Source book for Pre-CCAT

Name of the Organization ACTS C-DAC

1. **Course Objective:**
   a. To prepare for C-DAC entrance exam (C-CAT).

2. **Prerequisite:**
   Candidates should have knowledge of basics of Computer.

3. **Eligibility:**
   a. Graduate in discipline of Engineering (10+2+4 or 10+3+3 years)
   b. Post Graduate Degree in Physics / Mathematics / Statistics, OR
   c. MCA, MCM, OR
   d. Post Graduate Degree in Management with graduation in IT / Computer Science/Applications.

   The candidates must have secured a minimum of 50% marks in their qualifying examination.

4. **Teaching Schema: (Tabular format)**

Sr. No.	Module Name		Hours
1.	Section A	Computer Fundamentals and Concepts of Programming	10
		English Language / Verbal Ability	20
		Quantitative Aptitude	25
		Logical Reasoning	20
2.	Section B	Programming in C	30
		Data Structures	20
		Object Oriented Programming Concepts Using C++	10
		Operating System Concepts	10
		Networking	15
		Basic Concepts of Big Data	20
		Introduction to Artificial Intelligence	20
3.	Section C	Computer Architecture	40
		Microprocessors	50
		Digital Electronics	30
Total Hours			**320**

5. Detailed Course Contents

I. Section A (75 Hrs. Theory)

A. Computer Fundamentals and Concepts of Programming (10 Hours)

- Session 1-2:
  - Evaluation and Types of Computers
- Session 3-7:
  - Number Systems, Conversions and Data Representation (Binary, hex, octal etc.)
  - Input and Output Devices
  - Low level language vs High level language
- Session 8-10:
  - Evaluation of Programming languages
  - Algorithm and Flowcharts

B. English Language & Verbal Ability (20 Hours)

- Session 1-8:
  - Comprehension
  - Sentence completion
  - Fill in the blanks
  - Spotting errors
- Session 9-15:
  - Sentence correction
  - Sentence improvement
  - Sentence fillers
  - Sentence construction/arrangement
- Session 16-20:
  - Cloze test /Word substitution in the sentence with either synonym / antonym – idiom /phrases

C. Quantitative Aptitude (25 Hours)

- Session 1-4:
  - Compound & Simple Interest
  - Profit & Loss
  - Time & Work
- Session 5-7:
  - LCM & HCF
  - Number System
- Session 8-12:
  - Percentage
  - Average
- Session 13-18:
  - Pipes & Cistern
  - Time & Distance
  - Partnership
- Session 19-20:
  - Probability
- Session 21-25:
  - Ratio & Proportion
  - Problems on Age
  - Clock & Calendar

- Allegation & Mixtures
- Problems on Mensuration

D. Logical Reasoning (20 Hours)

- Session 1-4:
  - Coding & Decoding
  - Alphabets
  - Directions Sense Test
  - Series Completion (Number)
  - Odd Man Out (Number Series)
- Session 5-9:
  - Mathematical Operators
  - Symbols
  - Syllogism
- Session 10-15:
  - Blood Relation
  - Data Sufficiency
  - Puzzle Test
- Session 16-20:
  - Classification
  - Arithmetical Reasoning
  - Number & Ranking

II. Section B (125 Hrs. Theory)

A. Programming in C (30 Hours)

- Session 1-10:
  - Structure of a C program
  - Data Types
  - Constants
  - Operators
  - Arithmetic Expressions
  - Control-flow Statements
- Session 11-20:
  - Functions
  - Arrays
  - Pointers & Strings
  - Structures & Unions
- Session 21-30:
  - Dynamic Memory Allocation
  - Preprocessor statements
  - Storage classes
  - Writing multi file C programs
  - File & Console I/O and Command line arguments.

B. Data Structures (20 Hours)

- Session 1-5:
  - Introduction to Data Structures
  - Complexity of Algorithms
- Session 6-8:
  - Abstract data types, Lists, Stacks, Queues
- Session 9-12:

- Sorting Algorithms – Selection Sort, Insertion Sort, Bubble Sort, Quick Sort, Merge Sort, Heap Sort
- Session 13-15:
  - Searching Algorithms – Sequential Search, Binary Search, Hashing
- Session 16-18:
  - Trees – Binary Trees, Binary Search Trees
- Session 19-20:
  - Graphs

C. Object Oriented Programming Concepts Using C++ (10 Hours)

- Session 1-3:
  - Basic OOP Concepts
  - Features
  - Abstraction
  - Data Hiding
- Session 5-7:
  - Inheritance
  - Polymorphism
  - Classes, Objects
- Session 8-10:
  - Static data members & member functions
  - Friend functions
  - Constructors and Destructor
  - Benefits and Applications of OOP

D. Operating System Concepts (10 Hours)

- Session 1-2:
  - Introduction to operating system, goals, types of operating systems
  - Hardware Protection
  - Components
  - Operating System Services
- Session 3-5:
  - System Calls
  - Process Concept
  - Process Scheduling
  - Inter-process Communication
  - Synchronization
  - Deadlocks
  - Threads
- Session 6-7:
  - Memory management - contiguous memory allocation, paging, segmentation, virtual memory, demand paging, page fault & page replacement algorithms
- Session 8-10:
  - File system interface, structure and implementation
  - kernel I/O subsystem.

