

NANDYAL BANKING COACHING CENTER

NGOs Colony, NANDYAL • Phone: 7416206879

<https://nandyalbankcoachingcenter.in/>

COMPUTER APTITUDE

Chapter-wise Short Notes • Memory Tricks • Previous-Year-Style MCQs

For IBPS PO / Clerk / SO • SBI PO / Clerk • RRB PO / Clerk • RBI Assistant

2026 EDITION

Nandyal

INDEX

CHAPTER 1 COMPUTER FUNDAMENTALS, HISTORY & TYPES	7
1.1 What is a Computer?	7
1.2 History of Computers – Mechanical Era	7
1.3 History – Electro-mechanical & Electronic Era	8
1.4 Types of Computers	9
1.5 Supercomputers – Latest (2025–26)	10
1.6 Practice MCQs (Previous-Year Pattern)	11
CHAPTER 2 GENERATIONS OF COMPUTERS	12
2.1 What is a "Generation"?	12
2.2 Generations at a Glance	12
2.3 First Generation (1940–1956) – Vacuum Tubes	12
2.4 Second Generation (1956–1963) – Transistors	12
2.5 Third Generation (1964–1971) – Integrated Circuits	13
2.6 Fourth Generation (1971–1980) – Microprocessors	13
2.7 Fifth Generation (1980–present) – ULSI & AI	13
2.8 Comparison Tables (Exam Favourite)	14
2.9 Speed Units	14
2.10 Beyond the 5th Generation (2025–26)	15
2.11 Practice MCQs (Previous-Year Pattern)	15
CHAPTER 3 HARDWARE: CPU, MOTHERBOARD & I/O DEVICES	17
3.1 Hardware Basics	17
3.2 Central Processing Unit (CPU)	17
3.3 Buses	18
3.4 Motherboard, Power & Expansion	19
3.5 Ports & Connectors	19
3.6 Input Devices	20
3.7 Output Devices	22
3.8 Latest Processors & AI PCs (2024–26)	23
3.9 Practice MCQs (Previous-Year Pattern)	24
CHAPTER 4 MEMORY & STORAGE	25
4.1 Computer Memory – Basics	25
4.2 Memory Hierarchy & Access Time	25
4.3 Registers & Cache Memory	25
4.4 RAM – Random Access Memory	26
4.5 ROM – Read Only Memory	27
4.6 Flash Memory	27

4.7 Virtual Memory & Booting.....	27
4.8 Secondary Storage – Magnetic	28
4.9 Secondary Storage – Optical Discs.....	29
4.10 Secondary Storage – Solid State (Flash)	29
4.11 Units of Memory	30
4.12 Practice MCQs (Previous-Year Pattern).....	31
CHAPTER 5 SOFTWARE & OPERATING SYSTEMS.....	32
5.1 Software – Basics & Types	32
5.2 Freeware, Shareware, Open Source & Licences.....	33
5.3 Language Translators & Other System Programs.....	33
5.4 Operating System – Basics & Functions.....	33
5.5 Types of Operating System	34
5.6 Kernel, Shell & User Interface.....	35
5.7 Booting, BIOS / UEFI & POST	35
5.8 File Systems.....	36
5.9 Microsoft Windows.....	36
5.10 MS-DOS.....	37
5.11 UNIX, Linux & macOS.....	38
5.12 Mobile Operating Systems	38
5.13 Latest OS Versions (2025–26).....	39
5.14 Practice MCQs (Previous-Year Pattern).....	39
CHAPTER 6 MS OFFICE & MS WORD	41
6.1 MS Office – Overview	41
6.2 MS Word – Basics & Interface	42
6.3 Ribbon Tabs & Their Commands	43
6.4 Page Setup & Default Settings	43
6.5 Formatting & Editing Features.....	44
6.6 Important Word Features.....	45
6.7 Top MS Word Shortcuts.....	46
6.8 Practice MCQs (Previous-Year Pattern).....	46
CHAPTER 7 MS EXCEL.....	48
7.1 Spreadsheet Basics	48
7.2 Excel Limits & Defaults.....	48
7.3 Formulas, Functions & Cell References	49
7.4 Common Functions.....	49
7.5 Ribbon Tabs & Data Tools.....	50
7.6 Charts.....	51
7.7 New Excel Features (2019–2026)	51

7.8 Top Excel Shortcuts.....	51
7.9 Practice MCQs (Previous-Year Pattern).....	52
CHAPTER 8 MS POWERPOINT	54
8.1 PowerPoint Basics.....	54
8.2 Views in PowerPoint	54
8.3 Ribbon Tabs	55
8.4 Transitions vs Animations	55
8.5 Slide Show, Presenting & New Features.....	55
8.6 File Formats	56
8.7 Top PowerPoint Shortcuts	56
8.8 Practice MCQs (Previous-Year Pattern).....	57
CHAPTER 9 MS ACCESS & DBMS.....	58
9.1 Data, Database & DBMS	58
9.2 DBMS Architecture & Models.....	58
9.3 Relational Database (RDBMS).....	59
9.4 Database Keys.....	60
9.5 Normalization	60
9.6 Transactions & ACID	60
9.7 SQL – Structured Query Language.....	61
9.8 Data Warehouse, Data Mining, Big Data & NoSQL.....	61
9.9 Latest Database Versions (2025–26)	62
9.10 Microsoft Access.....	62
9.11 Practice MCQs (Previous-Year Pattern).....	63
CHAPTER 10 NETWORKING	65
10.1 Computer Network – Basics	65
10.2 Types of Networks (by Area)	65
10.3 Network Topologies.....	66
10.4 Transmission Modes, Media & Switching.....	66
10.5 Networking Devices	67
10.6 OSI Model & TCP/IP Model.....	67
10.7 Protocols & Port Numbers.....	68
10.8 IP Address & MAC Address	69
10.9 Wireless Technologies	70
10.10 Mobile Generations, 5G/6G & Satellite Internet.....	70
10.11 Practice MCQs (Previous-Year Pattern).....	71
CHAPTER 11 INTERNET & E-MAIL	73
11.1 What is the Internet?.....	73
11.2 Internet Users – Latest Figures (2025–26)	73

11.3 Types of Internet Connections	74
11.4 World Wide Web (WWW) & Web Terms	74
11.5 URL, Domain Names & DNS.....	75
11.6 IP Address, ISP & Protocols.....	76
11.7 Web Browsers & Search Engines.....	77
11.8 Cookies, Cache & Other Internet Terms.....	78
11.9 Internet Services – Social Media, Blogs & E-commerce	78
11.10 E-mail – Basics.....	79
11.11 Mailbox Folders & Features.....	80
11.12 E-mail Protocols & Ports	80
11.13 Popular E-mail Services (Updated)	81
11.14 E-mail Security	81
11.15 Practice MCQs (Previous-Year Pattern).....	81
CHAPTER 12 COMPUTER SECURITY & CYBER THREATS.....	83
12.1 Computer Security – Basics	83
12.2 Malware – Types.....	83
12.3 Computer Virus.....	84
12.4 Famous Malware – Timeline.....	84
12.5 Cyber Attacks & Frauds.....	85
12.6 Hackers & Cyber Crime Terms	86
12.7 Security Measures – Antivirus, Firewall, Proxy	86
12.8 Cryptography – Encryption & Digital Signatures	87
12.9 Authentication – Passwords, OTP, Biometrics, Passkeys	88
12.10 Indian Cyber Law – IT Act 2000	88
12.11 Indian Cyber Security Institutions & Laws (2025–26)	89
12.12 Practice MCQs (Previous-Year Pattern).....	90
CHAPTER 13 NUMBER SYSTEM & DATA REPRESENTATION	92
13.1 Number Systems – Basics	92
13.2 Conversions – Methods & Worked Examples	92
13.3 Binary Arithmetic.....	93
13.4 Complements & Signed Numbers.....	93
13.5 Data Units & Binary Codes.....	94
13.6 Logic Gates.....	95
13.7 Boolean Algebra Basics	95
13.8 Practice MCQs (Previous-Year Pattern).....	95
CHAPTER 14 PROGRAMMING BASICS	97
14.1 Program & Programming Language	97
14.2 Generations of Programming Languages	97

14.3 Translators – Compiler, Interpreter, Assembler	97
14.4 Algorithm, Flowchart & Pseudocode	98
14.5 Errors, Bugs & Debugging	98
14.6 Programming Paradigms & OOP.....	99
14.7 Popular Languages – Creators & Years	99
14.8 Web Languages, Markup vs Programming.....	100
14.9 Latest Trends (2025–26)	101
14.10 Practice MCQs (Previous-Year Pattern).....	101
CHAPTER 15 LATEST TECHNOLOGIES: AI, CLOUD, IOT, BLOCKCHAIN & DIGITAL BANKING.....	103
15.1 Artificial Intelligence (AI) – Basics.....	103
15.2 Popular AI Tools & Models (as of Oct 2026).....	104
15.3 Cloud Computing	105
15.4 IoT, Big Data & Other Emerging Technologies	106
15.5 Quantum Computing	107
15.6 Blockchain, Cryptocurrency & CBDC.....	107
15.7 Digital Payment Systems in India.....	108
15.8 Digital Public Infrastructure (India Stack) & Digital Banking	109
15.9 E-Governance & E-Commerce (Quick Facts)	110
15.10 Practice MCQs (Previous-Year Pattern).....	110
CHAPTER 16 KEYBOARD SHORTCUTS	111
16.1 Keyboard Basics for Shortcuts	111
16.2 Function Keys F1–F12	111
16.3 General Editing Shortcuts (Most Programs).....	111
16.4 Windows 11 Shortcuts.....	112
16.5 MS Word Shortcuts.....	113
16.6 MS Excel Shortcuts.....	114
16.7 MS PowerPoint Shortcuts.....	115
16.8 Web Browser Shortcuts (Chrome / Edge / Firefox).....	115
16.9 Practice MCQs (Previous-Year Pattern).....	116
CHAPTER 17 ABBREVIATIONS & FILE EXTENSIONS.....	117
17.1 How to Learn Abbreviations	117
17.2 Important Abbreviations A–Z	117
17.3 Banking & Digital-India Abbreviations (Quick Revision).....	123
17.4 File Extensions	123
17.5 Practice MCQs (Previous-Year Pattern).....	125

CHAPTER 1 COMPUTER FUNDAMENTALS, HISTORY & TYPES

1.1 What is a Computer?

- A **computer** is an **electronic device** that accepts **data (input)**, **processes** it under the control of a **program** (set of instructions), produces **information (output)** and **stores** results for future use.
- Word "computer" comes from the **Latin word "computare"** = to calculate / to count.
- A computer works only on instructions – it has **no IQ** and **no feelings** of its own.
- Modern definition (SBI PO): "An **electronic automated machine** that can solve problems involving **words and numbers**."

► Data vs Information

Data	Information
Raw , unorganised facts & figures	Processed , organised, meaningful data
No proper meaning by itself	Has meaning; useful for decision-making
Input to the computer	Output of the computer
e.g. marks of 50 students	e.g. class average, rank list
e.g. survey responses	e.g. survey report / result

► The IPO (Information Processing) Cycle

- **Input → Processing → Output → Storage** (4 basic functions).
- **Input** – data & instructions entered (keyboard, mouse, scanner).
- **Processing** – manipulating data to create information; done by the **CPU (brain of the computer)**.
- **Output** – result given to the user (monitor, printer, speaker).
- **Storage** – saving data/results (RAM temporarily, HDD/SSD permanently).
- Input + Processing + Output devices grouped together = a **computer system**.

🔑 MEMORY TRICK: Basic functions

- **"I P O S"** – Input, Process, Output, Store. If an option is not one of these (e.g. "Understanding", "Copy text", "Scan text"), it is **NOT** a basic function.

► Characteristics of a Computer

Feature	Meaning
Speed	Works in micro/nano/pico seconds; measured in Hz (GHz), MIPS , FLOPS
Accuracy	Errors are almost always human errors → GIGO
Diligence	No tiredness, no loss of concentration
Versatility	Can do many different kinds of jobs
Storage	Huge capacity; quick retrieval
Automation	Works automatically once a program is given
No IQ / No feelings	Cannot think or decide on its own (limitation)

★ REMEMBER THIS

- **GIGO = Garbage In, Garbage Out** – wrong input gives wrong output; computer accuracy depends on input.
- **CPU = brain of the computer**; in a PC the CPU is a single chip called the **microprocessor**.
- A computer system = **Hardware + Software + Data + People (Peopleware/Liveware) + Procedures**.
- An old system still in use = **Legacy system**.
- **Firmware** = software permanently stored in ROM (e.g. BIOS/UEFI).

1.2 History of Computers – Mechanical Era

Device (Year)	Inventor	Key point
Abacus (c. 2500 BC)	Ancient; bead form popular in China	First counting device; beads on rods. China = Suanpan, Japan = Soroban
Napier's Bones (1617)	John Napier	Rods for multiplication; book " Rabdologia "
Slide Rule (1622)	William Oughtred	Based on logarithms
Pascaline (1642)	Blaise Pascal	First mechanical adding machine (add/subtract)

Device (Year)	Inventor	Key point
Stepped Reckoner (1673)	G. W. Leibniz	Could add, subtract, multiply, divide
Jacquard Loom (1801–04)	Joseph M. Jacquard	Weaving loom controlled by punched cards
Difference Engine (1822)	Charles Babbage	Calculated tables of numbers
Analytical Engine (1834–37)	Charles Babbage	First design of a general-purpose computer: Mill (=CPU), Store (=memory), punched-card input
Tabulating Machine (1890)	Herman Hollerith	Punched cards for US Census ; his company later became IBM (1924)

- **Ada Lovelace** (1843) – wrote the first algorithm for the Analytical Engine → **world's first programmer**.
- **George Boole** (1854) – **Boolean algebra** (basis of logic gates).
- **Leibniz** – also described the **binary number system**.
- **Alan Turing** (1936) – **Turing Machine**; 1950 – **Turing Test** for machine intelligence.

