predictive parser, Intermediate codes-Quadruples, triples, Intermediate code
generation, code generation, Code optimization.

Unit—V
Analog and Digital transmission, Asynchronous and Synchronous transmission, Transmission
media, Multiplexing and Concentration, Switching techniques, Polling.
Topologies, Networking Devices, OSI Reference Model, Protocols for-(i) Data link layer,
(ii) Network layer, and (iii) Transport layer, TCP/IP protocols, Networks security, Network
administration.
Unit—VI
Definition, Simple and Composite structures, Arrays, Lists, Stacks queues, Priority queues, Binary trees, B-trees, Graphs.

Unit—VII
Object, messages, classes, encapsulation, inheritance, polymorphism aggregation, abstract classes generalization as extension and restriction, Object oriented design. Multiple inheritance, metadata.
HTML, DHTML, XML, Scripting, Java, Servelets, Applets.

Unit—VIII
Software development models, Requirement analysis and specifications. Software design, Programming techniques and tools, Software validation and quality assurance techniques, Software maintenance and advanced concepts, Software management.

Unit—IX
Introduction, Memory management, Support for concurrent process, Scheduling, System deadlock, Multiprogramming system, I/O management, Distributed operating systems, Study of Unix and Windows NT.

Unit—X
Definitions, AI approach for solving problems.
Automated Reasoning with propositional logic and predicate logic-fundamental proof procedure, refutation, resolution, refinements to resolution (ordering/pruning/restriction strategies).
State space representation of problems, bounding functions, breadth first, depth first, A, A*, AO*, etc. Performance comparison of various search techniques.
Frames, scripts, semantic nets, production systems, procedural representations, Prolog programming.
Components of an expert system, Knowledge representation and Acquisition techniques, Building expert system and Shell.
RTNs, ATNs, Parsing of Ambiguous CFGs. Tree Adjoining Grammars (TAGs).
Systems approach to planning, Designing, Development, Implementation and Evaluation of MIS.
Decision-making processes, evaluation of DSS, Group decision support system and case studies, 
Adaptive design approach to DSS development, Cognitive style in DSS, Integrating expert and 
Decision support systems.

PAPER—III (B) 
(ELECTIVE/OPTIONAL)

Elective—I

Theory of Computation: Formal language, Need for formal computational models, Non-computational problems, diagonal argument and Russel’s paradox.

Deterministic Finite Automaton (DFA), Non-deterministic Finite Automaton (NFA), Regular languages and regular sets. Equivalence of DFA and NFA. Minimizing the number of states of a DFA. Non-regular languages and Pumping lemma.

Pushdown Automaton (PDA), Deterministic Pushdown Automaton (DPDA), Non-equivalence of PDA and DPDA.

Context free Grammars: Greibach Normal Form (GNF) and Chomsky Normal Form (CNF), Ambiguity, Parse Tree Representation of Derivations, Equivalence of PDA’s and CFG’s. Parsing techniques for parsing of general CFG’s-Early’s, Cook-Kassami-Younger (CKY) and Tomita’s parsing.

Linear Bounded Automata (LBA): Power of LBA. Closure properties.


Chomsky Hierarchy of languages: Recursive and recursively-enumerable languages.

Elective—II

Models for Information Channel: Discrete Memoryless Channel, Binary Symmetric Channel (BSC), Burst Channel, Bit-error rates. Probability, Entropy and Shannon’s measure of information, Mutual information, Channel capacity theorem, Rate and optimality of Information transmission.

Variable Length Codes: Prefix Codes, Huffman Codes, Lempel-Ziev (LZ) Codes, Optimality of these codes, Information content of these codes.

Error Correcting and Detecting Codes: Finite fields, Hamming distance, Bounds of codes, Linear (Parity Check) codes, Parity check matrix, Generator matrix. Decoding of linear codes, Hamming codes.


Data Compression Techniques: Representation and compression of text, sound, picture, and video files (based on the JPEG and MPEG standards).

Elective—III

Linear Programming: Problem (LPP) in the standard form, LPP in canonical form, Conversion of LPP in standard form to LPP in Canonical form Simplex-Prevention of cyclic computations in Simplex and Tableau, Big Method, dual simplex and revised simplex.

Complexity of simplex algorithm(s) Exponential behaviour of simplex.
Ellipsoid method and karmakar’s method for solving LPPs, Solving simple LPPs through these methods. Comparison of complexity of these methods.

Assignment and Transportation Problems: Simple algorithms like Hungarian method, etc.

Shortest Path Problems: Dijkstra’s and Moore’s method, Complexity.


Matroids: Definition, Graphic and Cographic matroids, Matroid intersection problem.

Non-Linear programming: Kuhn-Tucker conditions, Convex functions and Convex regions, Convex programming problems, Algorithms for solving convex programming problems—Rate of convergence of iterative methods for solving these problems.

Elective—IV


Elective—V


Windows: Windows environment, Unicode, Documents and Views, Drawing in a window, Message handling, Scrolling and Spliting views, Docking toolbars and Status bars, Common dialogs and Controls, MDI, Multithreading, OLE, Active X controls, ATL, Database access, Network programming.

SAMPLE QUESTIONS

PAPER—II

1. Which among the following is not a structured data type in C?
   (A) Union
   (B) Pointer
   (C) String
   (D) Boolean

2. A B-tree of order m is an m-way search tree with
   (A) all leaves of the tree on the same level
   (B) each node, except for root and leaves, having less than m/2 subtrees
   (C) the root of the tree having more than m subtrees
   (D) all its leaves connected to form a linked list
3. A browser is a software tool that helps
   (A) linking of application program modules
   (B) viewing of application information
   (C) developing application programs
   (D) debugging of application software