

# UGC-NET Syllabus for Computer Science (CS)

## Discrete Structures

Sets, Relations, Functions. Pigeonhole Principle, Inclusion – Exclusion Principle Equivalence and Partial Orderings, Elementary, Counting Techniques Probability Measure (s) for information and Mutual information.

**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.

**Graph:** Definition, walks, paths, trails, connected graphs, regular and bipartite graphs, cycle and circuits. Tree and rooted tree. Spanning trees. Eccentricity of a vertex radius and diameter of a graph. Central Graphs. Centre(s) of a tree. Hamiltonian and Eulerian graphs, Planar graphs.

**Groups:** Finite fields and Error correcting / detecting codes.

## Computer Arithmetic

Propositional (Boolean) Logic, predicate Logic, Well – formed – formulae (WFF), Satisfiability and Tautology.

**Logic Families:** TTL, ECL, and C- MOS gates, Boolean algebra and Minimization of Boolean functions, flip – flops – types, race condition and comparison. Design of combinational and sequential circuits.

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

## Programming in C and C++

**Programming in C:** Elements of C- Tokens, identifiers, data types in C. control structures in C. Sequence, Selection and iteration (s). Structured data types in C- arrays, struct, union string and pointers.

**O-O Programming Concepts:** Class, object, instantiation. Inheritance polymorphism and overloading.

**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 handlings.

## 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.

### **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.

### **Computer Networks :**

**Networks 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.

**Data Communication:** Channel capacity. Transmission media – twisted pair, coaxial cables, fiber-optic cables, wireless transmission- radio, microwave, infrared and Millimeter waves. Lightwave transmission. Telephone's – local loop, trunks, multiplexing, switching, narrowband ISDN, broadband ISDN, ATM, High speed LANS. Cellular Radio. Communication satellites, Tunneling Fragmentation , firewalls.

**Routing:** Virtual circuits and datagrams. Routing algorithms. Routing algorithms. Congestion 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.

### **System Software and Compilers**

Assembly language fundamentals (8085 based assembly language programming). Assemblers – 2 pass and single – pass. Macros and macro processors.

Loading, linking, relocation, program relatability, Linkage editing.

Text editors. Programming Environments. Debuggers and program generators.

Compilations and Interpretation. Bootstrap compilers, Phases of compilation process. Lexical analysis. Lex package on UNIX system.

Context free grammars, parsing and parse trees. Representation of parser (derivation) trees as rightmost and leftmost derivations. Bottom up parsers- shift- reduce, operator precedence and LR. YACC package on UNIX system.

Top down parsers – left recursion and its removal. Recursive descent parser. Predictive parser, Intermediate codes – Quadruples, Triples, intermediate code generation, Code generation, Code optimization.

## **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.

**Scheduling:** CPU scheduling I/O scheduling, Resource scheduling, Deadlock and scheduling algorithms. Banker's algorithm for deadlock handling.

## **UNIX**

**The UNIX System:** File system, process management, Bourne shell, shell variables, and 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):** Create, open, close, read, lseek, link, unlink, state, fstat, unmask, chmod, exec, fork, wait, system.

## **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.

## **Current Trends and Technologies**

The topics of current interest in Computer Science and Computer Application 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 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 – cells, Framework, technology and switching methods, Mobile information access devices, mobile data internetworking standards, Cellular data communication protocols, mobile computing application. Mobile Databases – protocols, scope, tools and technology. M – Business.

### **E – Technologies**

Electronic Commerce: Framework, Media Convergence of Application,

Consumer Application, Organization Applications. Electronic Payment Systems: Digital Token, smart cards, credit Cards, Risks in Electronic payment System, Designing Electronic Payment Systems.

Electronic Data Interchange (EDI): Concepts, Application, (Legal, Security and Privacy) issues EDI and Electronic Commerce, Standardization and EDI, EDI Software. Implementation, EDI Envelope for

Message Transport, Internet –Based EDI. 7Digital Libraries and Data Warehousing: Concepts, Types of Digital documents, Issues behind document infrastructure, Corporate Data Warehouses.

Software Agents: Characteristics and Properties of Agents, Technology behind software Agents

(Applets, Browsers and software Agents) Broadband Telecommunications: Concepts, Frame Relay, Cell Relay, Switched Multimegabit Data Service, And Asynchronous Transfer Mode. 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 modeling, 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). Networking Programming.