🔑 **MEMORY TRICK: Order of mechanical devices**

➤ **"A Naughty Parrot Loves Juicy Bananas Hourly"** → Abacus, Napier, Pascal, Leibniz, Jacquard, Babbage, Hollerith.

1.3 History – Electro-mechanical & Electronic Era

Machine	Year	Key point
Z1 / Z3	1938 / 1941	Konrad Zuse (Germany). Z1 = mechanical binary; Z3 = first working programmable, fully automatic computer (relays)
ABC	1937–42	Atanasoff & Berry – first electronic digital computer (not programmable)
Colossus	1943–44	Tommy Flowers (UK) – first programmable electronic computer; code-breaking

Machine	Year	Key point
Harvard Mark I	1944	Howard Aiken (IBM) – electro-mechanical; Grace Hopper worked on it
ENIAC	1946	Eckert & Mauchly, Univ. of Pennsylvania – first general-purpose electronic digital computer ; ~18,000 vacuum tubes, ~30 tonnes
Manchester Baby	1948	First computer to run a stored program
EDSAC	1949	Maurice Wilkes (Cambridge) – first practical stored-program computer
EDVAC	1949–51	Moore School; based on von Neumann's 1945 report; binary, mercury delay-line memory
UNIVAC I	1951	Eckert & Mauchly – first commercial computer (USA; US Census Bureau)
IBM 650	1953–54	First mass-produced computer

► Key Inventions

Invention	Year	By
Transistor	1947	Bardeen, Brattain & Shockley (Bell Labs)
Integrated Circuit (IC)	1958–59	Jack Kilby (TI) & Robert Noyce (Fairchild)
Microprocessor – Intel 4004 (4-bit)	1971	Ted (Marcian) Hoff , Federico Faggin, Stanley Mazor
First microcomputer – Altair 8800	1975	MITS (Ed Roberts)
IBM PC	1981	IBM
Portable computer – Osborne 1	1981	Adam Osborne
Mouse	1964	Douglas Engelbart

🔑 **MEMORY TRICK: Three "First" machines**

- **ENIAC** – **"E" for Electronic** → first general-purpose electronic computer.
- **EDSAC** – **"S" for Stored** → first practical stored-program computer.
- **UNIVAC** – **"U" for Used in business** → first commercial computer.

► Fathers & Founders (Exam Favourite)

Title	Person
Father of Computer	Charles Babbage
Father of Modern Computer Science / Theoretical CS	Alan Turing
Stored-program concept (von Neumann architecture)	John von Neumann
Father of Artificial Intelligence (coined "AI", 1956)	John McCarthy
First programmer	Ada Lovelace
Father of Supercomputing	Seymour Cray
Father of Indian Supercomputing (PARAM)	Dr. Vijay Bhatkar
Father of Internet	Vint Cerf & Bob Kahn (TCP/IP)
Inventor of WWW (1989)	Tim Berners-Lee
Inventor of E-mail (1971)	Ray Tomlinson
C language	Dennis Ritchie
USB	Ajay Bhatt (Intel)
Optical disc / CD-ROM concept	James Russell
Microsoft founders	Bill Gates & Paul Allen
Windows OS developer	Microsoft (first version 1985)

► Computers in India

- **HEC-2M (1956)** – first computer installed in India, at ISI Kolkata.
- **TIFRAC (1960)** – first indigenous computer of India, by TIFR Mumbai.
- **PARAM 8000 (1991)** – India's first supercomputer, by C-DAC Pune ("Param" = Supreme).
- **C-DAC** = Centre for Development of Advanced Computing (est. 1988, Pune).

★ REMEMBER THIS

- Abacus → exam answer "**China**"; Japanese name **Soroban**; uses **beads**.
- **Babbage** = Father of Computer; **Analytical Engine** = his general-purpose design.
- **ENIAC (1946)** = first electronic general-purpose computer; used **vacuum tubes**.

- **UNIVAC** = first commercial computer; **EDSAC** = first stored-program (practical).
- **Intel 4004 (1971)** = first microprocessor; **Altair 8800** = first microcomputer.
- Punched cards: **Jacquard** (loom) → **Hollerith** (census) → early computers.

1.4 Types of Computers

► (A) Based on Data Handled

Type	Works on	Examples
Analog	Continuous physical quantities (voltage, temperature, speed, pressure)	Speedometer, thermometer, voltmeter, seismograph
Digital	Discrete data – binary 0 & 1	PC, laptop, smartphone, calculator, digital watch
Hybrid	Both analog & digital	ICU / ECG machines, petrol-pump dispenser, flight simulators

- Digital computers are superior in **accuracy & versatility**; analog input is **never converted** to digital inside an analog computer.

► (B) Based on Purpose

- **General-purpose** – many tasks (PC, laptop).
- **Special-purpose** – one dedicated task (ATM, traffic-light controller, washing machine) → **embedded systems**.

► (C) Based on Size & Power

Type	Features	Examples / Use
Supercomputer	Fastest, largest, costliest ; thousands of processors; speed in FLOPS (now exaFLOPS = 10^{18})	Weather forecasting, climate, nuclear & space research; PARAM, Frontier, El Capitan

Type	Features	Examples / Use
Mainframe	Very large, multi-user (thousands of users); high reliability; batch & transaction processing	Banks (core banking), railway & airline reservation; IBM z17 (2025)
Minicomputer	Mid-size, multi-user (tens–hundreds)	Small businesses, colleges; DEC PDP-8 , VAX
Microcomputer	Smallest & cheapest, single-user , based on a microprocessor ; most widely used & fastest-growing	Desktop, laptop, tablet, smartphone

🔪 **MEMORY TRICK: Size order (big → small)**

➤ "Super Man Makes Microwaves" → Super > Mainframe > Mini > Micro.

➤ Types of Microcomputers / Personal Computers

Type	Key point
Desktop	Fixed at one place; tower / flat / all-in-one models
Workstation	Powerful single-user PC for design, CAD, graphics
Laptop / Notebook	Portable; battery; touchpad; notebook ≈ 1–3 kg
Ultrabook	Thin, light laptop with low-voltage CPU & long battery
Tablet	Touch-screen, virtual keyboard, stylus
Palmtop / PDA / Handheld	Smallest of PCs; fits in palm; stylus; now replaced by smartphones
Wearable	Smartwatch, fitness band, smart glasses (body-borne computers)

➤ Other Important Terms

- **Server** – central computer that provides data, programs & services to many client PCs on a network.

- **Embedded system** – computer built into a larger device for one job (ATM, microwave, printer, car ECU, digital watch).
- **Kiosk** – public self-service terminal (railway enquiry, bank passbook printer).
- **Dumb terminal** – only keyboard & screen; no processing of its own; used to access mainframes.
- **Number cruncher** – informal name for a supercomputer.

1.5 Supercomputers – Latest (2025–26)

No.	System	Country	Speed
1	LineShine (NSC Shenzhen)	China	2.20 EF
2	El Capitan (LLNL, HPE)	USA	1.81 EF
3	Frontier (Oak Ridge, HPE)	USA	1.35 EF
4	Aurora (Argonne)	USA	1.01 EF
5	JUPITER (Jülich)	Germany	1.00 EF

TOP500 ranking, June 2026. EF = exaFLOPS. The list is updated every June & November.

- **Frontier (2022)** = world's first exascale supercomputer. **JUPITER** = Europe's first exascale system.
- **Fugaku** (Japan) was No. 1 in 2020–21.
- **First supercomputer** = **CDC 6600** (1964, Seymour Cray). **Cray-1** (1976) was installed at **Los Alamos, USA**.

➤ Indian Supercomputers

System	Key point
PARAM 8000 (1991)	First Indian supercomputer, C-DAC
AIRAWAT (C-DAC Pune)	India's AI supercomputer ; ranked 75th in TOP500 (2023)
PARAM Rudra (Sept 2024)	3 indigenous systems at Pune, Delhi, Kolkata
Arka & Arunika (Jan 2025)	Weather/climate HPC at IITM Pune & NCMRWF Noida
PARAM Pravega	IISc Bengaluru – largest in an Indian academic institute (3.3 PF)
PARAM Shivay (2019)	IIT-BHU – first system built under NSM

- **National Supercomputing Mission (NSM)** – launched **2015** by MeitY & DST; implemented by **C-DAC & IISc**.

★ **REMEMBER THIS**

- Supercomputer speed → **FLOPS**; PC processor speed → **GHz**; also **MIPS**.
- **Mainframes** are used in **banks** – remember **batch processing** & thousands of users.
- **Microcomputer** = least powerful, most widely used, fastest growing.
- **PARAM** → India; **Cray** → USA; Analog = **continuous**, Digital = **discrete (0/1)**.

1.6 Practice MCQs (Previous-Year Pattern)

Q1. Which of the following is NOT a basic function of a computer? (SBI Clerk)

- (a) Accept input (b) Process data
(c) Store data (d) Understand data
(e) Produce output

Ans: (d) A computer has no IQ; its basic functions are Input, Process, Output and Store.

Q2. ___ represents raw facts, whereas ___ is data made meaningful. (IBPS Clerk)

- (a) Information, reporting
(b) Data, information (c) Information, bits
(d) Records, bytes (e) Bits, bytes

Ans: (b) Data = raw facts; information = processed, meaningful data.

Q3. The abacus is known by which name in Japan? (SBI Associates)

- (a) Suanpan (b) Soroban (c) Schoty
(d) Napier's beads (e) None of these

Ans: (b) China – Suanpan; Japan – Soroban; Russia – Schoty.

Q4. Which machine, designed by Charles Babbage, is regarded as the first design of a general-purpose computer? (SBI Clerk)

- (a) Difference Engine (b) Analytical Engine
(c) Pascaline (d) Tabulating Machine
(e) Stepped Reckoner

Ans: (b) The Analytical Engine had a Mill (CPU), Store (memory) and punched-card input.

Q5. The first general-purpose electronic digital computer was: (IBPS RRB PO 2021)

- (a) UNIVAC (b) EDSAC (c) ENIAC (d) Mark I
(e) IBM 650

Ans: (c) ENIAC (1946) by Eckert and Mauchly used about 18,000 vacuum tubes.

Q6. Which was the world's first commercial computer?

- (a) ENIAC (b) UNIVAC I (c) EDVAC (d) ABC
(e) Z3

Ans: (b) UNIVAC I (1951) was the first computer built for commercial use.

Q7. Which is the smallest of the following computers? (SBI Clerk)

- (a) Notebook (b) Laptop (c) Desktop
(d) Workstation (e) Palmtop

Ans: (e) A palmtop/PDA fits in the palm and is smaller than a notebook.

Q8. In _____ computers, computation is carried out with physical quantities such as voltage, temperature or length. (PNB)

- (a) digital (b) analog (c) hybrid (d) micro
(e) mainframe

Ans: (b) Analog computers work on continuously varying physical quantities.

Q9. Which type of computer is mainly used by banks for core banking and by railways for ticket reservation?

- (a) Microcomputer (b) Minicomputer
(c) Mainframe (d) Workstation (e) Tablet

Ans: (c) Mainframes handle thousands of users and huge transaction volumes reliably.

Q10. PARAM, India's supercomputer series, was developed by: (LIC Asst)

- (a) ISRO (b) BARC (c) C-DAC (d) DRDO
(e) IIT Bombay

Ans: (c) C-DAC Pune built PARAM 8000 in 1991 under Dr. Vijay Bhatkar.

CHAPTER 2 GENERATIONS OF COMPUTERS

2.1 What is a "Generation"?

- A **generation** = a stage of technological advancement in computers. Each new generation is identified by a **change in the main electronic switching component**.
- Every new generation → **smaller size, faster speed, lower cost, less heat & power, more reliability**.
- We commonly study **5 generations** (exam answer); a "6th generation" is not officially defined.
- Machines before the 1st generation were **mechanical / electro-mechanical** (Pascaline, Analytical Engine, Harvard Mark I, Z3) – see Chapter 1.

2.2 Generations at a Glance

Gen.	Period	Main technology (switching component)
1st	1940–1956	Vacuum tubes (thermionic valves)
2nd	1956–1963	Transistors
3rd	1964–1971	Integrated Circuits (IC) – SSI / MSI
4th	1971–1980	LSI / VLSI → Microprocessor
5th	1980–present	ULSI, parallel processing, Artificial Intelligence

Years differ slightly between books (e.g. 2nd gen 1957–63, 4th gen 1971–present). In the exam, identify the generation by its technology.

- **SSI** = Small Scale Integration (< 100 transistors per chip); **MSI** = Medium SI (100–1,000).
- **LSI** = Large Scale Integration (1,000s); **VLSI** = **Very Large Scale Integration** (lakhs → millions).
- **ULSI** = **Ultra Large Scale Integration** (millions → billions of transistors on one chip).
- Today's chips hold **tens of billions** of transistors (e.g. Apple M-series, Nvidia GPUs).

🔑 **MEMORY TRICK: Technology order**

➤ **"Very Tall Indians Make Art"** → Vacuum tube, Transistor, IC, Microprocessor (VLSI), AI (ULSI).

2.3 First Generation (1940–1956) – Vacuum Tubes

- **Switching device:** vacuum tubes (invented by **J. A. Fleming**, diode valve 1904). ENIAC used about **18,000** tubes.
- **Main memory:** **magnetic drums**, also mercury delay lines & Williams tubes; magnetic core only at the end of the period.
- **Input/Output:** **punched cards** & paper tape; output on printouts.
- **Language:** only **machine language (binary 0/1)** – first-generation language (1GL).
- **OS:** **no operating system**; one job at a time → **batch processing**.
- **Speed:** calculations in **milliseconds**.
- **Drawbacks:** huge size (filled rooms), enormous **heat & power** use, frequent tube failure, air-conditioning needed, very costly, not portable.

