



CrackTarget

PREPARE PRACTICE PROGRESS

CONCEPTS
APPLICATIONS
CURRENT TRENDS
EXAM SUCCESS

FUNDAMENTALS OF COMPUTER APPLICATIONS

A Complete Exam-Oriented Textbook

Useful in



UPSC



EPFO APFC



**DRDO Senior
Administrative Officer (SAO)**



**& Equivalent Administrative
Officer Examinations**



**UPSC - EPFO AO • ESIC • GSI
NABARD • RBI Grade B & PFRDA Exams**



Comprehensive
Coverage



Concepts Made Easy



Exam-Oriented
Approach



Updated & Relevant



Practice for Success



Your Target
Our Commitment

2026
EDITION

Contents

Copyright and Imprint	2
About This Edition	3
2026 Edition — Updated for UPSC Recruitment-Examination Trends	3
How to Use This Book	4
Contents.....	5
History, Generations, and Types of Computers.....	9
1.1 The Electronic Computer Era — Key Milestones	9
1.2 Generations of Computers	10
1.3 Types of Computers.....	10
1.4 Key Personalities and Contributions (High-Yield)	13
1.5 Summary	14
Chapter 2.....	26
Computer Hardware and Memory.....	26
2.1 2026 Update	27
2.2 Program Counter (PC / Instruction Pointer):.....	27
2.3 Memory Hierarchy	28
2.4 System Bus and Interconnection	30
2.5 Input / Output (I/O) Devices	30
2.6 Ports, Interfaces and Modern Connectors.....	31
2.7 Summary	31
Chapter 3.....	43
Operating Systems and System Software	43
3.4 Major Operating System Families.....	44
3.5 Process Management Basics	46
3.6 CPU Scheduling (Basic Concepts)	47
3.7 Additional Important Concepts	47
3.8 Summary	47
Chapter 4.....	60
MS Office and Productivity Applications.....	60
4.3 Microsoft Excel — Spreadsheet Application	62
4.4 Microsoft PowerPoint — Presentation Software.....	64
4.5 Cross-Application & Universal Shortcuts	65
4.6 Summary	65

Chapter 5.....	76
Database Management Systems and SQL	76
5.5 Entity-Relationship (ER) Model Basics	78
5.6 Normalization (Conceptual Overview).....	78
5.7 Structured Query Language (SQL) — Concepts.....	78
5.8 Transactions and ACID Properties	79
5.9 Summary	80
Chapter 6.....	91
Computer Networks and Internet.....	91
6.4 Transmission Media	92
6.5 Switching Techniques.....	92
6.6 OSI Reference Model (7 Layers).....	93
6.7 TCP/IP Model.....	93
6.8 Important Protocols and Addressing.....	93
6.9 Network Devices.....	94
6.10 Summary	94
Chapter 7.....	106
Internet, Web, E-Governance and Digital Services	106
7.4 Digital India and Major E-Governance Initiatives.....	107
7.5 Benefits and Challenges of E-Governance.....	108
7.6 Summary	109
Chapter 8.....	120
Cybersecurity, Data Protection and Cyber Law.....	120
8.3 Basic Defence Mechanisms and Best Practices	121
8.4 Data Protection and Cyber Laws in India	122
8.5 Practical Cyber Hygiene for Administrative Officers.....	123
8.6 Summary	123
Chapter 9.....	135
Emerging Technologies and AI.....	135
9.4 Internet of Things (IoT)	137
9.5 Blockchain Technology	137
9.6 Web 3.0 (Conceptual Overview)	138
9.7 Other Notable Emerging Areas (Brief)	138
9.8 Summary	138
Chapter 10	150
10.1 Number Systems	150
10.2 Number-System Conversions	150

10.3 Binary Arithmetic	151
10.4 Complements	152
10.5 Storage Units	153
10.6 Boolean Algebra	154
10.7 Logic Gates	154
10.8 Digital Logic Exam Traps	155
10.9 Numerical Exam Practice — Worked Examples	155
10.10 Chapter Revision Card	156
10.11 75 High-Quality MCQs	156
Chapter 11	171
11.1 Programming Languages	171
11.2 Language Translators	171
11.3 Programming Concepts	172
11.4 Control Structures	172
11.5 C Programming Basics	172
11.6 C Operators	173
11.7 Data Structures	173
11.8 Basic Algorithms	174
11.9 Programming Exam Traps	174
11.10 75 High-Quality MCQs	175
Chapter 12	189
12.1 System Software versus Application Software	189
12.2 CPU Registers — Examination Table	189
12.3 System Calls	190
12.4 Process Concepts	191
12.5 Memory Management — Paging and Segmentation	191
12.6 Utility Programs	192
12.7 Real-Time Operating Systems	192
12.8 75 High-Quality MCQs	192
Chapter 13	207
13.1 Microsoft Access	207
13.2 Access versus Excel	207
13.3 Common File Extensions	208
13.4 Raster versus Vector Graphics	209
13.5 Email and Administrative Computing	209
13.6 Office File Management	209
13.7 Digital Signatures and E-Sign	210

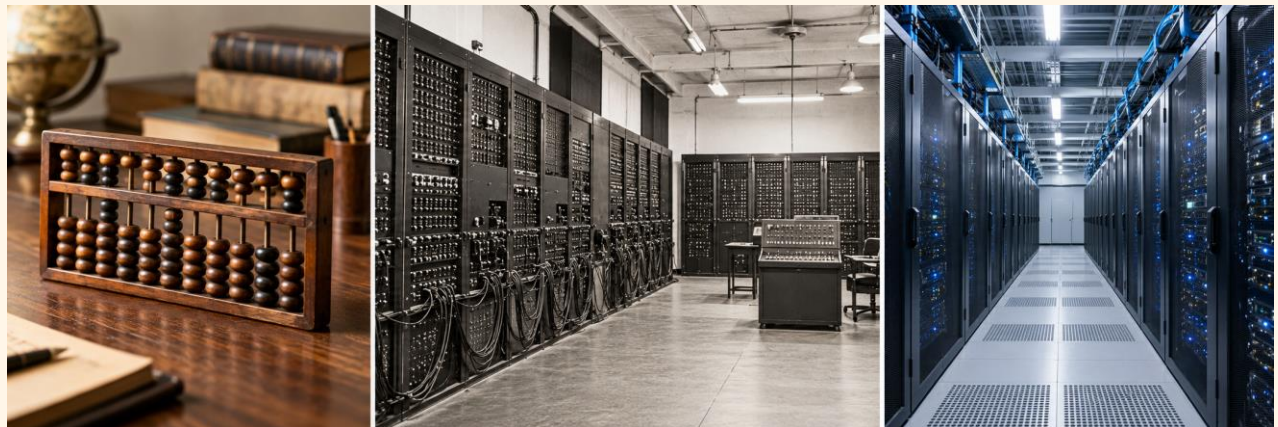
13.8 Administrative Office Cybersecurity.....	210
13.9 100 High-Quality MCQs	210
Chapter 14	229
14.1 Generative AI	229
14.2 Large Language Models.....	229
14.3 Chatbots and AI Assistants.....	230
14.4 AI Hardware.....	230
14.5 Edge AI	230
14.6 Emerging Technology One-Liners	230
14.7 Indian Digital Platforms — Examination Table	230
14.8 100 High-Quality MCQs	231
Section A.....	250
A. Hardware	250
B. Memory	251
C. Registers	252
D. Software.....	252
E. Operating Systems.....	253
F. MS Office	254
G. Access.....	255
H. DBMS	255
I. Networks.....	256
J. Internet.....	257
K. Cybersecurity	258
L. File Formats.....	259
M. Programming.....	259
N. Number Systems	260
O. Boolean Logic	260
P. AI	261
Q. Emerging Technology	261
R. Indian Digital Initiatives.....	262
Section B.....	264
Section C	268
Bibliography & Authoritative References.....	269

Chapter 1

History, Generations, and Types of Computers

CHART 1.A · Generations of computers (exam snapshot)

Generation	Period	Switching device	Typical trait
First	1940s–1950s	Vacuum tubes	Huge, hot, unreliable
Second	1950s–1960s	Transistors	Smaller, more reliable
Third	1960s–1970s	Integrated circuits	Minicomputers appear
Fourth	1970s–present	Microprocessor	Personal computers
Fifth (pedagogical)	1980s–present	ULSI / AI systems	Knowledge + learning



1.1 The Electronic Computer Era — Key Milestones

- ABC (Atanasoff-Berry Computer), 1937–42: An early electronic digital computing machine; historical 'first' claims are

contested and should be treated cautiously.

- ENIAC (Electronic Numerical Integrator and Computer), 1946: First general-purpose electronic digital computer. Used 18,000 vacuum tubes, weighed 30 tons, and consumed 150 kW of power. Programmed

by rewiring.

- EDVAC: Introduced the stored-program concept (von Neumann architecture).
- UNIVAC I (1951): First commercially available computer in the United States.

- EDSAC (1949, UK): First practical stored-program computer.

1.2 Generations of Computers

Computers are classified into generations primarily on the basis of the **technology used in their hardware**, particularly the **switching and memory devices**.

Mnemonic for Computer Generations — V-T-I-M-A

Vacuum Tubes → Transistors → Integrated Circuits → Microprocessors → Artificial Intelligence

1st Generation (1940–1956) — Vacuum Tubes

- **Switching Device:** Vacuum tubes
 - **Memory:** Magnetic drums / delay lines
 - **Language:** Machine language only
 - **Characteristics:** Very large, extremely expensive, high power consumption, frequent failures, and relatively slow
 - **Examples:** ENIAC, UNIVAC I, EDVAC, IBM 701
-

2nd Generation (1956–1963) — Transistors

- **Switching Device:** Transistors
 - **Important Fact:** Transistor invented in 1947 at Bell Labs
 - **Memory:** Magnetic core memory
 - **Language:** Assembly language + early high-level languages
 - **Examples of high-level languages:** FORTRAN (1957), COBOL (1959)
 - **Characteristics:** Smaller, faster, more reliable, less heat generation, but still generally room-sized
 - **Examples:** IBM 1401, IBM 7090, CDC 1604, PDP-1
-

3rd Generation (1964–1971) — Integrated Circuits (ICs)

- **Switching Device:** Integrated Circuits
- **Associated Inventors:** Jack Kilby and Robert Noyce
- **Memory:** Semiconductor memory began replacing magnetic-core memory
- **Language:** High-level languages became dominant
- **Key Developments:** Operating systems, multiprogramming, time-sharing and remote terminals
- **Characteristics:** Further miniaturisation and increased reliability
- **Examples:** IBM System/360, PDP-8, Honeywell 6000

4th Generation (1971–Present) — Microprocessors

- **Switching Device:** Microprocessor
- **Important Fact:** Intel 4004 (1971) is generally recognised as the first commercial microprocessor
- **Memory:** Semiconductor RAM/ROM; later cache and other advanced storage technologies
- **Technology:** VLSI (Very Large-Scale Integration)
- **Characteristics:** Personal computers, graphical user interfaces, networking, portability and massive increases in processing power
- **Examples:** Intel 8080/8086-based systems, Apple II, IBM PC (1981), modern PCs, laptops and smartphones

5th Generation (Present & Beyond) — AI-Oriented / Advanced Computing

Note: The "fifth generation = AI" classification is a **pedagogical classification**, rather than a universally agreed historical boundary.