E. Networking (15 Hours)

- Session 1-3:

- Introduction to Computer Networks
- LAN, WAN, Inter network
- Topologies

- Session 5-6:
  - ISO and TCP/IP reference model
- Session 7-8:
  - Transmission Media
  - Switching
  - Multiplexing
  - Coding
  - Data link layer design issues
- Session 9-11:
  - Error control
  - Flow control
  - Error detection and correction
  - Elementary data link protocols
  - Sliding window protocols
  - Medium access control and local area network protocols
- Session 12-13:
  - Internetworking
  - Devices
  - Addressing
  - Routing
  - Network layer protocols
  - Transport layer protocols
- Session 14-15:
  - TCP & UDP
  - Application layer
  - Client-Server model & sockets
  - DNS, SMTP, FTP, HTTP and WWW

F. <u>Basic Concepts of Big Data</u> (20 Hours)

- Session 1-4:
  - Concept and characteristics of Big Data
  - History of Big Data
  - Jobs in Big Data
  - Types of Big data (structured, semi-structured, unstructured)
- Session 5-9:
  - Big Data Frameworks
  - Big Data Programming Paradigms
  - Big Data Programming Languages
- Session 10-11:
  - Introduction to Data Science and Skillset required for working with Big Data
- Session 12-15:
  - Simplified Overview of Machine Learning Algorithms and Neural Networks
  - Types of Machine Learning (Supervised, Un-Supervised, Reinforcement)
- Session 16-18:

- Examples of Big Data and Data Science in Practice (Healthcare, Logistics & Transportation, Manufacturing etc.
- Session 19-20:
  - Application Examples and Real –World Use Cases (e.g., Healthcare, finance, marketing, etc.)

G. Introduction to Artificial Intelligence (20 Hours)

- Session 1-5:
  - Definition of Artificial Intelligence
  - Understanding AI
  - Different types of AI and main domains of AI technology
- Session 6-10:
  - History of Al
  - Al Uses
  - Various applications of AI
- Session 11-13:
  - Advantages and disadvantages associated with Artificial Intelligence
- Session 14-16:
  - Learn about the basics of Neural Networks, Fuzzy Logic and Genetic Algorithms
- Session 17-20:
  - Current trends and future directions in AI

III. Section C (120 Hrs. Theory)

A. Computer Architecture (40 Hours)

- Session 1-4:
  - Computer Organization and Architecture
    - Basic Computer Model and different units of Computer
    - Arithmetic and Logic Unit (ALU) of CPU
    - Main Memory Unit
    - I/O Devices
- Session 5-8:
  - Overview of CPU Design
    - Fetch Instruction
    - Interpret Instruction
    - Fetch Data
    - Process Data
    - Write Data
    - Data Bus
    - Address Bus
    - Control Bus
    - Register organization
    - User-visible registers
    - Control and status registers
    - Processor Status Word
- Session 9-11:
  - Control Unit Design
    - Hardwired Control
    - Microprogrammed Control

        - Organization of Control Unit
        - Programmable Logic Array
        - Control Word (CW)
- Session 12-15:
    - Concept of Memory
        - Register
        - Cache Memory
        - Main Memory
        - Magnetic Disk
        - Removable Media (Magnetic tape)
        - Binary Storage Cell
        - SRAM
        - SRAM
        - Operation of Cache Memory
- Session 16-19:
    - Input/Output Organization
        - Control and timing
        - Processor Communication
        - Device Communication
        - Data Buffering
        - Error Detection
        - Memory Mapped I/O
        - Isolated or Mapped I/O
- Session 20-25:
    - Arithmetic and Logic unit
        - Arithmetic Operations
        - Logical Operations
- Session 26-30:
    - Memory Management
        - Main Memory
        - Memory Management
        - Swapping
        - Partitioning
        - Variable size Partition
- Session 31-34:
    - Virtual Memory
        - Paging
        - Virtual Memory
        - Address Translation
        - Inverted page table structures
        - Translation Lookaside Buffer (TLB)
- Session 35-37:
        - Execution of a complete Instructions
        - Concept of Program Execution
        - Basic Instruction Cycle
- Session 38-40:
    - Internal Organization of Memory Chips
        - 1024 x 1 memory chips
    - Mapping Functions and Replacement Algorithms
        - Mapping Functions
        - Direct Mapping