Examples	Note
ENIAC	Electronic Numerical Integrator And Computer (1946)
EDVAC	Electronic Discrete Variable Automatic Computer
EDSAC	Electronic Delay Storage Automatic Calculator
UNIVAC I	Universal Automatic Computer – first commercial (1951)
IBM 650, IBM 701	650 = first mass-produced computer

2.4 Second Generation (1956–1963) – Transistors

- **Transistor** (Bell Labs, 1947 – Bardeen, Brattain, Shockley; see Ch. 1) replaced vacuum tubes → smaller, faster, cheaper, less heat, more reliable.
- Made of **semiconductor** material – germanium, later **silicon**.
- **Main memory:** **magnetic core**; **secondary:** magnetic **tape** & magnetic **disk** (IBM RAMAC, 1956 – first hard disk).

- **Language: assembly language** (mnemonics) and the first high-level languages – **FORTRAN** (1957) & **COBOL** (1959).
- **OS: batch processing** operating systems; **multiprogramming** began.
- **Speed: microseconds**. Still needed air-conditioning.
- Used commercially in banks, universities, atomic-energy research.
- **Examples: IBM 1401, IBM 1620, IBM 7090/7094, CDC 1604, CDC 3600, IBM 7030 (Stretch), CDC 6600** (1964, Seymour Cray).

2.5 Third Generation (1964–1971) – Integrated Circuits

- **IC** (Jack Kilby & Robert Noyce, 1958–59) – many transistors, resistors & capacitors on one **silicon chip**.
- **Memory:** magnetic core, then **semiconductor memory**; magnetic disks & tapes for storage. **Cache memory** first appeared (IBM 360 Model 85, 1968).
- **I/O: keyboard** for input & **monitor (VDU)** for output instead of punched cards & printouts.
- **Languages:** high-level languages widely used – FORTRAN-II to IV, COBOL, **BASIC** (1964), **PL/1**, ALGOL-68, Pascal.
- **OS:** full operating systems (e.g. IBM **OS/360**, **UNIX** 1969); **multiprogramming**, **time-sharing**, remote processing.
- **Speed: nanoseconds**. Smaller, cheaper, less power; computers became accessible to a larger audience.
- **Examples: IBM System/360** (1964), **IBM 370**, **PDP** series (PDP-8/I, PDP-11), **Honeywell 6000** series, **ICL 2900**.

★ REMEMBER THIS

- Third generation = **ICs + keyboard/monitor + OS + multiprogramming + time-sharing**.
- **Honeywell 6000** series & **IBM 360/370** → 3rd generation (asked in RBI Asst 2022 & IBPS RRB PO 2022).
- **Silicon** is a **semiconductor**; ICs are generally made of silicon.

2.6 Fourth Generation (1971–1980) – Microprocessors

- **LSI → VLSI** put the entire CPU on **one chip** = **microprocessor** (first: **Intel 4004**, 1971 – see Ch. 1).
- Birth of **personal computers (PCs)**, microcomputers & computer networks.
- **Memory: semiconductor memory** (RAM & ROM chips); storage on hard disk, **floppy disk**, magnetic tape, later optical discs (CD).
- **I/O:** keyboard, **mouse**, **GUI**, colour monitors, printers.
- **Languages:** **C** (1972), **C++** (1985), **dBASE**, **SQL** & other **4GLs**.
- **OS: time-sharing, real-time, networks, distributed OS;** MS-DOS, UNIX, early Windows & Mac OS.
- **Speed: picoseconds** (exam convention). Very small, cheap, reliable; **portable** computers appeared.
- **Examples: Altair 8800, Apple II** (1977), **IBM PC** (1981), **DEC 10**, **STAR 1000**, **CRAY-1** (1976), **CRAY X-MP**.

2.7 Fifth Generation (1980–present) – ULSI & AI

- Based on **ULSI** technology, **parallel processing** (many processors/cores working together) and **Artificial Intelligence (AI)**.
- Goal: computers that can **understand natural language, learn, reason & take decisions** – **Knowledge Information Processing System (KIPS)**.
- Japan's **Fifth Generation Computer Systems (FGCS)** project (MITI, **1982**) popularised the term; it used **Prolog**-style logic programming.
- Instructions are executed **both sequentially and in parallel**.
- **Languages:** AI languages **Prolog** (Programming in Logic), **LISP** (List Processing), **OPS5**, **Mercury**; also **Java**, **Python** & other modern languages.
- **Features:** multi-core CPUs, **Internet & WWW**, multimedia, **CD-ROM/DVD**, e-commerce, cloud, robotics, **expert systems**, voice/face recognition, mobile computing.
- **Storage:** semiconductor RAM, **SSD / flash memory**, optical discs, cloud storage.

- **Examples:** Pentium (1993) & later PCs, **Intel Core i3/i5/i7/i9, Core Ultra**, AMD Ryzen, laptops, **tablets, smartphones**, IBM Watson, modern supercomputers.

★ REMEMBER THIS

- 5th generation is also called **KIPS** – Knowledge Information Processing System.
- Major talking point of 5th generation = **Artificial Intelligence**; component = **ULSI** microprocessor.
- **KBS** = Knowledge Based System; **expert system** = AI program that works like a human expert.
- Not associated with 5th gen: **CUI (command line)** systems, vacuum tubes, punched cards.

2.8 Comparison Tables (Exam Favourite)

► Memory used

Gen.	Primary memory	Secondary storage
1st	Magnetic drum, delay lines	Punched cards, paper & magnetic tape
2nd	Magnetic core	Magnetic tape, magnetic disk
3rd	Magnetic core → semiconductor	Magnetic disk & tape
4th	Semiconductor (RAM/ROM chips)	Hard disk, floppy, tape, optical disc
5th	Semiconductor (DDR RAM)	SSD, flash, optical, cloud

- Magnetic disk = floppy disk, hard disk. Optical disc = CD, DVD, Blu-ray. Flash = pen drive, memory card, SSD.

► Language & processing

Gen.	Language	OS / processing
1st	Machine language (binary)	No OS; batch processing
2nd	Assembly ; FORTRAN, COBOL	Batch OS; multiprogramming begins
3rd	High-level: BASIC, PL/1, Pascal	Multiprogramming, time-sharing
4th	C, C++, SQL, 4GLs	Real-time, networks, distributed OS, GUI

Gen.	Language	OS / processing
5th	Prolog, LISP, Java, Python	Parallel processing , AI, Internet

► Generations of programming languages

Level	Example
1GL – Machine language	Binary 0 & 1 (understood directly by CPU)
2GL – Assembly language	Mnemonics: ADD, MOV (needs assembler)
3GL – High-level	FORTRAN, COBOL, BASIC, C, C++, Java
4GL – Very high-level	SQL, report generators, MATLAB
5GL – Logic / AI	Prolog, OPS5, Mercury

1GL & 2GL = low-level languages; 3GL onwards = high-level languages. Do not confuse language generations with computer generations.

► Input / Output

Gen.	Input	Output
1st & 2nd	Punched cards, paper tape	Printouts
3rd	Keyboard	Monitor
4th	Mouse, touch screen, scanner	Colour monitor, LCD, printers
5th	Voice, touch, pen, camera, biometrics	LED/OLED screens, speech

2.9 Speed Units

Unit	Value	Generation (exam)
Millisecond (ms)	10^{-3} s	1st
Microsecond (μs)	10^{-6} s	2nd
Nanosecond (ns)	10^{-9} s	3rd
Picosecond (ps)	10^{-12} s	4th / 5th
Femtosecond (fs)	10^{-15} s	not a real CPU speed

- A **5 GHz** processor has a clock cycle of **0.2 ns (200 ps)**.
- Processor speed is also expressed in **MIPS** (Million Instructions Per Second); supercomputers in **FLOPS**.

MEMORY TRICK: Speed order

- "My Mother Never Pampers" → Milli (1st), Micro (2nd), Nano (3rd), Pico (4th). Each step is **1,000 times** smaller.

2.10 Beyond the 5th Generation (2025–26)

- No official "6th generation" exists; current trends are **AI chips, quantum computing** and **nanotechnology**.
- **NPU** (Neural Processing Unit) – AI accelerator built into new PC & phone chips; speed in **TOPS** (Trillion Operations Per Second).
- **Quantum computer** – uses **qubits**, which can be 0 and 1 together (**superposition**) and linked (**entanglement**).
- **Google Willow** (Dec 2024) – **105-qubit** quantum chip with improved error correction.
- **Microsoft Majorana 1** (Feb 2025) – first chip with **topological qubits** (8 qubits).
- **India: National Quantum Mission (NQM)** – approved **April 2023**, outlay **₹6,003.65 crore**, 2023–24 to 2030–31 (DST).
- **QpiAI-Indus** (April 2025, Bengaluru) – India's **25-qubit** superconducting quantum computer under NQM.

★ REMEMBER THIS

- Vacuum tube → Transistor → IC → Microprocessor (VLSI) → ULSI/AI.
- 1st gen = machine language, batch processing, magnetic drum, milliseconds.
- 2nd gen = assembly language, magnetic core, transistors.
- 3rd gen = IC, OS, keyboard & monitor; 4th gen = microprocessor, PC, VLSI.
- 5th gen = AI, ULSI, parallel processing, KIPS.

2.11 Practice MCQs (Previous-Year Pattern)

Q1. _____ generation of computers started with using vacuum tubes as the basic components. (SBI Clerk 2012)

- (a) First (b) Second (c) Third (d) Fourth
(e) Fifth

Ans: (a) First-generation computers (1940–56) such as ENIAC used vacuum tubes.

Q2. The first generation computers could do:

(Allahabad Bank 2010)

- (a) multi-tasking (b) networking
(c) batch processing (d) multi-tabulation
(e) None of these

Ans: (c) First-generation machines ran one job at a time in batches; they had no OS.

Q3. During the second generation, the size of computers was decreased by replacing vacuum tubes with:

- (a) ICs (b) Microprocessors (c) Transistors
(d) Relays (e) ULSI chips

Ans: (c) Transistors replaced vacuum tubes in the 2nd generation (1956–63).

Q4. Which language was mainly used by second-generation computers?

- (a) Machine language (b) Assembly language
(c) Prolog (d) SQL (e) Python

Ans: (b) 2nd generation used assembly language (plus early FORTRAN and COBOL).

Q5. In which generation of computers was the Integrated Circuit introduced? (IBPS RRB 2016)

- (a) First (b) Second (c) Third (d) Fourth
(e) Fifth

Ans: (c) ICs were the basic component of 3rd-generation computers (1964–71).

Q6. Honeywell 6000 series computers belong to which generation? (RBI Asst 2022)

- (a) 1st (b) 2nd (c) 3rd (d) 4th (e) 5th

Ans: (c) Honeywell 6000 and IBM 360/370 were IC-based third-generation computers.

Q7. VLSI technology is used in _____ generation computers. (IBPS Clerk 2015)

- (a) First (b) Second (c) Third (d) Fourth
(e) None of these

Ans: (d) VLSI made the microprocessor possible – the hallmark of the 4th generation.

Q8. Real-time systems, networks and distributed operating systems are associated with which generation? (IBPS RRB PO 2023)

- (a) First (b) Second (c) Third (d) Fourth
(e) None of these

Ans: (d) Real-time, networked and distributed OS are listed under the 4th generation.

Q9. The major talking point of fifth generation computers is:

- (a) VLSI (b) Artificial Intelligence
(c) Batch processing (d) Magnetic core
(e) Punched cards

Ans: (b) 5th generation (KIPS) aims at AI – machines that can reason and learn.

Q10. The processing speed of first generation computers was measured in:

- (a) milliseconds (b) microseconds
(c) nanoseconds (d) picoseconds
(e) femtoseconds

Ans: (a) Convention: 1st – ms, 2nd – μ s, 3rd – ns, 4th – ps.

Scan the QR Code to Discover the Facts Behind the Incidents in Nandyal



ప్రియమైన విద్యార్థులారా,

నంద్యాలలో జరుగుతున్న దుర్ఘాటాలు:

1. తమ సంస్థ తప్ప ఇతర సంస్థలన్నీ ఫేక్ మరియు డమ్మీ కోచింగ్ సెంటర్లని అసత్య ప్రచారం చేయడం.
2. వారి సంస్థ విద్యార్థులు తప్ప ఇతర కోచింగ్ సెంటర్ల విద్యార్థులు నంద్యాలలోని హాస్టల్లో ఉండకూడదని బెదిరించడం; దీనిని అమలు చేయడం కోసం తమ సెక్యూరిటీ గార్డులను హాస్టల్కు పంపి ఐడీ కార్డులు తనిఖీ చేయించడం.

ఇటువంటి దుర్ఘాటాలను తట్టుకొని నిలబడి **NBCC** అద్భుతమైన ఫలితాలను సాధిస్తోందంటే, దాని వెనుక ఉన్న కష్టాన్ని అర్థం చేసుకోండి. సామాజిక స్పృహ, సామాజిక బాధ్యత మరియు వివేకంతో ఆలోచించండి. **రాముడెవరో**, రావణుడెవరో గుర్తించి **NBCC**ని ప్రోత్సహించాలని మా మనవి.

ఆత్మీయ విద్యార్థిగళే,

నంద్యాలದಲ್ಲಿ నడೆಯుత్తిరువ అన్యాయాలు:

1. తమ్మ సంస్థేయన్ను హోరతుపడిసి ఇతర సంస్థేయగళల్లవూ నకలి హాగూ డమ్మీ కలీజింగ్ సెంటర్గళెందు సుళ్ళు ప్రచార మాడువుదు.
2. తమ్మ సంస్థేయ విద్యార్థిగళన్ను బిట్టు బేరే యావుదే కలీజింగ్ సెంటర్గళె విద్యార్థిగళు నంద్యాలద హాస్టల్గళల్లి ఇరబారదెందు బేదరిసువుదు; ఇదన్ను జారిగొళిసలు తమ్మ సేక్యూరిటీ గార్డ్గళన్ను హాస్టల్గళిగే కళుహిసి ఐడి కార్డ్గళన్ను పరిశీలిసువుదు.