- **Technology:** ULSI, parallel processing, AI and advanced computing
- **Key Areas:** Artificial Intelligence, Natural Language Processing, expert systems, machine learning and quantum-computing research
- **Goal:** Machines capable of learning, reasoning and interacting using natural language
- **Examples:** AI-enabled computing systems, AI-accelerated supercomputers and emerging quantum computers

Feature	1st Generation	2nd Generation	3rd Generation	4th Generation	5th Generation
Main Technology	Vacuum Tubes	Transistors	Integrated Circuits	Microprocessors / VLSI	ULSI + AI + Parallel Processing
Size	Room-sized	Smaller	Smaller / More compact	Desktop / Portable	Highly portable / Cloud-based
Speed	Milliseconds	Microseconds	Nanoseconds	Picoseconds+	Very high + parallelism
Languages	Machine language	Assembly + early HLL	High-level languages	4GLs, OOP, etc.	Natural language / AI-oriented
Memory	Magnetic drum	Magnetic core	Semiconductor	Semiconductor + Cache	Advanced hierarchical memory
Power & Heat	Very high	High	Moderate	Low	Generally more efficient
Examples	ENIAC, UNIVAC I	IBM 1401	IBM System/360	IBM PC, modern PCs	AI computing systems

1.3 Types of Computers

Computers can be classified on several bases. A clear understanding of these classifications is frequently tested through

match-the-following and statement-based questions.

A. Classification by Data Handling / Signal Type

- Analog Computers: Work on continuous physical quantities (voltage, pressure, temperature). Used in process control, simulation. Example: Slide rule, analog differential analysers.
- Digital Computers: Work on discrete binary digits (0 and 1). Almost all modern computers are digital.
- Hybrid Computers: Combine analog and digital features. Used in specialised applications such as ICU monitoring systems and some scientific simulations.

B. Classification by Size and Capability

- Supercomputers: Fastest, most powerful. Used for weather forecasting, nuclear simulations, climate modelling, AI training. Examples: Frontier (USA), Fugaku (Japan), India's PARAM series, AIRAWAT.
- Mainframe Computers: Large, multi-user systems used by banks, railways, insurance companies for bulk data processing and transaction processing.
- Minicomputers (mid-range): Smaller than mainframes; used by medium-sized organisations. Largely replaced by powerful servers.
- Microcomputers / Personal Computers: Desktop, laptop, notebook, tablet, smartphone. Based on microprocessors.
- Workstations: High-performance single-user computers optimised for technical or scientific applications (CAD, animation, data analysis).
- Servers: Computers dedicated to providing services (web, database, file, mail) to other computers (clients) over a network.
- Embedded Computers / Microcontrollers: Special-purpose computers built into devices (washing machines, cars, ATMs, medical equipment).

C. Classification by Purpose

- General-purpose computers: Can perform a wide variety of tasks (PCs, smartphones).
 - Special-purpose computers: Designed for one specific task (embedded systems, traffic light controllers, digital signal processors).
- Mind Map — Types of Computers
Types of Computers
III By Signal Type →

Analog | Digital | Hybrid III By Size & Power → Supercomputer | Mainframe | Mini | Micro (PC/Laptop/Mobile) |

Workstation | Server / Embedded III By Purpose → General Purpose | Special Purpose

Mnemonic for Size Classification — S-M-M-M-W-S

Super → Mainframe → Mini → Micro → Workstation → Server/Embedded

1.4 Key Personalities and Contributions (High-Yield)

- Charles Babbage — Father of the Computer
- Ada Lovelace — First computer programmer
- Alan Turing — Conceptualised the Turing Machine; broke Enigma code
- John von Neumann — Stored-program concept (von Neumann architecture)
- Tim Berners-Lee — World Wide Web
- Gordon Moore — Moore's Law (number of transistors on a chip doubles approximately

every two years)

UPSC TRAP — Father of the Computer

“Who is known as the father of the modern computer?” – Some sources say Babbage, some say Turing or von Neumann.

In most Indian exam contexts (UPSC, SSC, banking, DRDO), Charles Babbage is the accepted answer for “Father of the

Computer”. Alan Turing is associated with theoretical foundations and AI.

2026 Update

Historical priority claims are qualified where contested, especially ABC/ENIAC.

The fifth-generation label is presented as a pedagogical classification, not a universally agreed historical boundary.

Moore's Law is described as a historical trend rather than an exact physical law.

Analog calculating instruments and modern analog computers are distinguished; 'server' is treated as a role rather than a strict

Abacus (ancient origins; exact date and place of origin are uncertain): An early manual calculating device using beads or

Napier's Bones (1617, John Napier): Rods with multiplication tables engraved on them;

Slide Rule (1622, William Oughtred): Based on logarithmic scales; used extensively by

Pascaline (1642, Blaise Pascal): The first mechanical calculator that could add and

Stepped Reckoner (1673, Gottfried Wilhelm Leibniz): Could perform all four arithmetic

Jacquard Loom (1801, Joseph Marie Jacquard): Used punched cards to control the weaving

Difference Engine and Analytical Engine (Charles Babbage, 1820s–1830s):

Difference Engine: Designed to compute polynomial tables automatically.

Analytical Engine: The conceptual ancestor of the modern computer. It had a “Store”

Hollerith's Tabulating Machine (1890, Herman Hollerith): Used punched cards to process

1.5 Summary

The journey from the abacus to AI-powered supercomputers reflects continuous advances in switching technology,

miniaturisation, and software sophistication. For an administrative

officer, the practical takeaway is clear: different classes of computers serve different organisational needs — from

embedded systems in office equipment to mainframes handling citizen databases and supercomputers supporting national

scientific missions. Mastery of this foundational chapter enables accurate interpretation of technology-related questions

across the entire Computer Applications syllabus.

CHAPTER 1 —MCQs

1. Which of the following is considered the first mechanical calculating device capable of addition and subtraction?

- a) Abacus
- b) Napier's Bones
- c) Pascaline
- d) Analytical Engine

Answer: c

Explanation: Pascaline (1642) was the first mechanical calculator that could add and subtract. Abacus is a manual counting device,

Napier's Bones primarily aid multiplication, and the Analytical Engine was a conceptual general-purpose machine that was never

fully completed in Babbage's lifetime.

2. The Analytical Engine was designed by:

- a) Blaise Pascal
- b) Charles Babbage
- c) Herman Hollerith
- d) John von Neumann

Answer: b

Explanation: Charles Babbage designed both the Difference Engine and the Analytical Engine. The latter is regarded as the

conceptual precursor of the modern general-purpose computer. Pascal invented the Pascaline; Hollerith the tabulating machine; von

Neumann formalised the stored-program architecture.

3. Who is credited with writing the first algorithm intended for a machine?

- a) Alan Turing
- b) Ada Lovelace
- c) Grace Hopper
- d) John von Neumann

Answer: b

Explanation: Ada Lovelace wrote extensive notes on the Analytical Engine that included what is recognised as the first published

algorithm intended for a machine. She is widely regarded as the world's first computer programmer. Turing, Hopper and von

Neumann made later foundational contributions.

4. ENIAC was:

- a) The first commercial computer
- b) The first stored-program computer
- c) The first general-purpose electronic digital computer
- d) The first transistor-based computer

Answer: c

Explanation: ENIAC (1946) was the first general-purpose electronic digital computer. It was programmed by physical rewiring, not

by a stored program. UNIVAC I was the first commercial computer; EDVAC/EDSAC introduced the stored-program concept;

transistors appeared in the second generation.

5. The stored-program concept is primarily attributed to:

- a) Charles Babbage
- b) Alan Turing
- c) John von Neumann
- d) Maurice Wilkes

Answer: c

Explanation: Although several researchers contributed, the architecture in which both data and instructions reside in the same

memory is universally known as the von Neumann architecture. Babbage conceived programmability earlier; Turing provided

theoretical foundations; Wilkes built EDSAC.

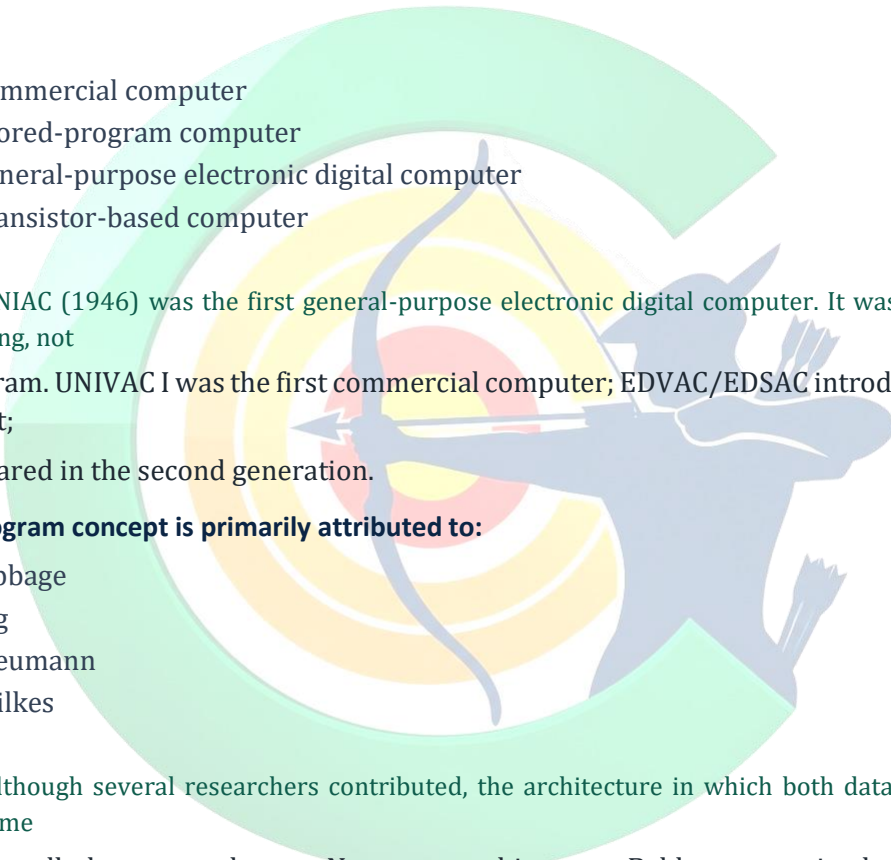
6. Which generation of computers used vacuum tubes as the primary switching device?

- a) First
- b) Second
- c) Third
- d) Fourth

Answer: a

Explanation: First generation (approximately 1940–1956) used vacuum tubes. Second generation used transistors, third used

integrated circuits, and fourth used microprocessors.



7. Transistors were invented at:

- a) IBM
- b) Bell Laboratories
- c) Intel
- d) Fairchild Semiconductor

Answer: b

Explanation: The point-contact transistor was invented in 1947 at Bell Labs by John Bardeen, Walter Brattain and William Shockley.

This invention enabled the second generation of computers.

8. Which of the following high-level languages appeared during the second generation?

- a) C
- b) FORTRAN
- c) Java
- d) Python

Answer: b

Explanation: FORTRAN (1957) and COBOL (1959) belong to the second generation. C was developed in the early 1970s

(fourth-generation era). Java and Python are much later languages.

9. The IBM System/360 series belongs to which generation?

- a) Second
- b) Third
- c) Fourth
- d) Fifth

Answer: b

Explanation: IBM System/360 (announced 1964) is a classic third-generation family based on integrated circuits. It introduced the

concept of a compatible family of computers.