- Associative Mapping
- Block-set-associative mapping
- Replacement Algorithms
- Least Recent Used (LRU) Replacement Policy
- FIFO replacement policy
- Random replacement policy

B. <u>Microprocessors</u> (50 Hours)

- Session 1-5:
  - Microprocessor
    - Basics of Microprocessor
    - 16, 32, 64 – bit Microprocessor
    - Types of Processors
    - Complex Instruction Set Computer (CISC)
    - Reduced Instruction Set Computer (RISC)
    - Explicitly Parallel Instruction Computing (EPIC)
- Session 6-8:
  - Microprocessor | Externally Initiated Operations
    - Reset
    - Interrupt
    - Ready
    - Hold
- Session 9-10:
  - Bus organization of 8085 microprocessor
    - Address bus
    - Data bus
    - Control bus
- Session 11-12:
  - Generations of computer
    - First Generation
    - Second Generation
    - Third Generation
    - Fourth Generation
    - Fifth Generation
- Session 13-14:
  - Intel x86 evolution and main features
    - 8080
    - 8086
    - 80286
    - 80386
    - Pentium
    - Pentium Pro
    - Pentium II
    - Pentium III
    - Pentium 4
    - Core
    - Core 2
- Session 15-16:
  - Memory Banking
    - Even Bank

        - Odd Bank
        - Lower Bank
        - Higher Bank
- Session 17-18:
    - Introduction to quantum computing
        - Superposition
        - Entanglement
- Session 19-20:
    - Conventional Computing vs Quantum Computing
- Session 21-22:
    - Rethinking binary with Quantum computers
        - How traditional computers work?
        - Rethinking binary and transistors
        - How quantum computing work?
        - Advantages and Applications
- Session 23-24:
    - Flynn's taxonomy
        - Parallel Computing
        - Single-instruction, single-data (SISD) systems
        - Single-instruction, multiple-data (SIMD) systems
        - Multiple-instruction, single-data (MISD) systems
        - Multiple-instruction, multiple-data (MIMD) systems
- Session 25-27:
    - Clusters in Computer Organization
        - Load Balancing Cluster
        - Fail over Clusters
        - High Availability Clusters
        - Advantages
- Session 28-30:
    - Parallel processing – systolic arrays
        - Characteristics
        - Advantages
        - Disadvantages
- Session 31-33:
    - 8259 PIC Microprocessor
        - Features
        - Pin Diagram
        - Block Diagram
    - Block Diagram of 8259 Microprocessor
        - Registers – ISR, IRR & IMR
        - Priority Resolver
        - SP/EN (Low Active Pin)
        - Cascade Buffer
    - Microprocessor | 8251 USART
        - Block Diagram
- Session 34-35:
    - Evolution of Microprocessors
        - 8, 16, 32, 64-bit microprocessors
        - Generation of Microprocessors
        - Types of Microprocessors
        - Advantages

        - Disadvantages
    - Human – Computer interaction through the ages
- Session 36-38:
    - Computer Ports
        - Serial Ports
        - Parallel Ports
        - PS/2 ports
        - Universal serial bus port
        - VGA Ports
        - HDMI Ports
        - Modem port
        - Ethernet Port
        - Game Port
        - Sockets
        - DVI Port
- Session 39-41:
    - Introduction to Parallel Computing
        - Introduction
        - Types of Parallelism
        - Bit-level parallelism
        - Instruction-level parallelism
        - Task Parallelism
        - Advantages and Limitations
        - Future of Parallel Computing
- Session 42-44:
    - Hardware architecture (parallel computing)
        - Computing
        - Types of Computing
        - Parallel computing
        - Hardware architecture of parallel computing
    - Computer Architecture | Multiprocessor and Multicomputer
        - Multiprocessor
        - Advantages, Benefits
        - Multicomputer
        - Difference between Multicomputer and Multiprocessor
- Session 43-46:
    - Timing diagram of INR M in 8085
    - Priority Interrupts
        - Software Method – Polling
        - Hardware Method – Daisy Chaining
    - I/O Interface
        - Modes of transfer
        - Programmed I/O
        - Interrupt-initiated I/O
        - Direct Memory Access
        - Types of DMA transfer using DMA Controller
        - Cyclic Stealing
    - Direct memory access with DMA controller 8257/8237
        - Modes of DMAC
    - Computer Organization | Asynchronous input output synchronization
        - Problem faced in asynchronous input output synchronization
        - Strobe Mechanism