ఇంతక దొజ్జగళన్ను ఎదురిసి నింతు **NBCC** ఁత్తమ ఫలితాంశగళన్ను తరుత్తిదే ఎందరే, అదర హిందిరువ కరిణ పరిశ్రమవన్ను అధ్దమాడికొళ్ళి. సామాజిక ప్రజ్ఞ, సామాజిక జవాబ్దారి హాగూ వివేకదింద యోజిసి. యారు రామ, యారు రావణ ఎంబుదన్ను గ్రిహిసి **NBCC** అన్ను ప్రోత్సాహిసబేకాగి నమ్మ వింత్తి.

CHAPTER 3 HARDWARE: CPU, MOTHERBOARD & I/O DEVICES

3.1 Hardware Basics

- **Hardware** = physical parts of a computer that can be **touched** (CPU, keyboard, monitor, printer). **Software** = programs; cannot be touched.
- **Peripheral devices** = external devices attached to the computer for input, output or storage (keyboard, mouse, printer, scanner). **Motherboard is NOT a peripheral.**
- **System unit / cabinet** = box holding motherboard, CPU, RAM, storage, SMPS, fans.
- **Computer architecture** = design, organisation & interconnection of the components of a computer system.
- **Von Neumann architecture** (1945) – program and data stored in the **same memory**; basis of almost all computers. **Harvard architecture** – separate memories for program & data.

Unit	Function
Input unit	Accepts data & instructions; converts them into machine-readable form
CPU	Processes data (ALU + CU + registers); brain of the computer
Memory unit	Stores data, programs & intermediate results
Output unit	Converts results into human-readable form (soft or hard copy)

3.2 Central Processing Unit (CPU)

- Also called **processor, central processor, microprocessor** (when on a single IC chip). Mobile CPUs are often part of a **SoC** (System on Chip).
 - Main parts: **ALU, CU and Registers** (some books: ALU, CU, MU). Performs all calculations & controls all operations.
 - Understands only **machine language** (binary).
 - Fitted in the **CPU socket** on the motherboard; cooled by a **heat sink & fan**.
- **(a) Arithmetic Logic Unit (ALU)**
- Performs **arithmetic** (+, −, ×, ÷) and **logical** operations (AND, OR, NOT, **comparison** <, >, =).

- **Computational centre** of the CPU; the part used for **calculating & comparing**.
 - Intermediate results are kept in the **accumulator / registers**.
- **(b) Control Unit (CU)**
- **Fetches and decodes** program instructions and **directs/coordinates** all other units – acts like a "traffic police / manager".
 - Controls the flow of data between memory, ALU and **I/O devices**; does **not** process data itself.
 - Manages computer resources and the **sequencing of events** inside the CPU.

► **(c) Registers – fastest memory**

Register	Holds
PC – Program Counter	Address of the next instruction
IR – Instruction Register	The current instruction being executed
MAR – Memory Address Reg.	Address of the memory location to read/write
MDR / MBR – Memory Data/Buffer Reg.	Data being read from / written to memory
Accumulator (AC)	Intermediate results of ALU operations
Flag / Status register	Conditions: carry, zero, overflow, sign

- Register size = **word size** of the CPU (32-bit / 64-bit). The circuit storing **1 bit** = **flip-flop**.
 - Speed order: **Registers > Cache > RAM > SSD > HDD**.
- **(d) Machine Cycle (Instruction Cycle)**
- **Fetch → Decode → Execute → Store** (write back) – repeated for every instruction.
 - **I-time** (instruction time) = fetch + decode; **E-time** (execution time) = execute + store.
 - **Opcode** = part of an instruction that specifies the operation; **operand** = data/address it works on.
 - **Microcode** = sequence of micro-instructions inside the CPU; **macro** = one instruction producing many machine instructions.
 - **Interrupt** = signal to the CPU asking for immediate attention (e.g. key press).

MEMORY TRICK: Machine cycle

➤ "FDES" – "Fresh Dosa Every Sunday" →
Fetch, Decode, Execute, Store.

➤ Clock speed, cores & threads

- **Clock speed** = number of cycles per second, measured in **Hertz** – modern CPUs in **GHz** (1 GHz = 10^9 cycles/s). Early-1980s PCs ran at ~5 MHz; today 3–6 GHz.
- Processing power is also measured in **MIPS**; supercomputers in **FLOPS**; AI chips in **TOPS**.
- **Core** = an independent processing unit inside a CPU: dual-core (2), quad-core (4), octa-core (8)...
- **Thread** = smallest sequence of instructions a core handles; Intel **Hyper-Threading** / AMD **SMT** = 2 threads per core. (Intel's newest Core Ultra chips have dropped Hyper-Threading.)
- **Hybrid design** – **P-cores** (performance) + **E-cores** (efficiency) since Intel 12th gen (2021); also in Apple & Arm chips.
- **Word size** = bits processed at a time (8, 16, 32, **64-bit** today).

➤ RISC vs CISC

RISC	CISC
Reduced Instruction Set Computer	Complex Instruction Set Computer
Few, simple instructions; few addressing modes	Many complex instructions; many addressing modes
Mostly 1 instruction per clock cycle	Instructions take several cycles
ARM (phones, Apple M-series, Snapdragon), RISC-V	x86 – Intel & AMD PC processors

➤ Other processing chips

Chip	Key point
GPU	Graphics Processing Unit – parallel processing for graphics, gaming & AI training (Nvidia, AMD)
NPU	Neural Processing Unit – low-power AI tasks on PCs & phones; speed in TOPS
Microcontroller	CPU + memory + I/O on one chip; for embedded control (washing machine, car)

Chip	Key point
Co-processor	Helps CPU with special jobs (e.g. maths co-processor 8087)
DSP	Digital Signal Processor – audio, video, mobile signals

3.3 Buses

- **Bus** = set of parallel wires / conducting lines that carry information between CPU, memory & I/O devices. The main bus on the motherboard = **system bus**.
- Bus speed is measured in **MHz**; bus **width** in bits.
- **Bus arbitration** decides which device may use the bus; the device that can start a transfer = **bus master**.

Bus	Carries	Direction
Data bus	Actual data	Bi-directional
Address bus	Memory / I/O location (address)	Uni-directional (CPU → out)
Control bus	Control & timing signals (read/write, clock, interrupt)	Bi-directional (each line is one-way)

- An address bus with **n lines** can address **2^n locations** – e.g. 12 lines → $2^{12} = 4,096$; 32 lines → 4 GB.
- Expansion buses: ISA → PCI → AGP → **PCI Express (PCIe)**. Latest spec **PCIe 7.0** (June 2025); PCs use PCIe 4.0/5.0.
- **DMA** (Direct Memory Access) – I/O device transfers data to/from RAM **without the CPU**.

★ REMEMBER THIS

- **Address bus = uni-directional; data bus = bi-directional.**
- Three main parts of a processor = **ALU, Control Unit and Registers.**
- **CU decodes** instructions; **ALU calculates & compares**; registers = **fastest** memory.
- Clock speed → **GHz**; processing power → **MIPS**; AI → **TOPS**.

3.4 Motherboard, Power & Expansion

- **Motherboard** = main **printed circuit board (PCB)**; also called **system board, mainboard, logic board** (Apple). Connects all components.
- Form factors: **ATX**, Micro-ATX, Mini-ITX. A smaller add-on board = **daughterboard**.

Component	Purpose
CPU socket	Holds the processor (LGA/PGA/BGA)
RAM slots	DIMM (desktop), SO-DIMM (laptop)
Chipset	Controls data flow; old Northbridge (CPU-RAM-GPU) & Southbridge (I/O); now PCH
BIOS / UEFI chip	Firmware in flash ROM ; runs POST & starts booting
CMOS + battery	Keeps BIOS settings, date & time (coin cell CR2032)
Expansion slots	PCIe slots to add graphics, sound, network cards
M.2 / SATA	Connect SSDs & hard disks (old: IDE/PATA)
Heat sink & fan	Absorb & remove heat from CPU/chips

- **Expansion slots** let users **add new components/capabilities** (expansion cards: graphics card, sound card, **NIC**, modem, TV tuner).
- **POST** (Power-On Self-Test) – stored in system ROM; checks hardware at start-up. **Booting** loads the OS from disk into **RAM**.
- **Cold boot** – starting a switched-off computer; **warm boot** – restarting (Ctrl+Alt+Del / Restart).

► Power devices

Device	Key point
SMPS	Switched-Mode Power Supply – converts mains AC to low-voltage DC (12 V, 5 V, 3.3 V); the PC's PSU
UPS	Uninterruptible Power Supply – battery backup during power cuts; types: offline, line-interactive, online
Voltage stabiliser / surge protector	Protects from voltage fluctuation / spikes

3.5 Ports & Connectors

- **Port** = interface/socket through which external (peripheral) devices connect to the computer.
- **Serial port** – sends **1 bit at a time** (slow); COM port, **9-pin (DB-9)**, RS-232 – old mouse, modem.
- **Parallel port** – sends **8 bits together**; LPT, **25-pin (DB-25)** – old **printers & scanners** (exam answer).

Port	Used for
USB	Almost every device; plug & play , hot-swappable; up to 127 devices per host controller
PS/2 (IBM, 1987)	6-pin mini-DIN for keyboard (purple) & mouse (green)
VGA	Analog video, 15-pin D-sub (blue) – old monitors, projectors
DVI	Digital Visual Interface – digital (and analog) video only
HDMI	High-Definition Multimedia Interface – audio + video in one cable (TV, projector)
DisplayPort	VESA standard; digital audio + video; PC monitors
Thunderbolt	Intel + Apple; data, video & power on USB-C connector
RJ-45	Ethernet / LAN cable (8 pins)
RJ-11	Telephone line / dial-up modem (4–6 pins)
FireWire (IEEE 1394)	Apple; old camcorders; 400 / 800 Mbps
SCSI / eSATA	Old high-speed storage connections

► USB versions

Version	Year	Max speed
USB 1.1	1998	12 Mbps
USB 2.0 (Hi-Speed)	2000	480 Mbps
USB 3.0 / 3.2 Gen 1	2008	5 Gbps
USB 3.1 / 3.2 Gen 2	2013	10 Gbps
USB 3.2 Gen 2x2	2017	20 Gbps
USB4	2019	40 Gbps
USB4 Version 2.0	2022	80 Gbps (120 one way)

- **USB = Universal Serial Bus**; developed by **Ajay Bhatt** (Intel) with a group of companies; USB 1.0 in **1996**.
- Connectors: **Type-A** (flat), Type-B (printers), Mini & Micro-USB, **Type-C** (24-pin, **reversible** – same plug on both ends).
- **USB Power Delivery** up to **240 W** over USB-C.
- **Thunderbolt 5** (Intel, Sept 2023): **80 Gbps** both ways, up to **120 Gbps** with Bandwidth Boost.
- **HDMI 2.1** – 48 Gbps (8K). **HDMI 2.2** (June 2025) – **96 Gbps**, new "**Ultra96**" cable, up to **16K**.
- **DisplayPort 2.1** – up to **80 Gbps** (UHBR20).
- **EU common charger law** – USB-C compulsory for phones etc. from **28 Dec 2024** and for laptops from **28 April 2026**.

► Audio jack colours (3.5 mm)

Colour	Use
Green	Line-out – speakers / headphones
Pink	Microphone
Blue	Line-in (audio input)

🔑 MEMORY TRICK: Ports quick recall

- "**HDMI = Hear + See**" – the port that carries **both audio & video**. **VGA = Very old Analog**.
- "**Pink Mic, Green Ear**" – pink = microphone, green = headphones.

3.6 Input Devices

Input devices convert **human-understandable data** into a form the computer can process. Examples: keyboard, mouse, scanner, microphone, webcam, joystick, light pen, OMR, MICR, barcode reader, biometric sensor.

► Keyboard

- Most common input device; layout **QWERTY** – designed by **Christopher Latham Sholes** (1870s) to avoid typewriter **key jamming**.
- Other layouts: **Dvorak** (faster typing), **AZERTY** (French), **QWERTZ** (German), **InScript** (Indian languages).
- Standard PC keyboard: **101–104 keys**; **12 function keys (F1–F12)**; numeric keypad = **17 keys**.
- **Home keys**: A S D F (left) & J K L ; (right); **F and J** have bumps; on the numeric keypad **5** is the guide key.
- There are **2 Shift**, 2 Ctrl, 2 Alt keys. **Spacebar** has no name printed on it.
- Keystrokes are converted to bits using **ASCII / Unicode** codes. Speed of typing = **WPM** (Words Per Minute).
- **On-Screen Keyboard** – virtual keyboard on the display.

Key type	Examples
Function keys	F1 (Help), F2 (Rename), F5 (Refresh / slide show), F7 (Spelling), F11 (Full screen)
Toggle keys	Caps Lock, Num Lock, Scroll Lock – switch on/off each press
Modifier keys	Shift, Ctrl, Alt, Fn, Windows – change the meaning of other keys
Alphanumeric keys	A–Z, 0–9, symbols
Navigation keys	Arrow keys, Home, End, Page Up/Down, Insert, Delete
Special keys	Enter, Esc, Tab, Backspace (deletes left), Delete (deletes right)

- **Shift + Delete** = delete permanently (skips Recycle Bin). **Ctrl + Alt + Del** = Task Manager / security screen.

► Mouse & other pointing devices

- **Mouse** – invented by **Douglas Engelbart** at **Stanford Research Institute (SRI)** in **1964** (first prototype built by **Bill English**; wooden case). Patent "X-Y Position Indicator" granted 1970.
- Most widely used **pointing device** ("point and draw" device). Pointer usually appears as an **arrow**.
- Types: **mechanical** (rubber/metal ball), **optical** (LED + small **CMOS** camera sensor), **laser**, **wireless** (RF / Bluetooth).
- Operations: click, double-click, **right-click** (opens shortcut menu / **properties**), drag & drop, scroll. Sensitivity in **DPI**; smallest movement unit = **mickey**.
- **Trackball** – "upside-down mouse"; ball on top is rolled by fingers; the device stays **stationary**.
- **Touchpad / trackpad** – default pointing device of **laptops**. **Pointing stick** (TrackPoint) – small stick in the middle of a laptop keyboard.