10. The first commercial microprocessor was:

- a) Intel 4004
- b) Intel 8080
- c) Motorola 6800
- d) Zilog Z80

Answer: a

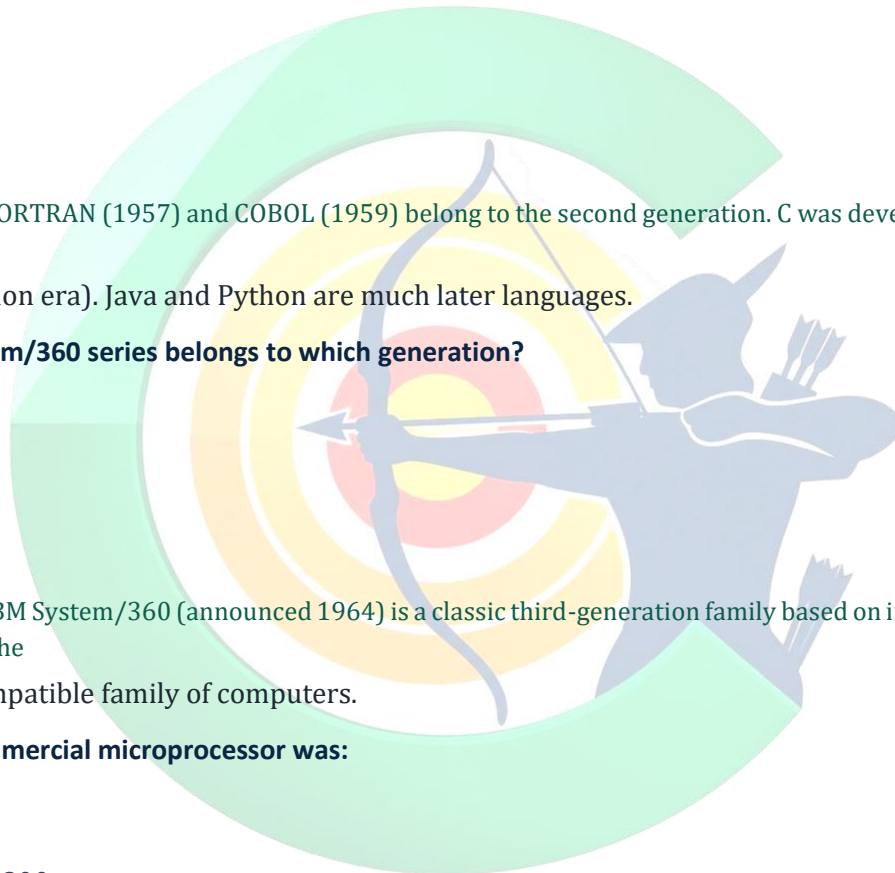
Explanation: Intel 4004 (1971) was the first commercially available microprocessor and marks the conventional beginning of the

fourth generation of computers.

11. Which of the following is a defining characteristic of fifth-generation computers?

- a) Use of vacuum tubes
- b) Batch processing only
- c) Emphasis on artificial intelligence and parallel processing
- d) Exclusive use of machine language

Answer: c



Explanation: Fifth generation focuses on AI, natural language processing, expert systems and massively parallel architectures. The

other options belong to earlier generations.

12. Moore's Law is related to:

- a) Speed of light in optical fibres
- b) Doubling of transistors on a chip approximately every two years
- c) Growth of internet users
- d) Increase in hard disk capacity

Answer: b

Explanation: Gordon Moore observed that the number of transistors that can be placed on an integrated circuit doubles roughly

every two years, driving exponential growth in computing power.

13. Analog computers work on:

- a) Discrete binary data
- b) Continuous physical quantities
- c) Both discrete and continuous exclusively in hybrid mode
- d) Only decimal numbers

Answer: b

Explanation: Analog computers process continuous signals such as voltage, temperature or pressure. Digital computers use

discrete binary values. Hybrid systems combine both.

14. Which of the following is a classic example of a hybrid computer application?

- a) Word processing
- b) Weather forecasting on a pure digital supercomputer
- c) Patient monitoring systems in ICUs
- d) Spreadsheet calculations

Answer: c

Explanation: ICU monitors often combine analog signal acquisition from sensors with digital computation, display and alarming — a

hybrid approach. The other options are purely digital.

15. Supercomputers are primarily used for:

- a) Routine office work
- b) Bulk transaction processing in banks
- c) Complex scientific simulations and weather modelling
- d) Embedded control in washing machines

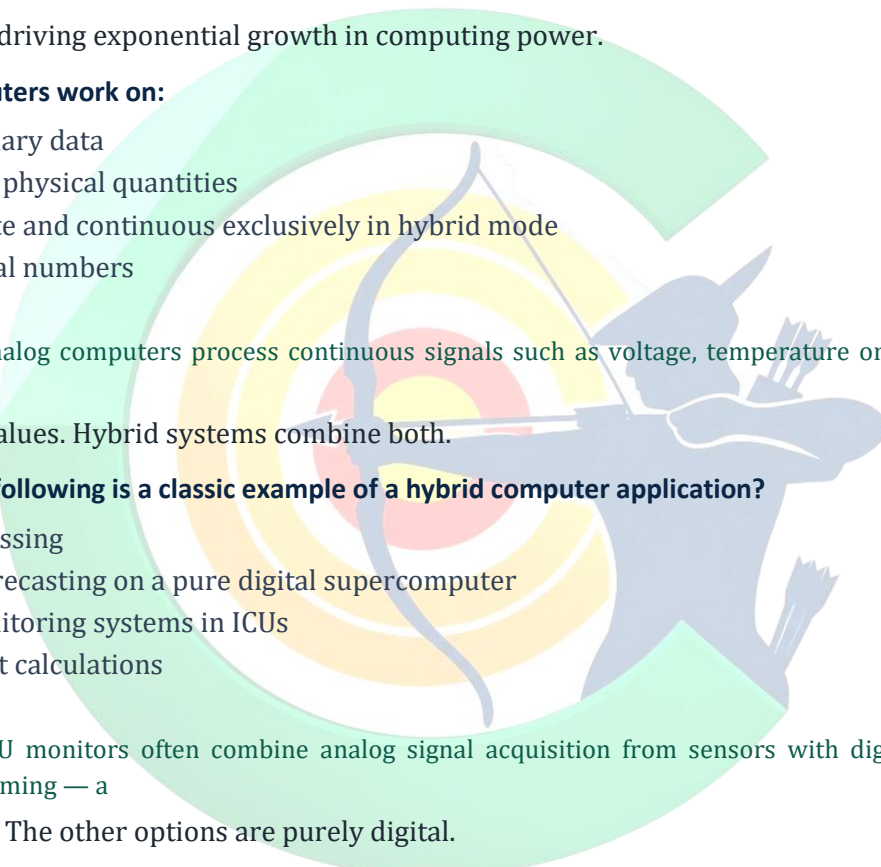
Answer: c

Explanation: Supercomputers excel at floating-point intensive, highly parallel scientific and engineering calculations. Banks use

mainframes; office work uses PCs; appliances use embedded systems.

16. Mainframe computers are most commonly associated with:

- a) Personal productivity applications



- b) Large-scale transaction processing and enterprise databases
- c) Mobile applications
- d) Real-time control of a single machine

Answer: b

Explanation: Banks, railways, insurance companies and government departments traditionally rely on mainframes for high-volume,

high-reliability transaction processing and large databases.

17. Which of the following is NOT a microcomputer?

- a) Desktop PC
- b) Laptop
- c) Smartphone
- d) Traditional mainframe

Answer: d

Explanation: Microcomputers are based on microprocessors and include PCs, laptops and smartphones. Mainframes constitute a

separate, much larger class of systems.

18. Embedded systems are best described as:

- a) General-purpose computers
- b) Special-purpose computers built into larger devices
- c) Always supercomputers
- d) Only used in mobile phones

Answer: b

Explanation: An embedded system is a computer system designed for a dedicated function within a larger mechanical or electrical

system (car ECU, washing-machine controller, medical device, etc.).

19. Which generation first saw the widespread practical use of operating systems?

- a) First
- b) Second
- c) Third
- d) Fourth

Answer: c

Explanation: Although primitive monitors existed earlier, multiprogramming and time-sharing operating systems became practical

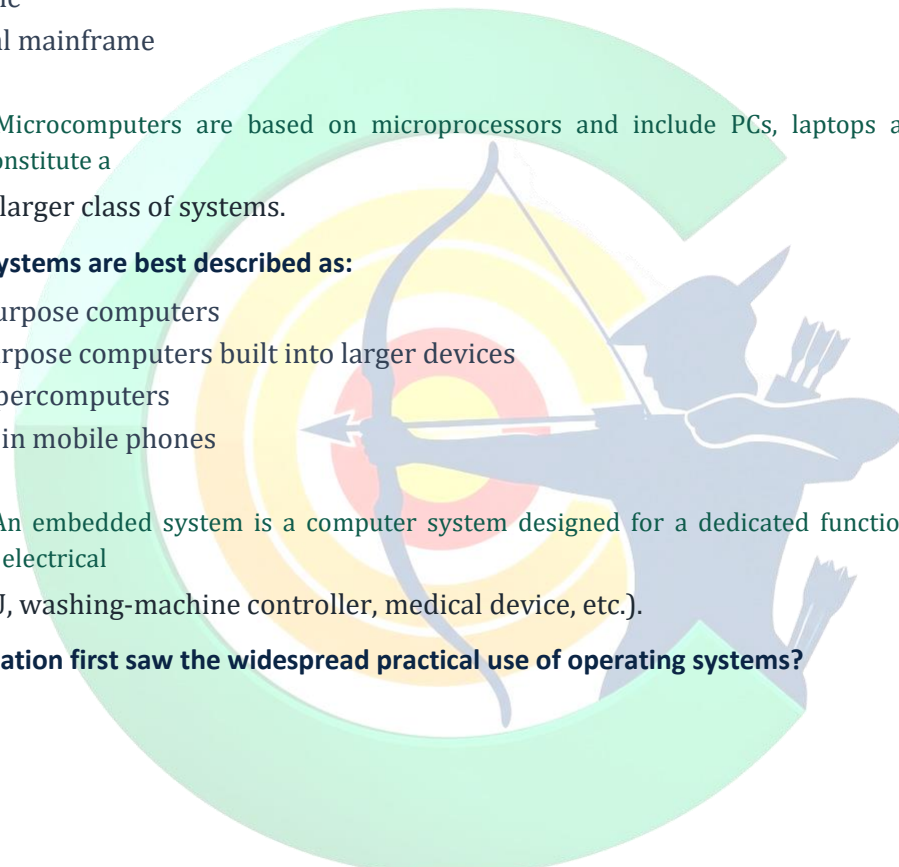
and widespread in the third generation with the advent of integrated circuits.

20. The PARAM series of supercomputers was developed in:

- a) USA
- b) Japan
- c) India
- d) China

Answer: c

Explanation: PARAM is an indigenous series of supercomputers developed by the Centre for Development of Advanced Computing



(C-DAC), India.

21. Which of the following statements is correct?

- a) All analog computers are digital
- b) All digital computers are analog
- c) Hybrid computers combine features of both analog and digital computers
- d) Supercomputers cannot be digital

Answer: c

Explanation: Hybrid computers incorporate both analog and digital components. The other statements are factually incorrect.

22. Jacquard's loom is historically important in computing because it:

- a) Used electricity
- b) Introduced the idea of punched cards for controlling a machine
- c) Was the first electronic computer
- d) Used vacuum tubes

Answer: b

Explanation: The punched-card control mechanism of the Jacquard loom (1801) inspired later data-processing and programming

concepts, including those used by Hollerith and Babbage.

23. UNIVAC I is significant because it was:

- a) The first electronic computer
- b) The first commercially available computer in the United States
- c) The first transistorised computer
- d) The first supercomputer

Answer: b

Explanation: UNIVAC I (1951) was the first commercially produced computer in the United States. ENIAC was earlier but not

commercial; transistors came later.

24. Which of the following is a characteristic of the fourth generation?

- a) Vacuum tubes
- b) Magnetic core memory as the dominant primary technology
- c) Microprocessors and personal computers
- d) Exclusive use of batch processing

Answer: c

Explanation: The microprocessor enabled the personal-computer revolution that defines the fourth generation. Vacuum tubes and

pure magnetic-core dominance belong to earlier generations.

25. Time-sharing systems became practical during the:

- a) First generation
- b) Second generation
- c) Third generation
- d) Fifth generation

Answer: c



Explanation: Third-generation hardware (ICs) and software advances made interactive time-sharing feasible for multiple concurrent

users.