## **CORE GROUP**

### **Unit – I**

Combinational circuit Design, Sequential Circuit Design, Hardwired and Micro programmed processor, Instruction formats, Addressing modes, Memory types and organization, 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, Normalization, SQL and QBE, Query Processing and Optimization, Centralized and Distributed Database, Security, Concurrency and Recovery in Centralized and Distributed Database System, Object Oriented Database Management System (Concepts, Composite objects, Integration with RDBMS applications). ORACLE.

### **Unit – III**

Display systems, Input devices, 2D Geometry, Graphic Operations 3D Graphics, Animation, Graphic standard, Applications.

Concepts, Storage Devices, Input Tools, Authoring Tools, Application files.

### **Unit – IV**

Programming language concepts, paradigms and models.

Data. Data type, operator's 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, type and polymorphisms, higher order functions, lazy evaluation, equations and pattern matching.

Principle, horn clauses and their execution, logical variables, relations, data structures, controlling the search order, program development in prolog, implementation of prolog, example in prolog.

Principles of parallelism, croutons, 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 constructions 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 expression and regular languages. LFX 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. Top down 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 structure, Arrays, Lists, Stacks queues, Priority queues, Binary trees , B- trees, Graphs.

Sorting and Searching Algorithm, Analysis of Algorithms, Interpolation and Binary Search, Asymptotic notations – big ohm, omega and theta .Average case analysis of simple programs like finding of a maximum of n elements, Recursion and its systematic removal. Quicksort- Non – recursive implementation with minimal stack storage. Design of Algorithms (Divide and Conquer, Greedy method, Dynamic programming, back tracking, branch and Bound). Lower bound theory, Non – deterministic algorithm- Non – deterministic programming constructs. Simple non – deterministic programs. NP – hard and NP – complete problems.

#### **Unit – VII**

Object messages, classes, encapsulation, inheritance, polymorphism, aggregation, abstract classes, generalization as extension and restriction. Object oriented design. Multiple inheritances, metadata.

HTML, DHTML, XML, Scripting, Java, Servlet's, 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 functional, breadth first depth first, A, A\*, AO\*, etc., performance comparison of various search techniques.

Frames, scripts, semantic nets, production systems, procedural representation, 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.

## **[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.

**Contexts 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 general CFG'S – Early's, Cook -Kassami- Younger (CKY), and Tomita's parsing.

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

**Turing Machine:** One tape, multistage. The notions of time and space complexity in terms of TM. Construction of TM for simple problems. Computational complexity.

**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, Hoffmann Codes, Lempel- Zueva (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.

**Image Processing:** Image Registration, Spatial Fourier Transforms, Discrete Spatial (2- Dimensional) Fourier Transform, Restoration, Loss compression of images (pictures).

**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 computation in Simplex and Tableau, Big – M method, dual simplex and revised simplex.

Complexity of simplex algorithm (s). Exponential behavior of simplex. Ellipsoid method Karmakar's method for solving LPP'S 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.

**Network Flow Problem:** Formulation, Max- Flow Min – Cut theorem. Ford and Fulkerson's algorithm. Malhotra – Pramodkumar – Mheshwari (MPM) Polynomial algorithm for solving Network



flow problem. Bipartite Graphs and Matchings; Solving matching problems using Network flow Problems.

**Matroids:** Definition, Graphic and Co graphic matroids. Matroid intersection problems.

**Non- linear Programming:** Kuhn – Tucker conditions. Convex functions and convex regions. Convex programming problems. Algorithm for solving convex programming problems- Rate of convergence of iterative methods for solving these problems.

#### **Elective -IV**

**Neural Networks:** Perceptron model, Linear Separability and XOR problem. Two and three layered neural nets, Back propagation – Convergence, Hopfield nets, Neural net learning, Applications.

**Fuzzy Systems:** Definition of a Fuzzy set, Fuzzy relations, Fuzzy functions, Fuzzy measures, Fuzzy reasoning, Application of Fuzzy systems.

#### **Elective – V**

**Unix :** Operating System , Structure of Unix Operating System , Unix Commands, Interfacing with Unix, Editors and Compilers for Unix , LEX and YACC, File systems , System calls, Filters, Shell programming.

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