- **Joystick** – stick pivoting on a base; moves **360°**; used for **games**, aircraft cockpits, cranes, CAD. A **gamepad** is held in both hands.
- **Light pen** – pen-shaped, **light-sensitive** device to point at / draw on a screen (CRT).
- **Stylus** – pen used on touch screens & tablets. **Graphics tablet / digitizer** – converts hand drawing on a tablet into digital signals (CAD, signatures).

► Touch screen

- Works as **both input & output** device.
- First touch screen (capacitive) – **E. A. Johnson**, UK, 1965. **Resistive** touch screen – **G. Samuel Hurst** (USA, 1970s) – the name usually given in exams.
- **Resistive** – layers pressed together; works with any stylus (ATMs, kiosks). **Capacitive** – senses the body's charge; multi-touch (smartphones, tablets).

► Scanners

- A **scanner** converts **hard copy into soft copy** (digital image). Resolution in **DPI**; document-scanner speed in **PPM**. Software standard = **TWAIN**.

Type	Key point
Flatbed	Document on a glass bed; can scan books & photos (most common)
Sheet-fed (ADF)	Automatic Document Feeder; loose sheets only, not books
Handheld	Moved by hand over the page; barcode & pen scanners are handheld
Drum	Uses photomultiplier tube (PMT) ; highest resolution (printing industry)

► Data-recognition devices (very important)

Device	Reads	Used in
OCR – Optical Character Recognition	Printed / typed / handwritten text → editable text	Digitising documents, image-to-text apps
OMR – Optical Mark Recognition	Pencil/pen marks in fixed positions	Multiple-choice exam sheets, surveys
MICR – Magnetic Ink Character Recognition	Characters printed with magnetic (iron-oxide) ink	Banks – cheque processing

Device	Reads	Used in
BCR – Bar Code Reader	Thick & thin lines of a barcode (laser/LED)	Shops (POS), libraries, inventory
QR code scanner	2-D matrix code (squares)	UPI payments, URLs, tickets
RFID reader	Radio tags without line of sight	FASTag toll, libraries, logistics

- **MICR code** (bottom strip of a cheque) = **9 digits: city code (3) + bank code (3) + branch code (3)**.
- Indian cheque MICR band: **cheque no. (6) – MICR code (9) – short account no. (6) – transaction code (2)**; font **E-13B** (CTS-2010 standard).
- **Cheque Truncation System (CTS)** – cheque **image** travels instead of paper. RBI moved CTS to **continuous clearing** from **4 Oct 2025** – cheques now clear within **hours** (phase 2 from 3 Jan 2026: banks must confirm within 3 hours).
- **QR code** = Quick Response code, invented **1994** by **Denso Wave** (Japan, Toyota group). Barcodes are 1-D; QR codes are 2-D.

✍ MEMORY TRICK: OCR / OMR / MICR

- **OCR** → "Characters" (text); **OMR** → "Marks" (exam sheets); **MICR** → "Magnetic Money" (cheques).

► Biometric & other input devices

- **Biometric devices** identify a person by **physical/behavioural traits: fingerprint, iris, retina, face, palm/vein, voice, signature**. Aadhaar uses fingerprint, iris & face.
- **Microphone** – converts sound to electrical signals (input); **speech-recognition software** converts voice into text/commands. Exams credit **Emile Berliner** (1876) with inventing the microphone.
- **Webcam** – digital video camera for video calls (input). **Digital camera** – input (exam answer may be "both input & output").
- Others: **magnetic-stripe & smart-card (chip) readers** (ATM/POS), sensors, **Braille keyboard**, game controllers, VR controllers.

3.7 Output Devices

- Output devices convert computer results into **human-understandable** form.
- **Soft copy** = output on screen/audio (temporary). **Hard copy** = printed on paper (permanent).
- **Monitor** = primary/standard output device; also **VDU** (Visual Display Unit).

► Monitor types

Type	Key point
CRT – Cathode Ray Tube	Vacuum tube with electron gun & phosphor screen; bulky, heavy
LCD – Liquid Crystal Display	Thin, low power; needs a backlight ; TFT = active-matrix LCD
LED monitor	LCD panel with LED backlight ; most common today
OLED – Organic LED	Self-emitting pixels, no backlight; true black; foldable phones
Plasma	Gas cells; large TVs (now obsolete)

► Display terms

- **Pixel** (Picture Element) – **smallest unit** of a displayed image; each colour pixel = **3 sub-pixels (Red, Green, Blue)**.
- **Resolution** – number of pixels (width × height). Higher resolution → **pixels closer together** → sharper image.
- **Refresh rate** – how many times per second the screen is redrawn (Hz: 60, 120, 144). **Dot pitch** – distance between pixels.
- **Screen size** – measured **diagonally** in inches.
Aspect ratio – usually **16:9**.

Name	Resolution
CGA (1981)	320 × 200 (4 colours)
EGA (1984)	640 × 350 (16 colours)
VGA (1987)	640 × 480
SVGA	800 × 600
XGA	1024 × 768
SXGA	1280 × 1024
HD (720p)	1280 × 720
Full HD (1080p)	1920 × 1080
QHD (1440p)	2560 × 1440

Name	Resolution
4K UHD	3840 × 2160
8K UHD	7680 × 4320

► Printers

Impact printers	Non-impact printers
Print head strikes a ribbon against paper	No striking ; ink, toner or heat
Noisy; can print carbon / multipart copies	Quiet; better quality; no carbon copies
Dot matrix, daisy wheel, line (drum, chain, band)	Laser, inkjet, thermal, LED, 3-D

Printer	Key facts
Dot matrix	Print head of 9 or 24 pins strikes an inked ribbon ; speed CPS ; prints text & simple graphics; used for bank passbooks & multipart forms
Daisy wheel	Rotating "petal" wheel (petal printer); letter quality; cannot print graphics ; prints one character at a time
Line printer	Prints a whole line at once (drum, chain, band); speed LPM
Inkjet	Sprays tiny ink drops from ink cartridges ; colour photos; home use
Laser	Toner powder + laser on a photosensitive drum (xerography); best for text & DTP ; speed PPM ; invented at Xerox PARC (Gary Starkweather, 1971)
Thermal	Uses heat on heat-sensitive paper , no ink; ATM slips, POS bills, fax
3-D printer	Builds objects layer by layer (additive manufacturing); common method FDM (Fused Deposition Modelling)

- Printer **speed**: **CPS** (dot matrix, daisy wheel), **LPM** (line printers), **PPM** (laser, inkjet).
Resolution (quality): **DPI** (dots per inch).
- **Spooling** – stores print jobs in a queue (buffer) so the CPU need not wait for the printer.
- **Multifunction printer (MFP)** – print + scan + copy + fax (input & output).
- Printing press (c. 1440) was by **Johannes Gutenberg**; **Epson EP-101** (1968) was the world's first mini electronic printer.

► Plotters & other output devices

- **Plotter** – draws **vector graphics** with pens (or inkjet) on large paper – architectural blueprints, maps, **CAD/CAM**. Types: **drum (roller)** & **flatbed**.
- **Speakers / headphones** – audio output; need a **sound card**. **Headset** = speaker (output) + mic (input).
- **Projector** – projects screen on a wall (LCD / DLP; brightness in **lumens**).
- Others: **Braille embosser**, VR headset display, **GPS navigator** screen, **ARU** (Audio Response Unit).

► Input + output (I/O) devices

- **Touch screen, modem, NIC (network card), headset, fax machine, multifunction printer, sound card, digital camera** (exam).
- **Dumb terminal** – only **keyboard + monitor**, no processing of its own. **POS terminal** – keyboard input + small display (shops, card payments).

★ REMEMBER THIS

- Mouse → **Douglas Engelbart (SRI, 1964)**; QWERTY → **Sholes**; USB → **Ajay Bhatt**; laser printer → **Xerox PARC**.
- **MICR** → banks/cheques; **OMR** → exam sheets; **OCR** → text; **BCR** → shops.
- Non-impact printers = **Laser, Inkjet, Thermal**; impact = **Dot matrix, Daisy wheel, Line, Drum, Chain**.
- Laser printer uses **toner**, not ink; thermal printer needs **special heat-sensitive paper**.
- **Pixel** = smallest unit of an image; **DPI** = printer/scanner resolution.
- USB supports up to **127 devices**; **Type-C** is reversible.

3.8 Latest Processors & AI PCs (2024–26)

- **AI PC** = computer with a built-in **NPU** for on-device AI (live captions, image generation, Copilot).
- **Copilot+ PC** (Microsoft, **May 2024**): needs an NPU of **40+ TOPS**, at least **16 GB RAM & 256 GB SSD**. First devices used Qualcomm **Snapdragon X Elite**.

Processor	Key facts
Intel Core Ultra Series 2 (2024)	Lunar Lake (200V, laptops) & Arrow Lake (200S, desktops)
Intel Core Ultra Series 3 (Jan 2026)	Panther Lake – first chips on Intel 18A process; up to 16 cores; NPU up to 50 TOPS
AMD Ryzen AI 300 (2024)	Zen 5 cores, NPU up to 50 TOPS
AMD Ryzen AI 400 (Jan 2026)	NPU up to 60 TOPS (Ryzen AI 9 HX 475)
Apple M4 (2024)	3 nm; first in iPad Pro
Apple M5 (Oct 2025)	3 nm (N3P); 10-core CPU; Neural Accelerator in every GPU core ; 16-core Neural Engine
Apple M5 Pro / M5 Max (Mar 2026)	For MacBook Pro
Qualcomm Snapdragon X2 Elite / X2 Elite Extreme	Arm-based; announced Sept 2025; NPU 80 TOPS ; laptops in 2026

► India's own processors

- **Vikram 3201** – India's first fully indigenous **32-bit microprocessor** for space use; by **ISRO (VSSC) & Semi-Conductor Laboratory (SCL)**, Chandigarh; **180 nm CMOS**; supports **Ada** language.
- First lots handed over in **March 2025**; validated in space on **PSLV-C60 (POEM-4)**; presented to PM Narendra Modi at **Semicon India 2025** (2 Sept 2025, New Delhi).
- **Kalpana 3201** – 32-bit **SPARC V8 RISC** processor developed alongside Vikram 3201.
- **SHAKTI** – open-source **RISC-V** processors by **IIT Madras. India Semiconductor Mission (ISM)** launched **Dec 2021**.

★ REMEMBER THIS

- **TOPS** = Trillion Operations Per Second (AI speed of NPU). Copilot+ PC = **40+ TOPS NPU**.
- **Panther Lake** = Intel Core Ultra Series 3 on **18A**; **M5** = Apple (Oct 2025); **Snapdragon X2 Elite** = Qualcomm, Arm.
- **Vikram 3201** = ISRO + SCL Chandigarh, 32-bit, 180 nm.

3.9 Practice MCQs (Previous-Year Pattern)

Q1. Which part of the computer is used for calculating and comparing? (IBPS PO 2012)

- (a) ALU (b) Control Unit (c) Disk unit
(d) Modem (e) None of these

Ans: (a) The ALU does arithmetic and logical (comparison) operations.

Q2. The function of the Control Unit in the CPU is to: (IBPS RRB 2023)

- (a) decode program instructions
(b) transfer data to primary storage
(c) store program instructions
(d) perform arithmetic operations
(e) None of these

Ans: (a) The CU fetches and decodes instructions and directs other units.

Q3. A microprocessor with 12 address lines is capable of addressing: (LIC Asst 2009)

- (a) 1,024 locations (b) 2,048 locations
(c) 4,096 locations (d) 64 locations
(e) 8,192 locations

Ans: (c) n address lines address 2^n locations; $2^{12} = 4,096$.

Q4. Which of the following buses is uni-directional?

- (a) Data bus (b) Address bus
(c) System bus as a whole (d) PCIe bus
(e) None of these

Ans: (b) The address bus carries addresses only from the CPU outwards.

Q5. Which device is used by banks to read the codes printed at the bottom of cheques?

- (a) OCR (b) OMR (c) MICR
(d) Barcode reader (e) Light pen

Ans: (c) MICR reads characters printed in magnetic ink on cheques.

Q6. Which of the following is a non-impact printer? (IBPS RRB PO 2023)

- (a) Dot matrix (b) Drum (c) Inkjet (d) Chain
(e) Daisy wheel

Ans: (c) Inkjet sprays ink; the others strike a ribbon (impact).

Q7. Which port carries both audio and video signals in a single cable? (IBPS RRB 2023)

- (a) VGA (b) PS/2 (c) HDMI (d) RJ-45
(e) Serial

Ans: (c) HDMI is a digital interface carrying both audio and video.

Q8. The first computer mouse was built by:

(Allahabad Bank Clerk 2011)

- (a) Douglas Engelbart (b) Christopher Sholes
(c) Ajay Bhatt (d) Alan Kay (e) None of these

Ans: (a) Engelbart built the first mouse at SRI in 1964.

Q9. The speed of a laser printer is measured in:

- (a) CPS (b) LPM (c) PPM (d) DPI (e) MIPS

Ans: (c) Laser and inkjet printers are rated in Pages Per Minute; DPI is resolution.

Q10. "Vikram 3201", India's first indigenous 32-bit space-grade microprocessor, was developed by:

- (a) DRDO and BEL (b) ISRO and SCL Chandigarh
(c) C-DAC and IIT Madras (d) Tata Electronics
(e) BARC

Ans: (b) ISRO's VSSC and Semi-Conductor Laboratory, Chandigarh, built it on 180 nm.