26. Which of the following pairs is correctly matched?

- a) First Generation – Transistors
- b) Second Generation – Integrated Circuits
- c) Third Generation – Microprocessors
- d) Fourth Generation – Microprocessors

Answer: d

Explanation: Fourth generation is defined by the microprocessor. First = vacuum tubes, Second = transistors, Third = ICs.

27. The binary number system is fundamental to:

- a) Analog computers only
- b) Digital computers
- c) Hybrid computers only
- d) Mechanical calculators only

Answer: b

Explanation: Digital computers represent and process data exclusively using binary digits (bits). Analog computers use continuous quantities.

28. Which of the following is NOT a characteristic of first-generation computers?

- a) Use of vacuum tubes
- b) High power consumption
- c) Use of high-level languages
- d) Large physical size

Answer: c

Explanation: First-generation computers were programmed in machine language only. High-level languages appeared in the second generation.

29. Workstations are typically:

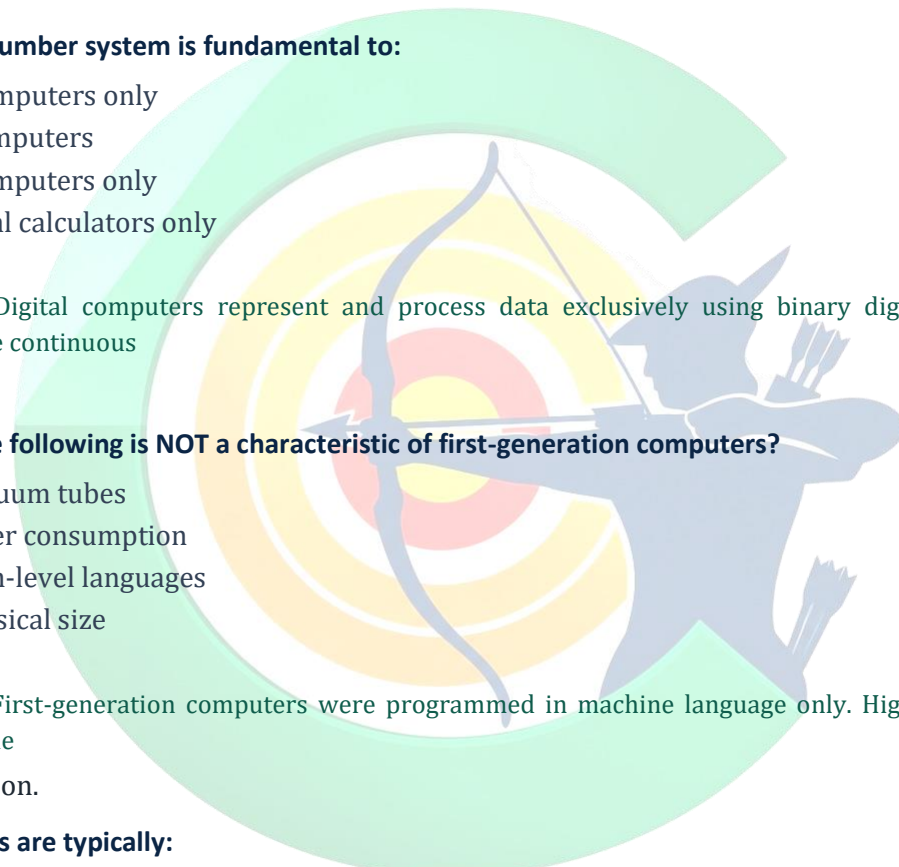
- a) Multi-user mainframes
- b) High-performance single-user computers for technical applications
- c) Embedded controllers
- d) Smartphones

Answer: b

Explanation: Workstations offer higher graphics and computational performance than ordinary PCs and are used for CAD, animation, scientific visualisation and similar technical workloads.

30. Which Indian supercomputer was ranked among the world's fastest AI systems around its launch period?

- a) PARAM Shivay
- b) AIRAWAT
- c) Pratyush



d) Mihir

Answer: b

Explanation: AIRAWAT, developed by C-DAC, was ranked among the top AI supercomputers globally when it appeared on relevant

international rankings.

31. Assertion (A): Second-generation computers were more reliable than first-generation computers.

Reason (R):

Transistors generated less heat and were more durable than vacuum tubes.

- a) Both A and R are true and R is the correct explanation of A
- b) Both A and R are true but R is not the correct explanation of A
- c) A is true but R is false
- d) A is false but R is true

Answer: a

Explanation: Both statements are true. The lower heat dissipation and greater durability of transistors directly explain the improved

reliability and reduced downtime of second-generation machines.

32. Match List-I with List-II and select the correct answer: List-I (Device) List-II (Inventor/Designer) A. Pascaline 1.

Charles Babbage B. Analytical Engine 2. Herman Hollerith C. Tabulating Machine 3. Blaise Pascal D. Difference

Engine 4. (same designer as Analytical Engine)

- a) A-3, B-1, C-2, D-1
- b) A-1, B-3, C-2, D-1
- c) A-3, B-2, C-1, D-1
- d) A-2, B-1, C-3, D-1

Answer: a

Explanation: Pascaline was invented by Blaise Pascal; both the Analytical Engine and Difference Engine were designed by Charles

Babbage; the Tabulating Machine was invented by Herman Hollerith.

33. Which of the following statements about microcomputers is correct?

- a) They always require a specialised air-conditioned environment
- b) They are based on microprocessor technology
- c) They cannot be used for networking
- d) They belong exclusively to the third generation

Answer: b

Explanation: The defining feature of microcomputers is the use of a microprocessor as the central processing unit. They do not

require special environments and are fully network-capable.

34. The term "generation" in the context of computers primarily refers to:

- a) The year of manufacture
- b) The underlying hardware technology, especially the switching device

- c) The programming language used
- d) The size of the primary memory

Answer: b

Explanation: Generational classification is based mainly on the technology of the switching and memory devices (vacuum tube →

transistor → IC → microprocessor → AI/parallel systems).

35. Which of the following is an example of a special-purpose computer?

- a) A laptop used for multiple office applications
- b) A desktop PC in a government office
- c) The computer controlling fuel injection in a modern car
- d) A mainframe handling citizen databases

Answer: c

Explanation: Automotive engine-control units are classic embedded, special-purpose computers designed for one dedicated task.

The others are general-purpose systems.

36. Which of the following correctly describes the Analytical Engine?

- a) It was a fully working electronic computer
- b) It was a mechanical general-purpose programmable machine design
- c) It used vacuum tubes
- d) It was invented by Herman Hollerith

Answer: b

Explanation: The Analytical Engine was a mechanical design for a general-purpose programmable computer. It was never

completed in Babbage's lifetime and was not electronic.

37. Magnetic core memory was predominantly used in which generation?

- a) First
- b) Second
- c) Fourth
- d) Fifth

Answer: b

Explanation: Magnetic core memory was the standard main memory technology of the second generation and continued into the

early third generation before semiconductor memory took over.

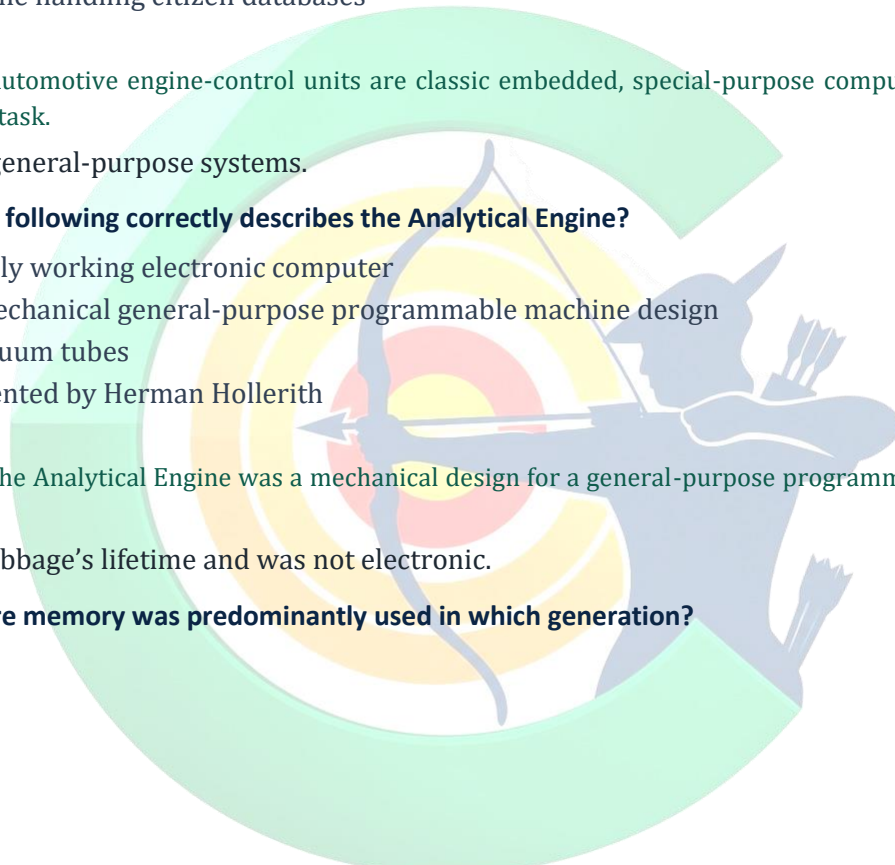
38. Which language is associated with the second generation of computers?

- a) Machine language only
- b) Assembly language and early high-level languages such as FORTRAN
- c) Only object-oriented languages
- d) Only Java and Python

Answer: b

Explanation: Second-generation machines used assembly language extensively and saw the birth of the first high-level languages

(FORTRAN, COBOL).



39. The invention of the integrated circuit is credited primarily to:

- a) William Shockley alone
- b) Jack Kilby and Robert Noyce
- c) Gordon Moore alone
- d) Charles Babbage

Answer: b

Explanation: Jack Kilby (Texas Instruments) and Robert Noyce (Fairchild) independently developed the integrated circuit in

1958–59, enabling the third generation.

40. Which of the following is true regarding fifth-generation computing goals?

- a) Exclusive reliance on vacuum-tube technology
- b) Machines capable of learning, reasoning and natural-language interaction
- c) Elimination of all software
- d) Return to pure batch processing

Answer: b

Explanation: The fifth-generation vision centres on artificial intelligence, knowledge processing, parallel architectures and

natural-language interfaces.

41. A computer that processes both continuous and discrete data is called a:

- a) Analog computer
- b) Digital computer
- c) Hybrid computer
- d) Supercomputer

Answer: c

Explanation: Hybrid computers combine analog and digital techniques to handle both continuous and discrete data within the same

system.