        - Handshaking Mechanism
- Session 44-47:
    - Programmable peripheral interface 8255
        - Block Diagram
        - Pin Diagram
        - Operating Modes
    - Interface 8255 with 8085 microprocessors for 1's and 2's complement of a number
    - Microprocessor | 8255 (programmable peripheral interface)
        - 8255
        - 8255 pin Diagram
        - Modes of 8255
    - Interface 8254 PIT with 8085 microprocessors
        - 8254 Control Register and Operating modes
    - Synchronous Data Transfer in Computer Organization
        - Advantages and Disadvantages
- Session 48:
    - Introduction of Input-Output Processor
        - The Block Diagram
    - MPU Communication in Computer Organization
        - I/Os with 8-bit addresses
        - I/Os with 16-bit addresses
- Session 49:
    - Memory mapped I/O and Isolated I/O
        - Isolated I/O
        - Memory Mapped I/O
        - Their differences
- Session 50:
    - BUS Arbitration in Computer Organization
        - Centralized bus arbitration
        - Distributed bus arbitration
        - Methods of Centralized BUS Arbitration

C. <u>Digital Electronics</u> (30 Hours)

- Session 1-3:
    - Number System and Representation:
        - Binary representations
        - Number System and Base Conversions
        - Floating Point Representation
- Session 4-8:
    - Programs:
        - Binary to Decimal Conversion
        - Decimal to Binary Conversion
        - Decimal to octal conversion
        - Octal to decimal conversion
        - Hexadecimal to decimal
- Session 9-13:
    - Boolean Algebra and Logic Gates:
        - Properties of Boolean algebra
        - Representation of Boolean Functions
        - Canonical and Standard Form
        - Functional Completeness

        - Logic Gates
- Session 14-16:
    - Gate Level Minimization:
        - K-Map (Karnaugh Map)
        - Implicants in K-Map
        - 5 variable K-Map
        - Variable entrant map (VEM)
        - Minimization of Boolean Functions
        - Consensus theorem
- Session 17-20:
    - Combinational Logic Circuits:
        - Half-Adder
        - Half-Subtractor
        - Half-Adder and Half-Subtractor using NAND NOR Gates
        - Full-Adder
        - Full Subtractor
        - Code Converters – BCD (8421) to/from Excess-3
        - Code Converters – Binary to/from Gray Code
        - Code Converters – BCD to 7 Segment Decoder
        - Parallel Adder & Parallel Subtractor
        - Carry Look-Ahead Adder
        - Magnitude Comparator
        - BCD Adder
        - Encoders and Decoders
        - Encoder
        - Binary Decoder
        - Combinational circuits using Decoder
        - Multiplexers
        - Static Hazards
- Session 21-22:
    - Flip-Flops and Sequential Circuits:
        - Latches
        - One-bit memory cell
        - Flip-Flops (Types and Conversions)
        - Master Slave JK Flip Flop
        - Introduction of Sequential Circuits
        - Synchronous Sequential Circuits
        - Asynchronous Sequential Circuits
        - Difference between combinational and sequential circuit
        - RTL (Register Transfer Level) design vs Sequential logic design
        - Difference between Synchronous and Asynchronous Sequential Circuits
- Session 23-25:
    - Register and Counters:
        - Counters
        - Design counter for given sequence
        - n-bit Johnson Counter
        - Amortized analysis for increment in counter
        - Ripple Counter
        - Digital Logic | Ring Counter
        - Shift Registers
        - Design 101 sequence detector
        - Universal Shift Register

        - RTL (Register Transfer Level) design vs Sequential logic design
        - Verilog Data Types
- Session 26-28:
    - Memory and Programmable Logic:
        - Read-Only Memory (ROM) | Classification and Programming
        - Programmable Logic Array
        - Programming Array Logic
        - RAM vs ROM
        - Operational Amplifier (op-amp)
- Session 29-30:
    - Data Communication:
        - Block Coding
        - Difference between Unipolar, Polar and Bipolar Line Coding
        - Difference between Broadband and Baseband Transmission
        - Transmission Impairment
        - What is Scrambling?
        - Analog to Analog Conversion (Modulation)
        - Analog to digital conversion
        - Digital to Analog Conversion
        - Difference Between Digital and Analog System

6. List of Reference Books

- Quicker math by M.Tyra (BSC publication co. Pvt. Ltd)
- How to prepare GRE by Barron's / galgotia publications pvt. Ltd
- Foundations of Computing, PK Sinha, BPB
- Data Structures with C (Schaum's Outline Series)
- Object-Oriented Programming with C++ (E Balagurusamy)
- Computer Organization and Architecture, William Stallings
- Microprocessor Architecture, Programming, and Applications with 8085, Ramesh Gaonkar
- The Intel Microprocessors, Barry. B. Brey
- Digital Design, Morris Mano
- Modern Digital Electronics, R. P. Jain
- C Programming Language (Kernighan & Ritchie)
- Let Us C (Yashavant Kanetkar)
- Artificial Intelligence for Dummies, John Paul Mueller by Luca Massaron)
- Big Data Fundamentals_Concepts_Drivers_&_Techniques by Paul Zikopoulos