CHAPTER 4 MEMORY & STORAGE

4.1 Computer Memory – Basics

- **Memory** = the part of a computer that **stores data, instructions and results** (like the human brain).
 - Two main types: **Primary (Main / Internal) memory** and **Secondary (Auxiliary / External) memory**.
 - Smallest unit of memory = **bit**; basic addressable unit = **byte**; one storage location = **memory cell**.
 - **Volatile** = contents lost when power goes OFF (RAM, cache, registers). **Non-volatile** = contents kept (ROM, flash, HDD, SSD, CD).
 - Data in secondary memory **cannot be processed directly** by the CPU – it is first copied into **RAM**.
- **How the CPU Searches for Data**
- **Register → Cache (L1 → L2 → L3) → RAM → Secondary storage**.
 - If data is found in cache = **cache hit**; not found = **cache miss**. Performance = **hit ratio** (hits ÷ total requests).
 - **Locality of reference** (recently/nearby used data is used again) is why cache works.

► **Primary vs Secondary Memory**

Primary Memory	Secondary Memory
Main / internal memory	Auxiliary / external / backup storage
Directly accessed by CPU	Not directly accessed; via RAM
Very fast, costly per bit	Slower, cheaper per bit
Small capacity (GB)	Huge capacity (TB)
RAM volatile; ROM non-volatile	Non-volatile (permanent)
Semiconductor chips on motherboard	Magnetic, optical, flash devices
e.g. RAM, ROM, cache	e.g. HDD, SSD, pen drive, CD, tape

4.2 Memory Hierarchy & Access Time

Level	Typical access time	Size
Registers (inside CPU)	< 1 ns	Bytes (32/64-bit each)
L1 cache	~1 ns	32–64 KB per core
L2 / L3 cache	~3–15 ns	MB (L3 shared)
RAM (DRAM)	~50–100 ns	8–64 GB (PC)
SSD (NVMe)	~0.1 ms (100 μ s)	0.5–8 TB
HDD	~5–10 ms	1–44 TB
Optical / Tape	Seconds (tape)	GB / tens of TB

Figures are approximate, for understanding only.

- Going **down** the pyramid: **speed ↓**, **cost per bit ↓**, **capacity ↑**, **access time ↑**.
- **Fastest** memory = **Register**; 2nd = **Cache**; then **RAM**. **Slowest** = magnetic tape.
- Time units: **ms (10^{-3} s) > μ s (10^{-6}) > ns (10^{-9}) > ps (10^{-12})**. Memory access time is usually in **nanoseconds**.
- **Access time** = time to locate & read data. For HDD: **Seek time + Rotational latency** (+ transfer time).
- **Data transfer rate** = amount of data moved per second (MB/s, GB/s).

✍ **MEMORY TRICK: Hierarchy order (fast → slow)**

► **"Real Cool Rabbits Stay Home On Tuesday"**
→ Register, Cache, RAM, SSD, HDD, Optical, Tape.

4.3 Registers & Cache Memory

► **Registers**

- Smallest, **fastest** memory, located **inside the CPU**; holds data/instructions being used **right now**.
- A **flip-flop** stores **1 bit**; a **group of flip-flops** = **register** (a **sequential circuit**).
- Register size = **word size** of the CPU (32-bit / 64-bit).

Register	Function
PC – Program Counter	Address of the next instruction
IR – Instruction Register	Instruction currently being executed
MAR – Memory Address Reg.	Address of memory location to read/write
MBR / MDR – Memory Buffer / Data Reg.	Data read from / to be written to memory
ACC – Accumulator	Intermediate results of ALU

► Cache Memory

- Very high-speed memory **between CPU and RAM**; holds **frequently used** data & instructions; reduces the **speed mismatch** between CPU and RAM.
- Made of **SRAM**; costly, so small. Today it is built **on the CPU chip** itself.
- **Levels: L1** (smallest, fastest, per core; split into instruction & data), **L2** (per core), **L3** (largest, shared by all cores).
- When cache is full, an old block is replaced – common policy **LRU = Least Recently Used**.
- Register = data needed **immediately**; Cache = data needed **in near future**.
- Other caches: **disk cache/buffer** on HDD/SSD, **browser cache**, **CPU-GPU shared cache**.

► Buffer

- Temporary area (usually in **RAM**) that holds data **before it is used**; compensates for **different speeds** of two devices (e.g. video streaming, printer **spooling**).

4.4 RAM – Random Access Memory

- **Read/Write memory (RWM)**; **volatile** & temporary; called "random access" because **any location can be reached directly in the same time**.
- Holds the **OS, running programs and data** currently in use. More RAM = more programs at once (multitasking).
- **Robert H. Dennard** (IBM) invented the **one-transistor DRAM cell** (1966; patented 1968). **Intel 1103** (1970) = first commercial DRAM chip.
- Speed: data rate in **MT/s** (mega-transfers/s), often loosely written as MHz (e.g. **DDR5-6400** = 6400 MT/s); also **latency (CL)** and **bus width**.

- Module types: **DIMM** (desktop), **SO-DIMM** (laptop); **LPDDR** is soldered on phones/thin laptops.

► SRAM vs DRAM

SRAM (Static)	DRAM (Dynamic)
Cell = flip-flop (~6 transistors)	Cell = 1 transistor + 1 capacitor
No refresh needed while power is ON	Must be refreshed constantly (capacitor leaks; each row within ~64 ms)
Faster, costlier , more power	Slower, cheaper , high density
Used for cache	Used as main memory (PC, laptop, mobile)

► Evolution of DRAM (exam + 2025–26 update)

Type	Key point
SDRAM	Synchronous DRAM – synchronised with system clock (1990s)
DDR SDRAM	Double Data Rate – transfers on both clock edges (2000); DDR2 (2003), DDR3 (2007), DDR4 (2014)
DDR5 (2020)	Current PC/server RAM; JEDEC speeds up to 8800 MT/s (2024 update); on-module PMIC, on-die ECC
DDR6	Still being developed by JEDEC; products expected ~2027–28 (not yet in PCs)
LPDDR5X → LPDDR6	Low-Power DDR for phones; LPDDR6 standard published by JEDEC July 2025
GDDR7	Graphics DDR for GPUs (JEDEC 2024); used in Nvidia RTX 50 series (2025)
HBM3E → HBM4	High Bandwidth Memory – stacked DRAM for AI GPUs ; HBM4 (JEDEC Apr 2025): 2048-bit interface, up to 2 TB/s per stack; volume use from 2026 (Nvidia Rubin)
Older names	RDRAM = Rambus DRAM; EDO, FPM = early asynchronous DRAM

- **CXL (Compute Express Link)** – open interconnect over PCIe to **add / share (pool) extra memory** in servers; **CXL 4.0** released Nov 2025 (128 GT/s).

4.5 ROM – Read Only Memory

- **Non-volatile**, permanent memory; mainly read; contents written by manufacturer (or by special process).
- Stores **firmware** – e.g. **BIOS/UEFI**, **bootstrap loader** (start-up program).
- Primary memory = **RAM + ROM** (note: only RAM is volatile).

Type	Programmed / erased	Key point
MROM (Mask ROM)	Written by factory during manufacture	Cannot change; cheap in bulk; custom-built
PROM	Programmed once by user (PROM burner)	OTP – One-Time Programmable; Wen Tsing Chow (1956)
EPROM / UVEPROM	Erased by ultraviolet light (quartz window), whole chip	Dov Frohman , Intel (1971)
EEPROM / E²PROM	Erased electrically , byte by byte, in-circuit	Most flexible ROM; small settings storage
Flash	Erased electrically in blocks	Fast, high-density form of EEPROM

✎ MEMORY TRICK: ROM family order

- **"My Pet Eats Eggs Fast"** → **MROM**, **PROM**, **EPROM**, **EEPROM**, **Flash** (less flexible → most flexible).
- **EPROM = UV** ("**E-P-R-O-M** sees the **Ultraviolet sun**"); **EEPROM = Electric** (**double E = Electric Erase**).

► Firmware

- **Firmware** = software permanently stored in a hardware chip (ROM/flash) – "software + hardware".
- Two PC firmware types: **Legacy BIOS** (old) and **UEFI** (Unified Extensible Firmware Interface – modern PCs; supports **GPT** disks > 2 TB, **Secure Boot**).
- Modern BIOS/UEFI is stored in a rewritable **flash (EEPROM-type) chip** so it can be updated ("flashing the BIOS").

- Examples: routers, TV remote, digital watch, washing machine controller, CCTV, modem.

4.6 Flash Memory

- **Non-volatile**, electrically erasable memory developed from **EEPROM**; invented by **Dr. Fujio Masuoka (Toshiba, c. 1980; NOR shown 1984, NAND 1987)**.
- Named "flash" because a whole **block is erased in a flash**. EEPROM = **byte-level** erase; Flash = **block-level** erase.
- "Flash is based on ROM" – it belongs to the **ROM (EEPROM) family** (non-volatile), but in practice it is **read-write** storage.
- Has **finite** program/erase (P/E) cycles → wear-leveilling by controller.
- Uses: **pen drive, SD card, SSD, phone storage, digital camera, BIOS chip**.

NOR Flash	NAND Flash
Random byte/word access; fast read	Page-wise read, block erase
Lower density, costlier	Higher capacity , cheaper
Code storage (BIOS, firmware)	SSD, pen drive, memory card, phone

► NAND cell types (bits per cell)

Type	Bits/cell	Note
SLC	1	Fastest, longest life, costly
MLC	2	Older consumer SSDs
TLC	3	Most common today
QLC	4	High capacity, cheaper, lower endurance
PLC	5	Not yet commercial (2026)

- **3D NAND** stacks cells vertically; **300+ layer** chips in mass production (SK hynix 321-layer, 2025).

4.7 Virtual Memory & Booting

► Virtual Memory

- Part of **secondary storage (HDD/SSD)** used as if it were **RAM** → gives the **illusion of a very large main memory**.
- Lets larger / more programs run than physical RAM allows; managed by the **OS** with the **MMU** (Memory Management Unit).

- Memory divided into fixed-size **pages** (RAM blocks = **frames**); **demand paging** = bring a page in only when needed.
- **Page fault** = page not in RAM; **swap in / swap out** = moving pages between RAM & disk; too much swapping = **thrashing**.
- Windows file: **pagefile.sys**; Linux: **swap** partition/file.

► Booting

- **Booting** = starting the computer and **loading the OS from disk into RAM**.
- **Cold boot** = switching ON from power-off; **Warm boot** = restart (Ctrl+Alt+Del / Restart).
- Steps: power ON → CPU runs **BIOS/UEFI** firmware → **POST** (Power-On Self-Test) checks RAM, keyboard, disks → **bootstrap loader** finds boot device → OS loaded into **RAM**.
- **CMOS** (small battery-backed memory, coin cell) keeps **BIOS settings & date/time**.
- Disk partition styles: **MBR** (old, ≤ 2 TB) and **GPT** (with UEFI).

★ REMEMBER THIS

- **Cache = SRAM; Main memory = DRAM; DRAM needs refresh, SRAM does not.**
- **Fastest memory = Register; memory nearest to CPU = register; high-speed buffer between CPU & RAM = cache.**
- **BIOS is stored in ROM (flash); during booting the OS is loaded into RAM.**
- **EPROM → UV light; EEPROM → electric signal; PROM → once; Mask ROM → factory.**
- **Virtual memory = illusion of large RAM using hard-disk space (demand paging).**
- **Instructions stored in ROM = Firmware. Starting program in ROM = Bootstrap loader.**

4.8 Secondary Storage – Magnetic

- Access methods: **SASD** (Sequential Access Storage Device) – e.g. **magnetic tape**; **DASD** (Direct Access) – e.g. HDD, CD, SSD.

► Magnetic Tape

- Plastic ribbon coated with magnetic oxide; **sequential access** (slowest), **cheapest per GB**, long life.
- Used for **backup & archives** (banks, data centres, mainframes) – an "air-gap" defence against ransomware.
- Modern format **LTO (Linear Tape-Open): LTO-10 – 30 TB native** (2025); a **40 TB LTO-10** cartridge announced Nov 2025 (up to 100 TB compressed).

► Hard Disk Drive (HDD)

- Non-volatile, **random/direct access**; rigid **platters** (aluminium/glass) coated with magnetic material, on a **spindle**.
- Parts: **read/write head** on an **actuator arm**, platters, spindle motor. Head "flies" over the surface; touching it = **head crash**.
- Surface divided into concentric **tracks** → each track into **sectors** (512 bytes or 4 KB); same track on all platters = **cylinder**.
- Dividing a disk into tracks & sectors = **formatting**. Speed in **RPM**: 5400 / 7200 (PC), 10,000 / 15,000 (servers).
- First HDD: **IBM 350 RAMAC (1956)**, ~5 million characters (~3.75 MB).
- **Largest HDDs (2026): Seagate Mozaic 4+ (HAMR)** drives up to **44 TB** shipping to cloud providers (Mar 2026). **HAMR** = Heat-Assisted Magnetic Recording (laser heats the spot while writing).
- **Hybrid drive (SSHD / HHDD)** = HDD + small flash cache.

► Floppy Disk (Diskette)

Size	Capacity	Note
8-inch	80 KB → ~1.2 MB	IBM, 1971 (team led by Alan Shugart)
5.25-inch	360 KB / 1.2 MB	Shugart Associates, 1976
3.5-inch	1.44 MB (HD)	Sony; hard plastic shell

- Thin flexible plastic disk coated with **iron oxide**; drive = **FDD**; drive letters **A:** and **B:** reserved for floppies, so the hard disk became **C:**.
- Iomega **Zip disk** (100–750 MB) – larger removable magnetic disk of the 1990s.

4.9 Secondary Storage – Optical Discs

- Data read by a **laser**; pits and lands on a reflective layer; data on a single **spiral track**. Writing data on a disc = **burning**.
- Optical disc concept: **David Paul Gregg** (videodisc, 1958); digital optical recording: **James Russell** (1965). Audio CD was developed by **Philips & Sony** (1982).
- Suffixes: **ROM** = read only; **R** = recordable once (**WORM** – Write Once Read Many); **RW / RE** = rewritable.