42. Which of the following statements about mainframes is correct?

- a) They are primarily single-user systems
- b) They are designed for very high volume of simultaneous transactions and data throughput
- c) They are the same as smartphones
- d) They cannot run operating systems

Answer: b

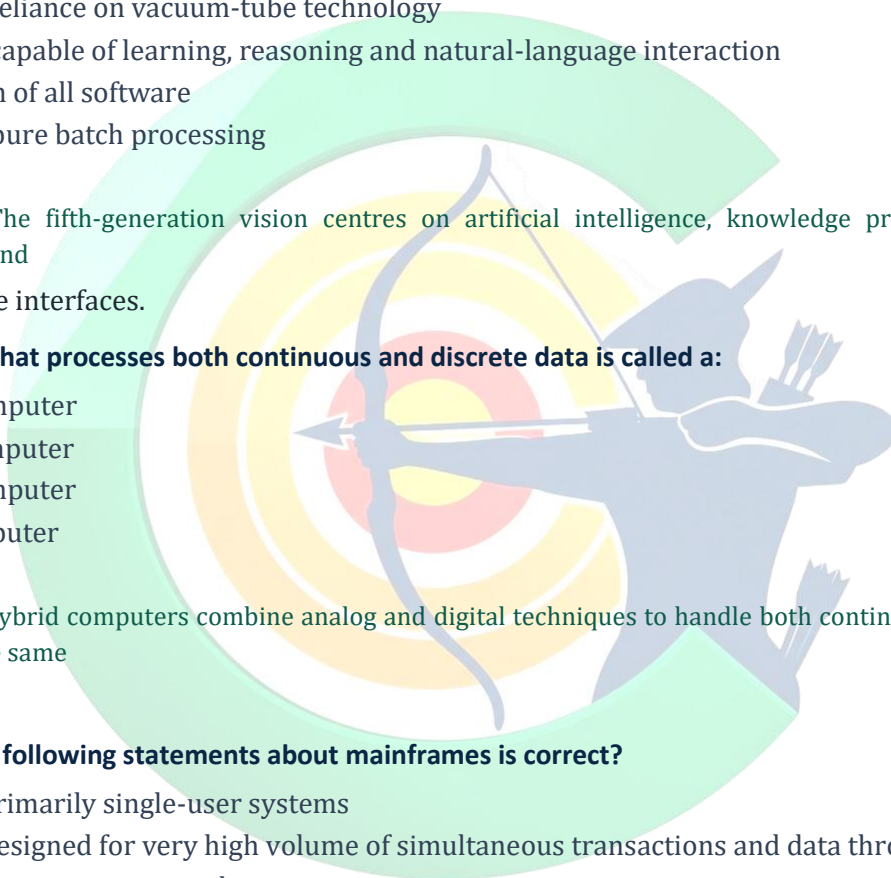
Explanation: Mainframes are optimised for extreme reliability, security and throughput in multi-user, high-transaction environments

such as banking and government record systems.

43. The first practical stored-program computer is generally considered to be:

- a) ENIAC
- b) EDSAC
- c) Pascaline
- d) Analytical Engine

Answer: b



Explanation: EDSAC (1949) at Cambridge is widely recognised as the first practical stored-program electronic computer. ENIAC

was not stored-program; the earlier machines were mechanical or non-stored-program.

44. Which generation is associated with the emergence of personal computers?

- a) Second
- b) Third
- c) Fourth
- d) First

Answer: c

Explanation: The fourth generation, enabled by the microprocessor, saw the birth and mass adoption of personal computers (Apple

II, IBM PC and successors).

45. Ada Lovelace is known as the first computer programmer because she:

- a) Built the first electronic computer
- b) Wrote the first algorithm intended to be processed by a machine
- c) Invented the transistor
- d) Designed the UNIVAC

Answer: b

Explanation: Her notes on Babbage's Analytical Engine contained the first published description of an algorithm specifically

intended for machine execution.

46. Which of the following is NOT typically classified as a microcomputer?

- a) Tablet computer
- b) Smartphone
- c) Traditional mainframe system
- d) Laptop computer

Answer: c

Explanation: Tablets, smartphones and laptops are all microprocessor-based microcomputers. Mainframes form a distinct and

much larger class.

47. The primary reason second-generation computers were smaller and more reliable than first-generation machines

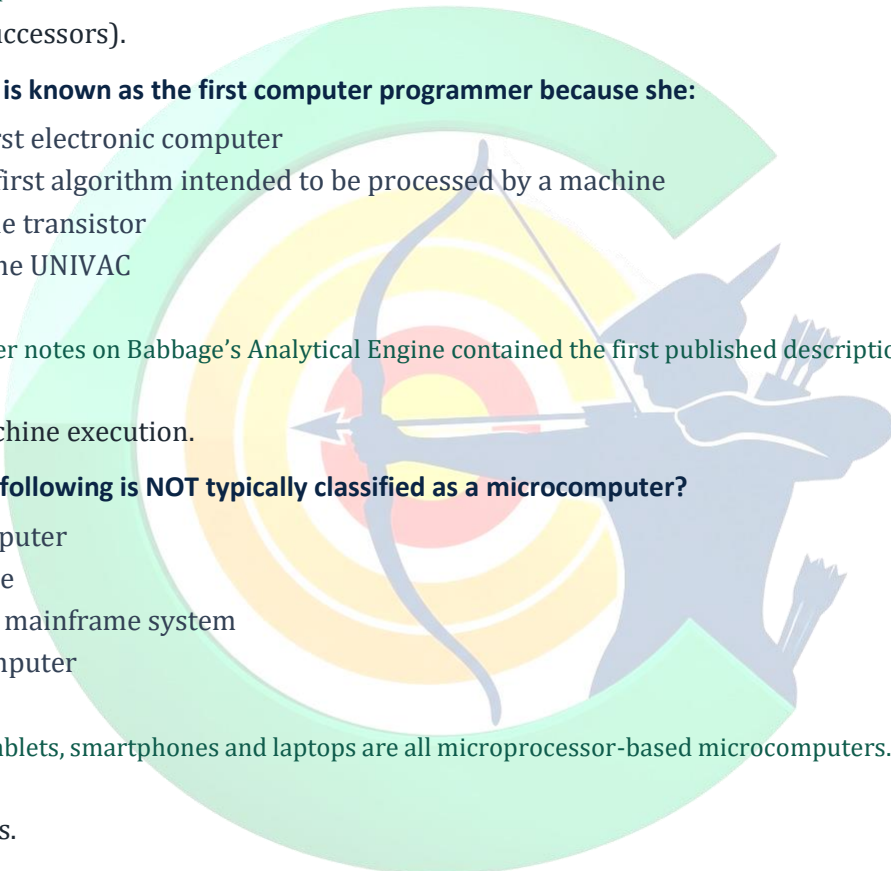
was the replacement of:

- a) Magnetic drums by punched cards
- b) Vacuum tubes by transistors
- c) Transistors by integrated circuits
- d) Machine language by natural language

Answer: b

Explanation: The shift from fragile, heat-producing vacuum tubes to solid-state transistors produced dramatic improvements in size,

power consumption and reliability.



48. Which of the following best describes a server?

- a) A computer dedicated to providing services to other computers over a network
- b) A single-user gaming machine only
- c) An analog-only calculating device
- d) A mechanical calculator

Answer: a

Explanation: A server is a computer (or system) whose primary role is to supply data, resources or services to client machines

across a network.

49. In the context of computer generations, VLSI technology is most closely associated with the:

- a) First generation
- b) Second generation
- c) Third generation
- d) Fourth generation and beyond

Answer: d

Explanation: Very Large Scale Integration (VLSI) enabled the dense microprocessors of the fourth generation and continues to

underpin later developments including fifth-generation systems.

50. Which of the following statements is correct regarding the classification of computers by purpose?

- a) All computers are special-purpose by definition
- b) General-purpose computers can perform a wide variety of tasks while special-purpose computers are designed for one specific

function

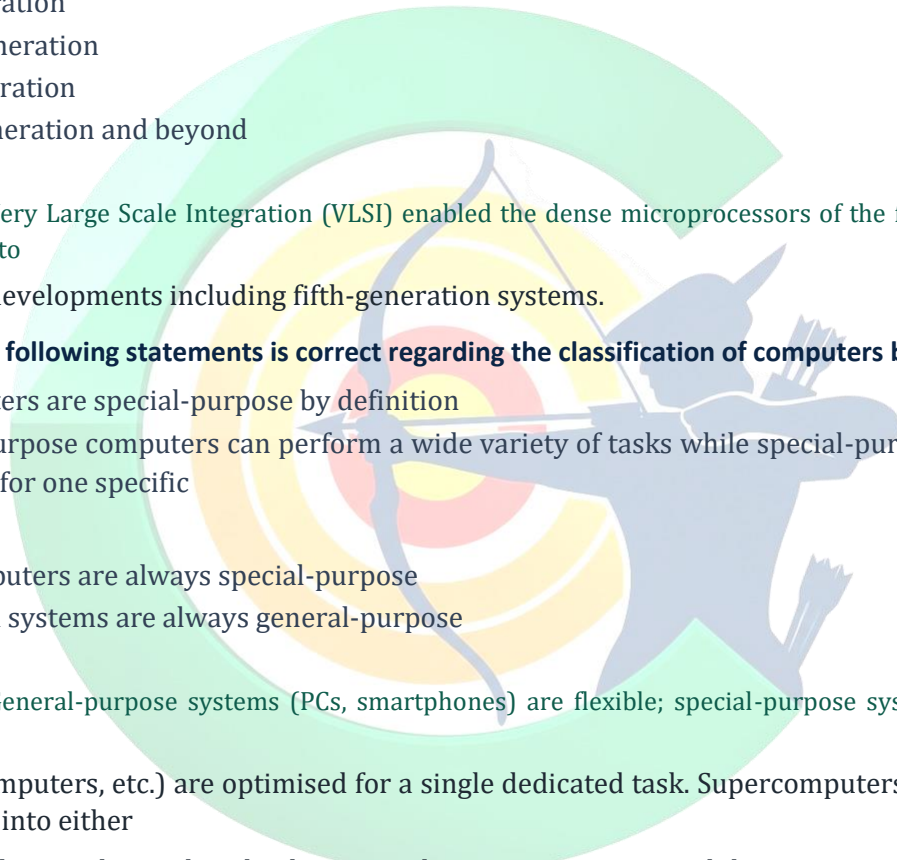
- c) Supercomputers are always special-purpose
- d) Embedded systems are always general-purpose

Answer: b

Explanation: General-purpose systems (PCs, smartphones) are flexible; special-purpose systems (embedded controllers,

traffic-signal computers, etc.) are optimised for a single dedicated task. Supercomputers and embedded systems can fall into either

category depending on design, but the distinction by purpose remains valid.



Chapter 2

Computer Hardware and Memory

FIGURE 2.2 · Photo plate

CHART 2.A · Memory hierarchy (speed vs capacity)

Level	Example	Speed	Capacity	Volatility
Registers	Inside CPU	Fastest	Bytes–KB	Volatile
Cache	L1 / L2 / L3	Very fast	KB–MB	Volatile
Primary	RAM	Fast	GB	Volatile
Secondary	SSD / HDD	Slower	GB–TB	Non-volatile
Tertiary / archive	Tape / cold store	Slowest	TB–PB	Non-volatile



2.1 2026 Update

2026 Update

The 32-bit address-bus example is qualified as assuming byte-addressable memory.

DMA, interrupts, cache locality and the von Neumann bottleneck are stated with exam-safe distinctions. Modern CPUs are noted as often using modified-Harvard cache organisation over a von Neumann main-memory model.

Single shared memory for both instructions (program) and data.

Single shared bus between CPU and memory (the von Neumann bottleneck).

Sequential instruction execution: Fetch → Decode → Execute.

Used in almost all general-purpose PCs, servers and mainframes.

Separate memories and buses for instructions and data.

Allows simultaneous access to instruction and data, improving throughput.

Common in microcontrollers, DSPs and many embedded systems.

2.2 Program Counter (PC / Instruction Pointer):

Holds the address of the next instruction to be fetched.

- Instruction Register (IR): Holds the current instruction being executed.
- Accumulator: Holds intermediate results of ALU operations (in simpler architectures).
- General-Purpose Registers: Used for temporary data storage and arithmetic.
- Status / Flag Register: Holds condition codes (Zero, Carry, Overflow, Sign, etc.).
- Memory Address Register (MAR) and Memory Data Register (MDR / MBR): Interface with main memory.

Mnemonic for key registers — P-I-A-S-M

Program Counter • Instruction Register • Accumulator / GPRs • Status Flags • MAR/MDR

2.2.2 Instruction Cycle (Machine Cycle)

The basic sequence of operations performed by the CPU for every instruction is called the instruction cycle (or machine

cycle): 1. Fetch — The address in the Program Counter is placed on the address bus; the instruction is read from memory

into the Instruction Register; PC is incremented. 2. Decode — The Control Unit examines the instruction and determines

the required operation and operands. 3. Execute — The ALU or other units perform the operation; results may be written

back to registers or memory. Some instructions also involve an explicit Write-back or Store stage. Modern CPUs use

pipelining to overlap these stages for multiple instructions.