Disc	Laser	Capacity
CD (12 cm)	Infrared, 780 nm	650 MB (74 min) / 700 MB (80 min)
DVD	Red, 650 nm	4.7 GB single layer; 8.5 GB dual layer; up to 17 GB (double-sided dual layer)
Blu-ray (BD)	Blue-violet, 405 nm	25 GB single, 50 GB dual; BDXL 100–128 GB
HVD	Holographic	Several TB (planned) – never reached market

- **DVD** = Digital **Versatile** / Video Disc (1995–96). Rewritable types exist: **DVD-RW, DVD+RW, DVD-RAM**.
- **Blu-ray** – developed by the **Blu-ray Disc Association** led by **Sony** (launched 2006); shorter-wavelength blue laser → denser data → about **5×** a single-layer DVD; used for **HD/4K Ultra HD** video. Formats: **BD-ROM, BD-R, BD-RE** (rewritable).
- **2025**: Sony **ended production of recordable Blu-ray (BD-R) media** in February 2025 – optical media is declining.

🔑 MEMORY TRICK: Disc capacities

- **"7-4-2-5"** → CD **700 MB**, DVD **4.7 GB**, Blu-ray **25 GB** (×2 for dual layer = 50 GB).
- Laser colour gets **bluer** → **shorter wavelength** → **more data**: Infrared (CD) → Red (DVD) → Blue (BD).

4.10 Secondary Storage – Solid State (Flash)

➤ Pen Drive (USB Flash Drive)

- Also called **flash drive / thumb drive / jump drive / memory stick**; NAND flash + USB

connector; plug-and-play, removable, rewritable.

- Appeared around **2000**; capacities today from a few GB up to **1–2 TB**. USB was invented by **Ajay V. Bhatt** (Intel).

➤ SSD – Solid State Drive

- Storage on **NAND flash chips** + controller; **no moving parts** → faster boot, silent, shock-resistant, less power, lighter.
- Interfaces: **SATA** (~550 MB/s) and **NVMe** (Non-Volatile Memory Express) over **PCIe** – usually in **M.2** form factor.
- SSD **"wears out"** after many writes (finite P/E cycles), but modern SSDs last many years.

NVMe generation	Max sequential read (approx.)
PCIe 3.0 x4	~3.5 GB/s
PCIe 4.0 x4	~7 GB/s
PCIe 5.0 x4	~14 GB/s (current high-end PCs)
PCIe 6.0 x4	~28 GB/s – Micron 9650 , first PCIe 6.0 SSD, mass production 2026 (data centres)

- **PCIe 7.0** spec (128 GT/s) finalised **June 2025**; **PCIe 8.0** (256 GT/s) announced Aug 2025.
- **Largest SSD: 245.76 TB** enterprise QLC SSDs (Kioxia **LC9**, July 2025).

➤ HDD vs SSD

HDD	SSD
Spinning magnetic platters	Flash memory chips
Moving parts – noise, heat, damage risk	No moving parts – durable
Slower (~100–250 MB/s)	Much faster (0.5–14+ GB/s)
Cheaper per TB ; largest sizes	Costlier per TB

➤ Memory Cards & Phone Storage

- **Memory card / flash card** – small, removable flash storage for cameras, phones. **SD** (Secure Digital, 1999), **miniSD**, **microSD**; older **MMC** (MultiMediaCard), **CF** (CompactFlash).
- **microSD Express** – uses **PCIe/NVMe**; up to **~985 MB/s** (vs ~104 MB/s UHS-I). **Nintendo Switch 2** (June 2025) accepts **only microSD Express** cards for games.

- Phone internal storage: **eMMC** (budget) and **UFS** (Universal Flash Storage). **UFS 4.0/4.1** $\approx$ 4–5.8 GB/s; **UFS 5.0** published by JEDEC (early 2026), up to **10.8 GB/s**.

SD type	Capacity range
SDSC – Standard Capacity	up to 2 GB
SDHC – High Capacity	> 2 GB to 32 GB
SDXC – eXtended Capacity	> 32 GB to 2 TB
SDUC – Ultra Capacity	> 2 TB to 128 TB

★ REMEMBER THIS

- **Sequential access** = magnetic tape;
Direct/random access = HDD, CD/DVD, SSD.
- **3.5-inch floppy** = **1.44 MB**; **CD** = **700 MB**;
DVD = **4.7 GB**; **Blu-ray** = **25/50 GB**.
- Blu-ray uses a **blue-violet laser (405 nm)**;
company associated = **Sony**.
- Pen drive, SD card, SSD = **solid-state / flash**
storage. **No moving parts**.
- **CD-RW / DVD-RW / BD-RE** = rewritable; **CD-R**
= write once (WORM).
- Concentric circles on a disk = **tracks**; pie-
shaped divisions = **sectors**.

4.11 Units of Memory

- **Bit** (Binary digIT) = 0 or 1 – smallest unit. **4 bits**
= **1 Nibble**. **8 bits** = **1 Byte** (also called an
Octet). A byte stores **one character**; its value
range is **0–255**.
- **Word** = number of bits a CPU handles at once
(16 / 32 / 64 bits).

Unit	Binary (exam) value	Power of 2
1 Kilobyte (KB)	1024 Bytes	2^{10}
1 Megabyte (MB)	1024 KB	2^{20}
1 Gigabyte (GB)	1024 MB	2^{30}
1 Terabyte (TB)	1024 GB	2^{40}
1 Petabyte (PB)	1024 TB	2^{50}
1 Exabyte (EB)	1024 PB	2^{60}
1 Zettabyte (ZB)	1024 EB	2^{70}
1 Yottabyte (YB)	1024 ZB	2^{80}
1 Ronnabyte (RB)	1024 YB (SI: 10^{27} B)	2^{90}
1 Quettabyte (QB)	1024 RB (SI: 10^{30} B)	2^{100}

- **Ronna (10^{27})** and **quetta (10^{30})** were added to
the SI system by the **27th CGPM in November 2022** – the first new SI prefixes since 1991.
They are now the largest official prefixes.
- "**Brontobyte**" and "**Geopbyte**" are **unofficial**
names – not SI units.

► KB vs KiB – Decimal vs Binary

Decimal (SI) – used by disk makers	Binary (IEC, 1998)
1 kB = 1000 B = 10^3	1 KiB (kibibyte) = 1024 B = 2^{10}
1 MB = 10^6 B	1 MiB (mebibyte) = 2^{20} B
1 GB = 10^9 B	1 GiB (gibibyte) = 2^{30} B
1 TB = 10^{12} B	1 TiB (tebibyte) = 2^{40} B

- In bank exams, **1 KB = 1024 bytes** (unless the
question says decimal). Strictly, 1024 bytes = **1 KiB**.
- That is why a "1 TB" drive shows only about
931 GB in Windows ($10^{12} \div 2^{30} \approx 931$).
- Small **b** = bit, capital **B** = byte: **1 MBps = 8 Mbps**.

✎ MEMORY TRICK: Order of units

- "**King Midas Gave The Poor Every Zinc Yellow Ring Quickly**" → Kilo, Mega, Giga, Tera, Peta, Exa, Zetta, Yotta, Ronna, Quetta.
- Each step = $\times 1024$ (binary) or $\times 1000$ (decimal).

★ REMEMBER THIS

- **4 nibbles = 16 bits = 2 bytes**; 1 byte = 8 bits;
1 KB = 1024 bytes = 8192 bits.
- **1024 TB = 1 PB**; **1024 PB = 1 EB**; **1024 EB = 1 ZB**; **1024 ZB = 1 YB**.
- Approx: **MB $\approx$ million bytes**, **GB $\approx$ billion bytes**, **TB $\approx$ trillion bytes**.
- Descending: **PB > TB > GB > MB > KB > Byte > Nibble > Bit**.

4.12 Practice MCQs (Previous-Year Pattern)

Q1. Which type of RAM is used to make cache memory? (SBI Clerk 2012)

- (a) SRAM (b) DRAM (c) SDRAM (d) EEPROM
(e) Flash

Ans: (a) Cache needs high speed and no refresh, so it uses Static RAM.

Q2. Which of the following memories must be refreshed many times per second? (IBPS Clerk 2011)

- (a) SRAM (b) DRAM (c) ROM (d) EPROM
(e) Flash

Ans: (b) A DRAM cell stores charge in a leaking capacitor, so it must be refreshed constantly.

Q3. The high-speed memory that compensates for the speed gap between the processor and main memory is: (IBPS Clerk 2015)

- (a) PROM (b) EPROM (c) Virtual memory
(d) Hard disk (e) Cache

Ans: (e) Cache sits between CPU and RAM and holds frequently used data.

Q4. Virtual memory is: (SBI Clerk 2011)

- (a) an extremely large main memory (b) an extremely large secondary memory
(c) an illusion of an extremely large main memory
(d) a memory used only in supercomputers
(e) a type of ROM

Ans: (c) The OS uses disk space as if it were RAM, giving the illusion of large main memory.

Q5. In which type of ROM is the data erased using ultraviolet light?

- (a) Mask ROM (b) PROM (c) EPROM
(d) EEPROM (e) Flash

Ans: (c) EPROM (UVEPROM) is erased by exposing the chip window to UV light; EEPROM is erased electrically.

Q6. When you first turn on a computer, the CPU is preset to execute instructions stored in the: (IBPS PO 2015)

- (a) RAM (b) Flash drive (c) CD-ROM (d) ROM
(e) ALU

Ans: (d) The BIOS/UEFI start-up firmware and bootstrap loader are in ROM (flash).

Q7. 1024 Exabytes (EB) is equal to one: (IBPS RRB PO 2023)

- (a) Petabyte (b) Yottabyte (c) Zettabyte
(d) Terabyte (e) Ronnabyte

Ans: (c) Order: PB → EB → ZB → YB; 1024 EB = 1 ZB.

Q8. How many bits are there in 4 nibbles? (IBPS RRB Scale-II 2023)

- (a) 64 (b) 16 (c) 8 (d) 32 (e) 4

Ans: (b) 1 nibble = 4 bits, so 4 nibbles = 16 bits (2 bytes).

Q9. A single-layer Blu-ray disc can store about:

- (a) 700 MB (b) 4.7 GB (c) 8.5 GB (d) 25 GB
(e) 50 GB

Ans: (d) Single-layer BD = 25 GB; dual-layer = 50 GB; DVD = 4.7 GB; CD = 700 MB.

Q10. Which storage device accesses data only sequentially?

- (a) Hard disk (b) Magnetic tape (c) CD-ROM
(d) SSD (e) Pen drive

Ans: (b) Magnetic tape is a SASD; it must be read in order to reach the required data.

CHAPTER 5 SOFTWARE & OPERATING SYSTEMS

5.1 Software – Basics & Types

- **Software** = a set of **programs, instructions & data** that tells the computer what to do. It is **intangible** (cannot be touched).
- **Program** = a set of instructions for one task.
Module = smallest independent unit of a software; a collection of modules makes a software.
- Executable file extension in Windows = **.exe** (also .com, .bat); a collection of linked object code = **executable file**.
- Two main categories: **System software** and **Application software** (IBPS / Allahabad Bank favourite).
- Primary purpose of software = turn **data into information**.

System Software	Application Software
Runs & manages the hardware ; platform for other software	Performs a specific user task (letter, music, billing)
Computer cannot run without it	Computer can run without it
Starts at boot, runs till shutdown	Starts/stops on user request
Runs independently; mostly low-level code	Needs system software (OS) to run; written in high-level languages
e.g. OS, device drivers, firmware, translators, utilities	e.g. MS Word, Chrome, Photoshop, Tally, VLC

► Kinds of System Software

Type	Meaning	Examples
Operating System	Interface between user & hardware; manages all resources	Windows, macOS, Linux, Android, iOS
Device Driver	Lets the OS communicate with a particular I/O device	Printer, graphics, sound, mouse drivers
Firmware	Software permanently stored in ROM/flash of a device	BIOS/UEFI, router & camera firmware

Type	Meaning	Examples
Utility Software	Maintains, protects & improves performance	Antivirus, Disk Cleanup, Defragmenter, WinRAR/7-Zip, backup
Language Translator	Converts program code to machine code	Compiler, interpreter, assembler

- **Middleware** – "glue" software between the OS/database and applications, or between **client & server** parts (e.g. web servers, message queues). **Embedded middleware** links built-in apps with a real-time OS.
- **Disk Defragmenter** – utility that collects scattered **fragments** of files into continuous blocks → faster disk access (needed for HDD, not SSD).
- **Compression utility** (WinZip, WinRAR, 7-Zip) – makes files **smaller & faster to transfer**.
- **DirectX** – Microsoft software (APIs) that drives graphics/multimedia & games.

► Kinds of Application Software

Type	Examples
Word processor	MS Word, Google Docs, Apple Pages, LibreOffice Writer, WordStar (old)
Spreadsheet	MS Excel, Google Sheets, Apple Numbers , Lotus 1-2-3 (old, DOS)
Presentation	MS PowerPoint, Google Slides, Apple Keynote
DBMS / Database	MS Access, MySQL, Oracle, FoxPro, dBase
Web browser	Chrome, Edge, Firefox, Safari, Opera
E-mail client	MS Outlook, Thunderbird
Multimedia / graphics	Photoshop, VLC, Windows Media Player, CorelDRAW
Accounting / banking	Tally; Finacle (Infosys) & BaNCS (TCS) – core banking

- **Horizontal software** – general software usable by all businesses (MS Office).

- **Vertical software** – industry-specific, niche / customised software (e.g. **Finacle** for banks, hospital software).
- **Software package / suite** – set of programs with full **documentation** (e.g. MS Office). A **user manual** tells how to use a program.
- **Text editor** (Notepad) – treated as **application software** in exam keys.