Instruction Cycle Flow

Fetch → Decode → Execute (→ Write-back) → next Fetch ...

UPSC TRAP — Clock Speed vs Performance

A common trap is to equate higher clock speed (GHz) automatically with higher performance. Real performance also

depends on CPI (Cycles Per Instruction), number of cores, cache size, architecture efficiency, and workload. Two CPUs

with the same clock can differ dramatically in actual speed.

2.2.3 CPU Performance Indicators

- Clock Speed (GHz): Number of cycles per second.
- CPI (Cycles Per Instruction): Average number of clock cycles required per instruction.
- MIPS (Million Instructions Per Second) and FLOPS (Floating-point Operations Per Second).
- Number of cores / threads and support for parallel execution.
- Cache size and hierarchy effectiveness.

2.3 Memory Hierarchy

No single memory technology is simultaneously fast, large and cheap. Therefore computers use a hierarchy of memory

technologies that trades off speed, capacity and cost. Data that is needed

most frequently is kept in the fastest (and most expensive) levels; less frequently used data resides further down the

hierarchy.

The Classic Memory Hierarchy (fastest slowest)

1. CPU Registers — Fastest, smallest, most expensive (inside the CPU). 2. Cache Memory (L1 → L2 → L3) — Very fast

SRAM, small to medium size. 3. Main Memory (RAM) — DRAM, larger capacity, slower than cache. 4. Secondary Storage

(SSD / HDD) — Non-volatile, large capacity, much slower. 5. Tertiary / Offline Storage (optical, tape, cloud cold storage) —

Archival.

Mnemonic — R-C-R-S-T

Registers → Cache → RAM → Secondary → Tertiary

2.3.1 Cache Memory

Cache is a small, high-speed memory (usually SRAM) that stores copies of frequently used data and instructions from

main memory. It exploits the principles of temporal locality (recently used data is likely to be used again) and spatial locality

(nearby data is likely to be used soon).

- L1 Cache: Smallest and fastest; often split into Instruction cache (I-cache) and Data cache (D-cache); located on the CPU die.
- L2 Cache: Larger, slightly slower; may be per-core or shared.
- L3 Cache: Still larger, shared among cores on modern multi-core processors.

A cache hit occurs when the required data is found in cache; a cache miss forces a fetch from a lower (slower) level.

2.3.2 Primary Memory — RAM and ROM

RAM (Random Access Memory) — Volatile; contents are lost when power is removed. Used as the main working memory.

- SRAM (Static RAM): Faster, more expensive, used for cache. Does not need periodic refreshing.
- DRAM (Dynamic RAM): Slower, cheaper, higher density, used for main memory. Needs constant refreshing.

SRAM vs DRAM — Comparative Table

Parameter	SRAM	DRAM	Full Form	Static Random Access Memory	Dynamic Random Access Memory
Speed	Faster	Slower			

Cost	More expensive	Cheaper	Density	Lower (larger cell)	Higher (smaller cell)
Refresh	Not required	Required			

Typical Use	Cache memory (L1/L2/L3)	Main system memory (RAM)	Power	Higher (static)	Lower (when idle)
-------------	-------------------------	--------------------------	-------	-----------------	-------------------

after refresh) Volatility Volatile Volatile ROM (Read-Only Memory) — Non-volatile; retains contents without power. Used to

store firmware/BIOS/UEFI.

- PROM: Programmable once by the user.
- EPROM: Erasable by ultraviolet light, then reprogrammable.
- EEPROM: Electrically erasable and reprogrammable (byte-level).
- Flash Memory: A form of EEPROM that is erased/written in blocks; used in SSDs, USB drives, mobile storage.

UPSC TRAP — RAM is volatile — ROM is not

A classic trap question: “Which memory loses its contents when power is switched off?” Answer is RAM (both SRAM and

DRAM). ROM, Flash, SSD and HDD retain data. Candidates sometimes confuse ‘read-only’ with ‘non-volatile’ or think

Flash is a type of RAM.

2.3.3 Secondary Storage

Non-volatile, high-capacity storage used for programs, data and the operating system when not in active use.

- Hard Disk Drives (HDD): Magnetic storage, mechanical, large capacity, relatively slow, lower cost per GB.
- Solid State Drives (SSD): Flash-based, no moving parts, much faster, more expensive per GB, increasingly standard.
- Optical media (CD/DVD/Blu-ray) and magnetic tape for archival/backup.
- USB Flash drives and memory cards.

2.4 System Bus and Interconnection

A bus is a shared communication pathway that connects the CPU, memory and I/O devices. The classic system bus

consists of three groups of lines:

- Data Bus: Carries actual data between components. Width (8, 16, 32, 64-bit...) determines how much data can be transferred at once.
- Address Bus: Carries memory addresses. Width determines the maximum addressable memory space (e.g., 32-bit address bus → 4 GB).
- Control Bus: Carries control signals (read/write, interrupt, clock, bus request/grant, etc.).

Mnemonic — D-A-C

Data Bus • Address Bus • Control Bus

2.5 Input / Output (I/O) Devices

I/O devices allow the computer to communicate with the external world and with secondary storage. They are broadly

classified as input devices, output devices and storage devices (already covered under secondary storage).

2.5.1 Input Devices

Devices that feed data or control signals into the computer:

- Keyboard, Mouse, Trackpad, Touch screen, Stylus
- Scanner, Barcode / QR reader, OCR devices
- Microphone, Webcam, Digital camera
- Joystick, Game controllers, Biometric sensors (fingerprint, iris, face)
- Sensors (temperature, pressure, GPS, accelerometers) in embedded and IoT systems

2.5.2 Output Devices

Devices that present results or information from the computer:

- Monitor / Display (LCD, LED, OLED), Projector

- Printer (Impact: Dot-matrix; Non-impact: Inkjet, Laser, Thermal)
- Speakers, Headphones, Plotters
- Actuators and control signals in industrial / embedded systems

2.5.3 I/O Techniques (Conceptual)

How the CPU communicates with I/O devices:

- Programmed I/O: CPU continuously polls the device status (busy-wait). Simple but wastes CPU cycles.
- Interrupt-driven I/O: Device interrupts the CPU when ready. More efficient.
- Direct Memory Access (DMA): A DMA controller transfers data directly between memory and device without continuous CPU involvement. Essential for high-speed devices (disk, network).

UPSC TRAP — DMA vs Interrupt

Many candidates confuse DMA with interrupts. Interrupts notify the CPU that a device needs attention; the CPU still

performs or manages the transfer. DMA allows the device (via the DMA controller) to move data to/from memory with

minimal CPU intervention, freeing the CPU for other work.

2.6 Ports, Interfaces and Modern Connectors

Ports provide physical and logical interfaces between the computer and external devices.

- USB (Universal Serial Bus): Dominant interface for peripherals; supports hot-plugging and multiple speeds (USB 2.0, 3.x, 4).
- HDMI / DisplayPort: Digital video/audio output.
- Ethernet (RJ-45): Wired network connectivity.
- Audio jacks, SD card slots, Thunderbolt, legacy ports (serial, parallel — now rare).
- Wireless: Wi-Fi, Bluetooth, NFC.

2.7 Summary

Computer architecture defines how the CPU, memory and I/O subsystems are organised and communicate. The CPU

(ALU + Control Unit + Registers) executes instructions through the Fetch–Decode–Execute cycle. The memory hierarchy

(Registers → Cache → RAM → Secondary storage) balances speed, capacity and cost. I/O devices and techniques

(programmed, interrupt-driven, DMA) enable interaction with the external world. A solid conceptual understanding of these

elements is indispensable for answering both direct and analytical questions in UPSC-level examinations.

CHAPTER 2 — 50 HIGH-STANDARD MCQs

UPSC / DRDO SAO / EPFO / ESIC / GSI AO Level • Correct answer and focused explanation provided for every question.

1. The architecture in which instructions and data share the same memory and bus is known as:

- a) Harvard architecture
- b) von Neumann architecture
- c) Parallel architecture
- d) Quantum architecture

Answer: b

Explanation: Von Neumann architecture uses a single shared memory for both instructions and data and a common bus. Harvard

architecture keeps them separate. Parallel and quantum are different paradigms.

2. Which of the following is a key disadvantage of the pure von Neumann architecture?

- a) Separate buses for data and instructions
- b) The von Neumann bottleneck caused by the shared bus
- c) Inability to use registers
- d) Absence of an ALU

Answer: b

Explanation: Because instructions and data share the same bus, the CPU cannot fetch an instruction and data simultaneously,

creating the classic von Neumann bottleneck. The other options are incorrect descriptions.

3. The Arithmetic Logic Unit (ALU) is primarily responsible for:

- a) Storing the next instruction address
- b) Performing arithmetic and logical operations
- c) Managing input/output devices directly
- d) Providing long-term non-volatile storage

Answer: b

Explanation: The ALU executes arithmetic (add, subtract, etc.) and logical (AND, OR, comparisons) operations. The Program

Counter stores the next instruction address; I/O is handled by other subsystems; storage is the role of memory.

4. The register that holds the address of the next instruction to be fetched is the:

- a) Instruction Register (IR)
- b) Program Counter (PC)
- c) Accumulator
- d) Memory Data Register (MDR)

Answer: b

Explanation: The Program Counter (also called Instruction Pointer) contains the address of the next instruction. IR holds the current

instruction; Accumulator holds intermediate results; MDR holds data being transferred to/from memory.

5. The basic instruction cycle consists of which sequence?

- a) Execute → Fetch → Decode
- b) Fetch → Decode → Execute
- c) Decode → Execute → Fetch
- d) Store → Fetch → Execute

Answer: b

Explanation: The fundamental sequence is Fetch (bring instruction from memory), Decode (interpret it), Execute (perform the operation). Other orders are incorrect.

6. Which component of the CPU generates the control signals that coordinate the activities of other units?

- a) ALU
- b) Control Unit
- c) Cache
- d) System bus

Answer: b

Explanation: The Control Unit decodes instructions and issues control signals to the ALU, registers, memory and I/O. The ALU performs calculations; cache and bus are not control generators.

7. Cache memory is usually implemented using:

- a) DRAM
- b) SRAM
- c) Magnetic disks
- d) Optical media

Answer: b

Explanation: Cache requires very high speed, so it is built from SRAM. DRAM is used for main memory; disks and optical media are secondary storage.

8. Which level of cache is typically the smallest and fastest and is often split into instruction and data caches?

- a) L3 cache
- b) L2 cache
- c) L1 cache
- d) Main memory

Answer: c

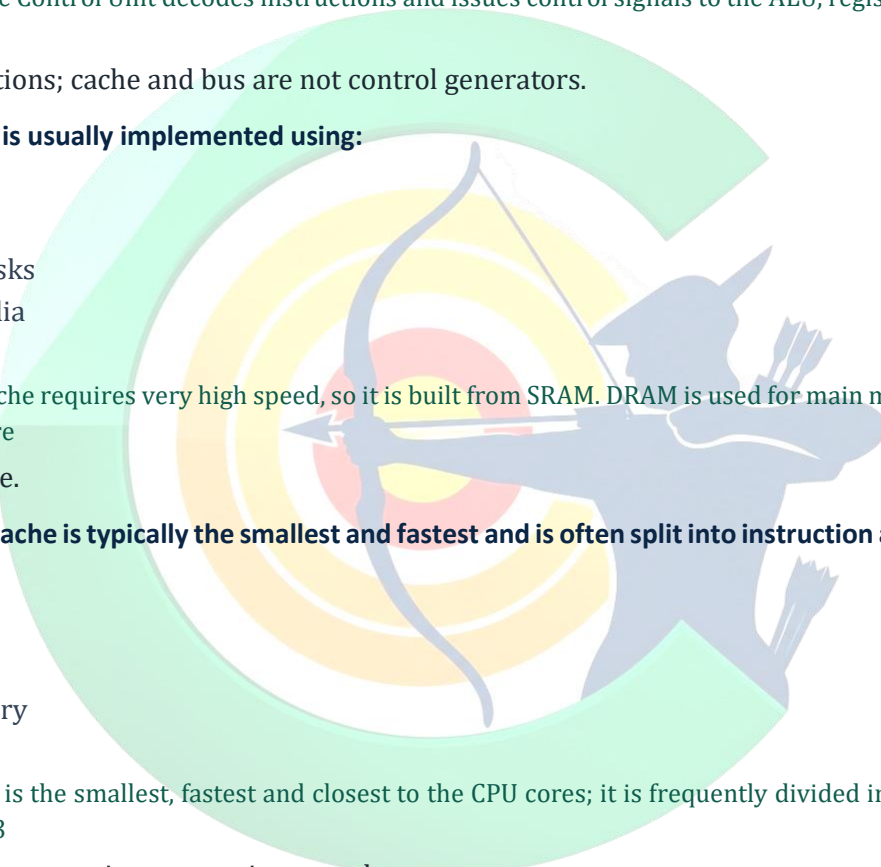
Explanation: L1 is the smallest, fastest and closest to the CPU cores; it is frequently divided into I-cache and D-cache. L2 and L3 are larger and slower; main memory is not cache.

9. The principle that 'recently accessed data is likely to be accessed again soon' is called:

- a) Spatial locality
- b) Temporal locality
- c) Sequential locality
- d) Random locality

Answer: b

Explanation: Temporal locality refers to the reuse of the same data/instructions in a short time window. Spatial locality refers to the likelihood of accessing nearby addresses.



10. Which of the following statements about SRAM and DRAM is correct?

- a) SRAM needs periodic refreshing; DRAM does not
- b) DRAM is faster and more expensive than SRAM
- c) SRAM is faster and more expensive; used mainly for cache
- d) Both are non-volatile

Answer: c

Explanation: SRAM is faster, costlier and does not need refreshing; it is used for cache. DRAM is denser and cheaper, needs

refreshing, and forms main memory. Both are volatile.

11. Main memory (RAM) in modern computers is predominantly:

- a) SRAM
- b) DRAM
- c) ROM
- d) Flash only

Answer: b

Explanation: System main memory is almost always DRAM because of its high density and lower cost. SRAM is reserved for

caches; ROM and Flash serve different non-volatile roles.

12. Which type of memory retains its contents even when power is switched off?

- a) SRAM
- b) DRAM
- c) ROM / Flash
- d) Cache only

Answer: c

Explanation: ROM and Flash (a form of EEPROM) are non-volatile. SRAM, DRAM and ordinary cache lose their contents when

power is removed.

13. EEPROM differs from EPROM mainly in that:

- a) EEPROM can be erased electrically while EPROM requires ultraviolet light
- b) EEPROM is volatile
- c) EPROM is faster than DRAM
- d) EEPROM cannot be reprogrammed

Answer: a

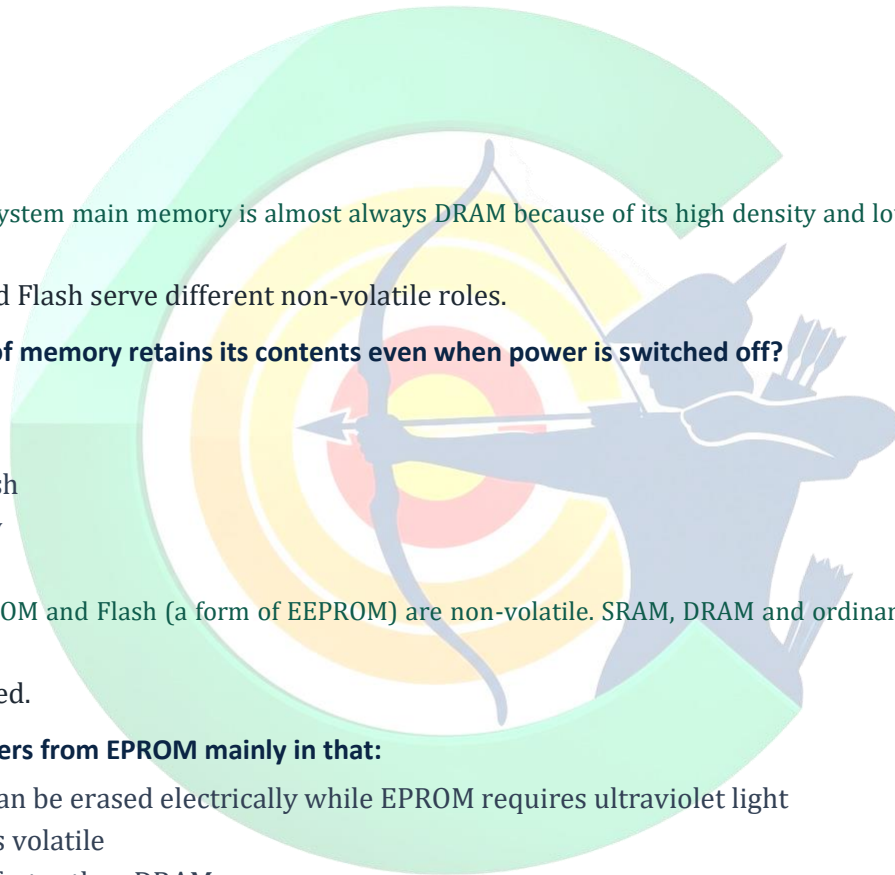
Explanation: EPROM is erased by exposure to UV light; EEPROM (and Flash) can be erased and reprogrammed electrically,

making them far more convenient.

14. The memory hierarchy is ordered from fastest/smallest to slowest/largest as:

- a) RAM → Cache → Registers → HDD
- b) Registers → Cache → RAM → Secondary storage
- c) HDD → RAM → Cache → Registers
- d) Cache → Registers → SSD → RAM

Answer: b



Explanation: The standard hierarchy is Registers (fastest) → Cache → Main memory (RAM) → Secondary storage.
Any other order

is incorrect.

15. A 'cache hit' means:

- a) The required data is not found in cache and must be fetched from main memory
- b) The required data is found in the cache
- c) The cache is full and must be emptied
- d) The CPU has halted

Answer: b

Explanation: A cache hit occurs when the requested item is present in the cache. A miss occurs when it is not present and must be

retrieved from a lower level.

16. The width of the address bus primarily determines:

- a) The speed of the CPU
- b) The maximum amount of memory that can be addressed
- c) The number of cores
- d) The size of the cache

Answer: b

Explanation: An n-bit address bus can address 2^n distinct memory locations. Clock speed, core count and cache size are

independent parameters.

17. The three main components of a system bus are:

- a) Data bus, Address bus, Control bus
- b) Input bus, Output bus, Memory bus
- c) Serial bus, Parallel bus, USB bus
- d) Cache bus, RAM bus, Disk bus

Answer: a

Explanation: The classic system bus comprises the Data bus (actual data), Address bus (locations) and Control bus (signals). The

other groupings are not standard.

18. Direct Memory Access (DMA) is used to:

- a) Allow the CPU to execute two instructions simultaneously
- b) Transfer data between memory and I/O devices with minimal CPU intervention
- c) Increase the clock speed of the processor
- d) Convert analog signals to digital

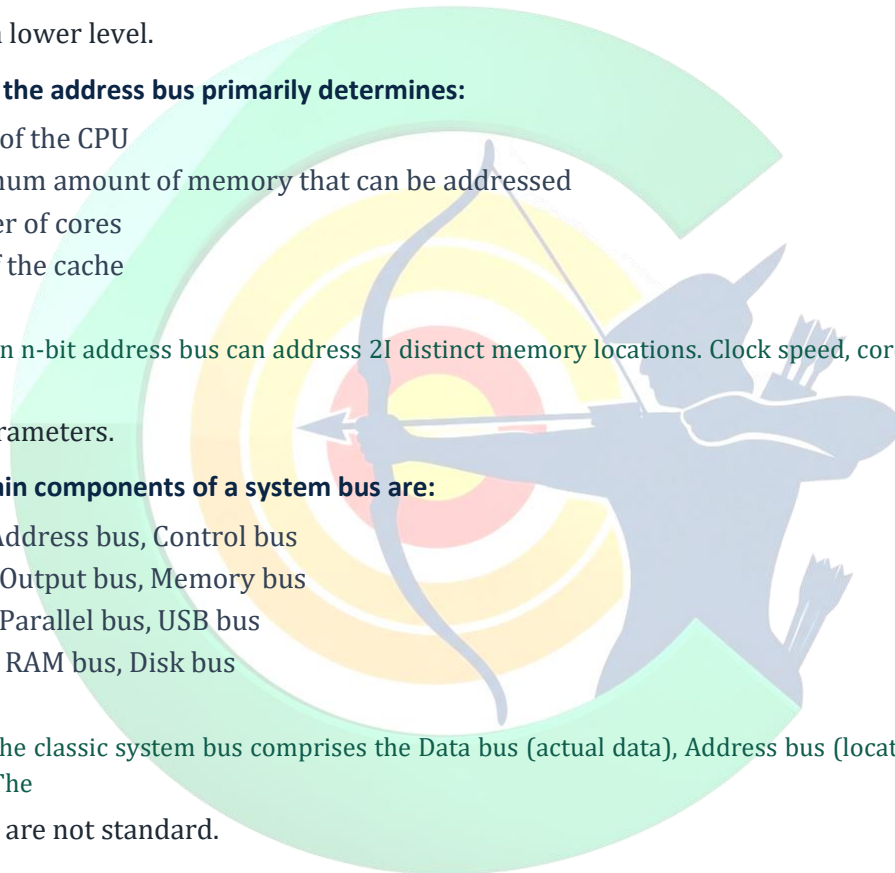
Answer: b

Explanation: DMA enables high-speed devices to read/write memory directly via a DMA controller, freeing the CPU from

byte-by-byte transfers.

19. In programmed I/O (polling):

- a) The device interrupts the CPU when ready



- b) The CPU continuously checks the device status
- c) A DMA controller handles the entire transfer
- d) No software is involved

Answer: b

Explanation: Programmed I/O requires the CPU to poll the device repeatedly. Interrupt-driven I/O lets the device signal the CPU;

DMA offloads the transfer itself.

20. Which of the following is an input device?

- a) Monitor
- b) Printer
- c) Scanner
- d) Speaker

Answer: c

Explanation: A scanner feeds data into the computer and is therefore an input device. Monitor, printer and speaker are output

devices.

21. Which printer type is classified as an impact printer?

- a) Laser printer
- b) Inkjet printer
- c) Dot-matrix printer
- d) Thermal printer

Answer: c

Explanation: Dot-matrix printers strike an inked ribbon against paper (impact). Laser, inkjet and thermal printers are non-impact.

22. The Program Counter is incremented during which phase of the instruction cycle?

- a) Execute only
- b) Fetch
- c) Decode only
- d) After the entire program finishes

Answer: b

Explanation: During the Fetch phase the instruction is read and the Program Counter is normally incremented to point to the next

sequential instruction.

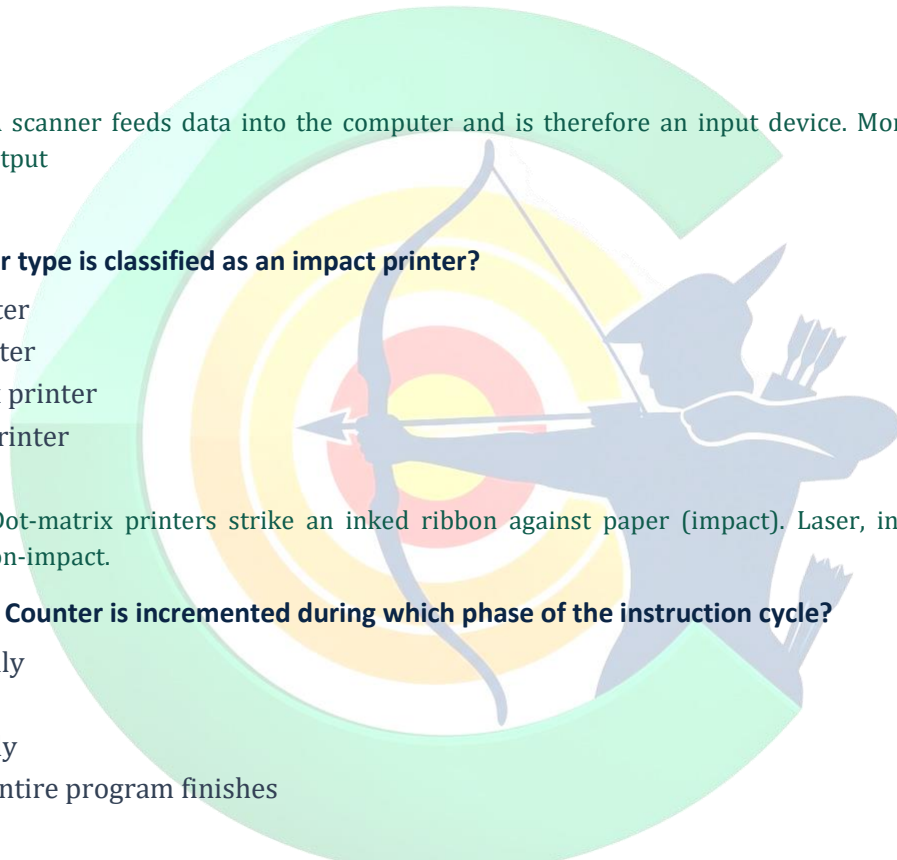
23. Which of the following best describes the role of the Memory Address Register (MAR)?

- a) It holds the data being transferred to or from memory
- b) It holds the address of the memory location to be accessed
- c) It stores the result of ALU operations
- d) It keeps the current instruction

Answer: b

Explanation: MAR contains the address that is placed on the address bus. MDR/MBR holds the data; the Accumulator or GPRs

hold ALU results; IR holds the instruction.



24. Pipelining in a CPU is a technique that:

- a) Increases the physical size of registers
- b) Overlaps the execution stages of multiple instructions
- c) Eliminates the need for cache
- d) Makes memory non-volatile

Answer: b

Explanation: Pipelining divides the instruction cycle into stages and allows different instructions to be in different stages

simultaneously, improving throughput.

25. Which of the following is non-volatile storage?

- a) CPU registers
- b) L1 cache
- c) SSD / Flash memory
- d) DRAM main memory

Answer: c

Explanation: SSD and Flash retain data without power. Registers, cache and DRAM are volatile.

26. The term 'CPI' in CPU performance stands for:

- a) Cycles Per Instruction
- b) Clock Performance Index
- c) Central Processing Indicator
- d) Cache Performance Indicator

Answer: a

Explanation: CPI (Cycles Per Instruction) measures the average number of clock cycles required to execute an instruction. Lower

CPI generally indicates better efficiency.

27. Harvard architecture is commonly found in:

- a) Most desktop personal computers
- b) Many microcontrollers and digital signal processors
- c) Only quantum computers
- d) Magnetic tape drives

Answer: b

Explanation: Harvard (or modified Harvard) architectures with separate instruction and data memories are widely used in

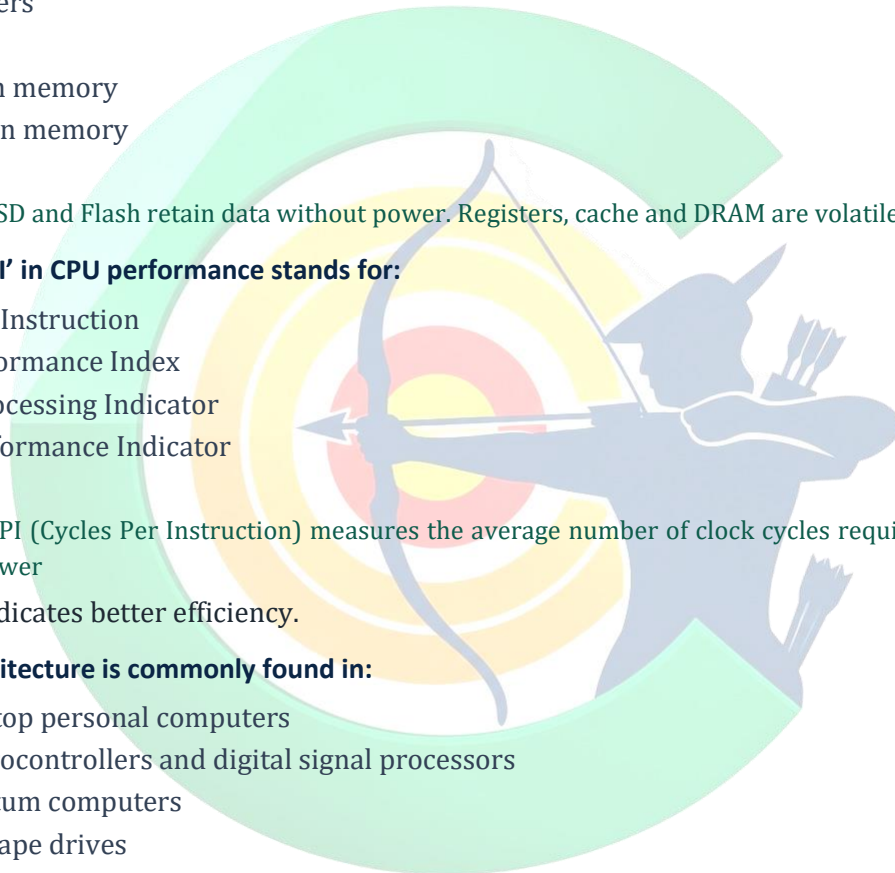
microcontrollers and DSPs. General-purpose PCs follow von Neumann (with cache refinements).

28. Which statement about secondary storage is correct?

- a) It is faster than cache memory
- b) It is volatile
- c) It provides large non-volatile capacity at lower cost per bit than RAM
- d) It is located inside the CPU die

Answer: c

Explanation: Secondary storage (HDD/SSD) offers large capacity and non-volatility at far lower cost per bit than RAM or cache; it is



slower and external to the CPU.

29. An interrupt-driven I/O system is more efficient than programmed I/O because:

- a) The CPU never has to execute any instructions
- b) The CPU can perform other work until the device signals it is ready
- c) Interrupts eliminate the need for an operating system
- d) Devices become faster than the CPU

Answer: b

Explanation: With interrupts the CPU is free to execute other processes until the device raises an interrupt, avoiding continuous

polling.

30. Which of the following is a correct match?

- a) SRAM – main memory in servers
- b) DRAM – cache memory
- c) Flash – non-volatile solid-state storage
- d) ROM – temporary working storage for running programs

Answer: c

Explanation: Flash is non-volatile solid-state storage. SRAM is used for cache; DRAM for main memory; ROM holds firmware, not

temporary working data.

31. Assertion (A): Cache memory improves system performance. Reason (R): Cache stores frequently used data

closer to the CPU, reducing average memory access time.

- a) Both A and R true; R explains A
- b) Both A and R true; R does not explain A
- c) A true, R false
- d) A false, R true

Answer: a

Explanation: Both statements are true and R is the direct reason why cache improves performance (exploitation of locality).

32. The Control Bus carries:

- a) Only numerical data
- b) Memory addresses only
- c) Timing and control signals such as read/write and interrupts
- d) Only video signals

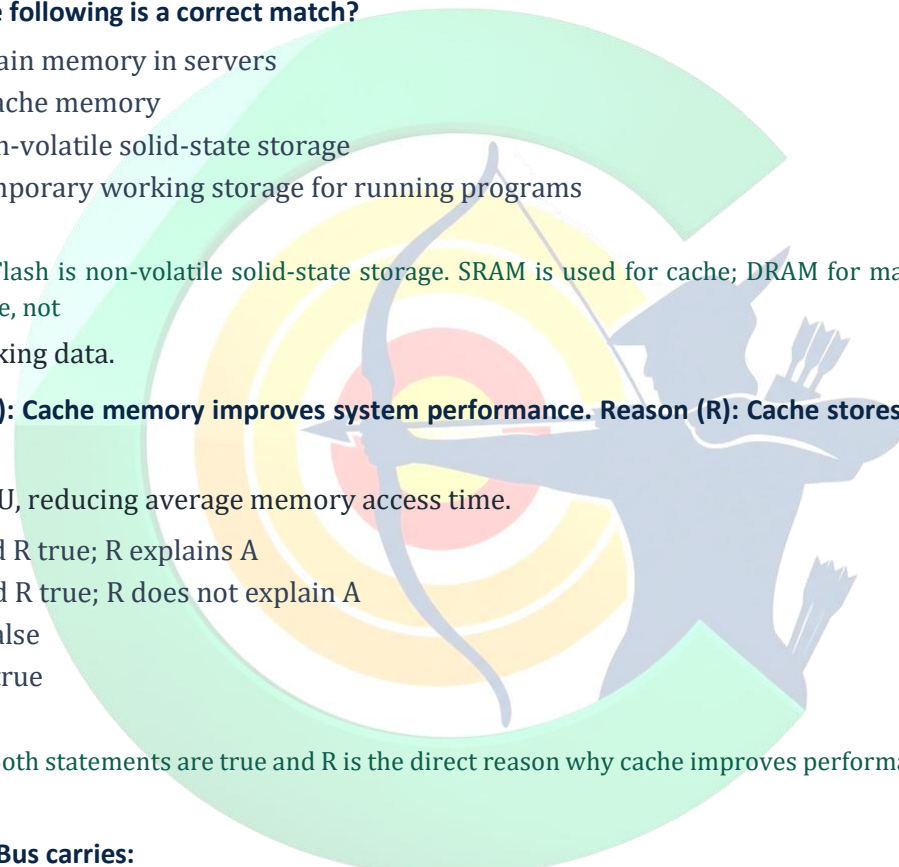
Answer: c

Explanation: The control bus transmits command and status signals (read, write, interrupt request, clock, bus arbitration, etc.). Data

travels on the data bus; addresses on the address bus.

33. Which device is both an input and an output device?

- a) Keyboard
- b) Monitor



- c) Touch screen
- d) Speaker

Answer: c

Explanation: A touch screen accepts touch input and simultaneously displays output, making it a combined I/O device. Keyboard is

input-only; monitor and speaker are output-only.

34. The von Neumann bottleneck refers to:

- a) Limited number of registers
- b) The performance limitation caused by the shared bus between CPU and memory
- c) Overheating of vacuum tubes
- d) Lack of secondary storage

Answer: b

Explanation: Because a single bus is shared by instruction fetches and data transfers, the CPU cannot do both at the same time,

limiting throughput — the classic bottleneck.

35. Which of the following is true of multi-core processors?

- a) They contain multiple independent processing units on a single chip
- b) They eliminate the need for an operating system
- c) They use only analog circuits
- d) They cannot run more than one thread

Answer: a

Explanation: A multi-core processor integrates two or more independent cores (CPUs) on one chip, enabling true parallel execution

of threads/processes.

36. Flash memory is a type of:

- a) Volatile SRAM
- b) Electrically erasable non-volatile memory
- c) Magnetic storage only
- d) Optical storage

Answer: b

Explanation: Flash is a form of EEPROM — non-volatile and electrically erasable/writable (usually in blocks). It is neither volatile

nor magnetic/optical.

37. The Instruction Register (IR) holds:

- a) The address of the next instruction
- b) The instruction currently being decoded/executed
- c) Intermediate arithmetic results only
- d) The contents of the entire cache

Answer: b

Explanation: After an instruction is fetched it is placed in the IR so the Control Unit can decode and execute it. The PC holds the

next address.