5.2 Freeware, Shareware, Open Source & Licences

Type	Key point	Examples
Freeware	Free to use; no source code , cannot modify	Adobe Acrobat Reader, CCleaner Free, IrfanView
Shareware	Free trial for limited time/features; then pay	WinZip, WinRAR (trial)
Open Source (OSS)	Source code available ; can study, modify & redistribute	Linux, Android (AOSP), Firefox, LibreOffice, VLC, MySQL, Apache, OBS Studio
Proprietary / Closed source	Source code secret; paid licence; only the owner can change	MS Windows, MS Office, macOS, Photoshop
Public domain	No copyright at all; anyone may use/change	Old freely released programs, SQLite
Commercial	Sold for profit – majority of software bought from publishers	MS Office, Tally

- **FOSS = Free & Open Source Software**; **FLOSS** = Free/Libre & Open Source. **GNU GPL** – common open-source licence (Richard Stallman, Free Software Foundation, 1985).
- **Trialware / Demoware** – limited trial version (a shareware model). **Nagware (Annoyware/Begware)** – keeps showing **pop-up reminders** to buy. **Adware** – shows ads. **Malware** – malicious software (virus, worm, Trojan, spyware, ransomware).
- **EULA = End User License Agreement** – legal contract between publisher & user.
- **Software piracy** – illegal copying & distribution of software.

- **Bug** – error/defect in software; **Debugging** – finding & removing bugs.
- **Patch / fix** – small repair for a known bug (usually free). **Update** – changes to the existing version. **Upgrade** – replacing with a **new version**.
- **Alpha testing** – by testers **inside** the company; **Beta testing** – by real **end users** before final release.

✎ MEMORY TRICK: Free vs Open

- **"Free = Free Beer, Open = Open Recipe"** – Freeware costs nothing but hides the recipe (source code); Open source gives you the recipe to change.
- **SHAREware = SHARE trial, then pay;**
NAGware = NAGs you with pop-ups.

5.3 Language Translators & Other System Programs

Program	Job
Assembler	Assembly language (mnemonics) → machine code
Compiler	Whole high-level program → machine/object code in one go ; fast execution
Interpreter	High-level program → executed line by line ; slower; no object file (Python, BASIC)
Linker	Joins object modules & libraries into one executable ; resolves references among files
Loader	Loads the executable from disk into RAM (main memory) for execution

- Flow: **Source code → Compiler → Object code → Linker → .exe → Loader → RAM.**
- **Java** uses **both** – compiler (javac → bytecode) + JVM interpreter/JIT. Java compiler is **OS-independent** (bytecode runs anywhere).
- Errors shown by the compiler = **syntax errors**. Interpreter = **slower** in execution (IBPS Clerk 2012). Details in Chapter 14.

5.4 Operating System – Basics & Functions

- **Operating System (OS)** = system software that acts as an **interface between user & hardware**

and controls execution of all programs; also called **resource manager / resource controller**.

- It is a **collection of software routines**, built **directly on the hardware**; the **first program loaded** when the computer boots. A computer **cannot boot without an OS**.
- "Every computer has an **operating system**, many also have **application programs**." (RBI Grade B 2014)
- **First OS = GM-NAA I/O (1956)** by **General Motors** (with North American Aviation) for the **IBM 704** (often written "GMOS").
- **Gary Kildall** – created **CP/M (1974)**, the first popular microcomputer OS; often called "father of the PC operating system".

► Functions of an OS

Function	What it does
Process management	Creates, schedules & ends processes; CPU time-sharing
Memory management	Allocates/frees RAM; virtual memory (swap/page file on disk)
Device (I/O) management	Controls devices via drivers ; handles interrupts ; spooling
File management	Creates, stores, names, deletes files & folders
Security	Passwords, user accounts, permissions
User interface	Provides CLI or GUI
Networking	Lets computers share data & resources

► Important OS Terms (asked in RRB PO 2022–23)

Term	Meaning
Process	A program in execution
Thread	Smallest unit of a process; one path of execution (placeholder for one use of a multi-user program)
Interrupt	Signal from hardware/software needing the OS's immediate attention
Deadlock	Two processes each hold a resource the other needs → both stuck
Virtual memory	Part of the hard disk used as extra RAM (swap file / page file)

Term	Meaning
Paging	Memory divided into equal pages/frames; page fault = page not found in RAM; demand paging loads pages only when needed
Spooling	Queues jobs (e.g. print jobs) on disk for a slow device
Turnaround time	Total time from submission to completion of a process
fork()	UNIX system call that creates a new process
Event	User action such as a key-press or mouse click

5.5 Types of Operating System

Type	Key point	Examples
Batch	Similar jobs grouped & run together; no user interaction	IBM early mainframe OS; payroll/billing runs
Multiprogramming	Several programs kept in memory ; CPU switches when one waits for I/O	Early mainframe OS
Multitasking	One user runs many tasks at once	Windows, macOS
Time-sharing	CPU time divided into time slices among many users (interactive)	UNIX, Multics
Multiprocessing	Two or more CPUs run programs simultaneously	Servers, modern multicore PCs
Real-time (RTOS)	Response within strict time limit ; fastest response	VxWorks, QNX, RTLinux, FreeRTOS – missiles, robots, ABS
Distributed	Many networked computers appear as one system	Amoeba, cluster/cloud systems
Network (NOS)	Runs on a server ; shares files/printers among clients	Windows Server, Novell NetWare, Linux

Type	Key point	Examples
Mobile / Embedded	For phones & devices; touch-based	Android, iOS, HarmonyOS

By users / tasks	Examples
Single-user, single-task	MS-DOS , early Palm OS
Single-user, multitask	Windows 95 onward (desktop), macOS
Multi-user, multitask	UNIX, Linux , Windows Server, mainframe OS

► OS by Computer Generation

Generation	OS feature
1st (vacuum tube)	No OS – machine language, plug-boards
2nd (transistor)	Batch OS (first OS, 1956)
3rd (IC)	Multiprogramming & time-sharing (CTSS 1961, Multics, UNIX 1969)
4th (microprocessor)	PC OS, GUI , network, distributed & real-time OS in wide use

★ REMEMBER THIS

- **Real-time OS** = fastest response; used in **process control**, ATMs, flight control. **Palm OS is NOT an RTOS.**
- **Linux** = time-sharing + multi-user + multitasking OS ("All of the above").
- Most of the world's **supercomputers run Linux** (100% of TOP500).
- **Batch processing** = grouping & processing all transactions **at one time** (IBPS Clerk 2011).
- Mobile phone OS = **embedded OS**; OS for a server = **Network OS**.

5.6 Kernel, Shell & User Interface

Kernel	Shell
Core / heart of the OS	Outer layer – user's interface to the kernel
Manages CPU, memory, devices; first part loaded, stays in memory	Reads user commands & passes them to the kernel

Kernel	Shell
Hidden from user; runs in kernel mode	Also called command interpreter
e.g. Linux kernel, Windows NT kernel, XNU (macOS)	e.g. Bash, CMD, PowerShell, Windows Explorer shell

- **User mode** – applications run with limited access; **Kernel mode** – full hardware access for the OS core.

GUI	CLI / CUI
Graphical User Interface – icons, windows, menus, mouse/touch	Command Line / Character User Interface – typed text commands
User-friendly; no commands to remember	Needs knowledge of commands; fast for experts
Windows, macOS, Android, iOS	MS-DOS, Linux terminal, CMD, PowerShell

- First GUI – **Xerox PARC (Xerox Alto, 1973)**; made popular by **Apple Macintosh (1984)** and Windows.
- **WIMP** = Windows, Icons, Menus, Pointer – elements of a GUI.
- **Menu** = list of choices from which the user selects (asked in RRB Clerk Mains 2023, answer UI/GUI).

5.7 Booting, BIOS / UEFI & POST

- **Booting** = starting/restarting the computer and **loading the OS from disk into RAM.**
- **Cold boot** – starting from **power-off** (power button). **Warm boot** – **restarting** a computer already on (Restart, earlier Ctrl+Alt+Del in DOS).
- **Bootstrap loader** – small program in ROM that starts loading the OS.
- **BIOS = Basic Input/Output System** – firmware in **ROM/flash** on the motherboard; includes boot firmware & power management. BIOS settings stored in **CMOS** (kept alive by a coin battery).
- **UEFI = Unified Extensible Firmware Interface** – modern replacement of BIOS: **Secure Boot**, faster boot, mouse-driven setup, supports **GPT** disks over 2 TB (BIOS uses **MBR**). Windows 11 needs **UEFI + Secure Boot + TPM 2.0**.

- **POST = Power-On Self-Test** – BIOS/UEFI checks RAM, keyboard, disks etc.; errors reported by **beep codes**.

Step	Boot sequence
1	Power ON → CPU runs BIOS/UEFI from ROM
2	POST checks hardware
3	Boot device found (MBR/GPT) → boot loader (Windows Boot Manager, GRUB)
4	Kernel loaded into RAM → drivers, services
5	Login screen / desktop ready

- Setup key at start-up: usually **Del** or **F2**. **F8** gave the Advanced Boot Menu / **Safe Mode** in Windows XP/7; in Windows 10/11 use **Shift + Restart** (or Settings → Recovery).
- **Safe Mode** loads only a **minimal set of drivers** – for troubleshooting. **Normal mode** = default start.
- **Sleep** – low power, work kept in **RAM**, quick resume (short break). **Hibernate** – work saved to **hard disk**, power fully off (long break, unknown duration).

✎ MEMORY TRICK: Cold vs Warm

- **Cold = Cold machine (switched OFF) → switch ON. Warm = machine already warm (ON) → Restart.**
- **Sleep = Short nap (RAM); Hibernate = Hibernating bear (long, saved to disk).**

5.8 File Systems

- **File system** = method an OS uses to **organise, store, name & retrieve** files on a disk/partition.

File system	Full form / key point	Used by
FAT12 / FAT16	File Allocation Table ; old	MS-DOS, floppies
FAT32	Max 4 GB per file ; very compatible	Windows 95 OSR2 onward, pen drives
NTFS	New Technology File System – security, encryption, large files, journaling	Windows NT/XP to 11 (default)
exFAT	Extended FAT – large files, for flash drives / SD cards	Windows, macOS, cameras

File system	Full form / key point	Used by
ReFS	Resilient File System	Windows Server
HFS / HFS+	Hierarchical File System	Old Mac OS
APFS	Apple File System (2017) – SSD-optimised	macOS, iOS (current)
ext2/3/4	Extended File System; ext4 default	Linux, Android
UFS / ZFS	Unix File System	UNIX, BSD, Solaris

- Invalid file system in options like "FXZ", "LMFS" → NOT a file system.
- FAT volume/disk label – up to **11 characters**.

5.9 Microsoft Windows

Version	Year	Key point
Windows 1.0	1985	First Windows (GUI shell on MS-DOS); had Control Panel
Windows 3.0 / 3.1	1990 / 1992	3.1 – no built-in networking (3.11 for Workgroups added it)
Windows NT 3.1	1993	First of the NT family (all modern Windows are NT)
Windows 95	1995	Start button, Taskbar, My Computer, Recycle Bin; plug & play
Windows 98 / Me	1998 / 2000	Consumer 9x line
Windows 2000	2000	Client-server network OS (NT 5.0)
Windows XP	2001	Most popular; XP x64 edition (2005)
Windows Vista	2007	Aero look, UAC
Windows 7	2009	Taskbar pinning, Aero Snap & Shake
Windows 8 / 8.1	2012 / 2013	8 – no Start button (Start screen, tiles); 8.1 restored button
Windows 10	2015	Start menu back, Cortana, Edge, Windows Hello
Windows 11	2021	Announced 24 June 2021 , released 5 Oct 2021 ; centred taskbar

- Developer: **Microsoft** (Bill Gates & Paul Allen). Windows is a **GUI OS**; does not need typed

commands. Windows 10/11 belong to the **Windows NT family**.

- Windows 11 minimum: **64-bit** 1 GHz dual-core CPU, **4 GB RAM**, **64 GB** storage, **UEFI Secure Boot**, **TPM 2.0**.
- Default browser: **Microsoft Edge** (Internet Explorer retired **15 June 2022**). Built-in text editor = **Notepad**; **WordPad** was removed in Windows 11 24H2 (2024).
- Windows 11 AI features: **Copilot** app & **Copilot key** on new keyboards; **Copilot+ PCs** (with NPU, 2024).

► Windows Desktop Features

Feature	Use
Taskbar	Bar at bottom: Start, pinned/running apps; switch between programs
Notification area (System tray)	Right end of taskbar: clock, date , volume, network, battery, antivirus
Start menu	Run apps, settings, power off
Recycle Bin	Holds deleted files from hard disk; can restore . Shift+Del deletes permanently
File Explorer	(old Windows Explorer) – file & folder manager
Control Panel / Settings	Change system settings, date/time, uninstall programs
Task Manager	End not-responding programs; monitor CPU, RAM , start-up apps
Snap / Aero Shake	Snap arranges windows side by side; Shake minimises all except the active window
Clipboard	Temporary store for cut/copy data; Win+V = history

- Title bar buttons: **Minimize**, **Maximize/Restore**, **Close**. Default save location: **Documents** (My Documents).
- **Dr. Watson** – old Windows **diagnostic/error-debugging tool**. **diskpart** – command to manage disks & partitions; **chkdsk** – checks disk errors.

► Windows Shortcut Keys

Keys	Action
Win	Open/close Start menu (also Ctrl+Esc)

Keys	Action
Win + D	Show / hide desktop
Win + E	Open File Explorer
Win + L	Lock PC / switch user
Win + R	Run dialog box
Win + I	Open Settings
Win + S	Search
Win + M / Win + Shift + M	Minimise all / restore minimised
Win + Shift + S	Snipping Tool (screenshot of area)
Win + V	Clipboard history
Win + Tab	Task View / virtual desktops
Alt + Tab	Switch between open apps
Alt + F4	Close active window / program
Alt + Enter	Properties of selected item
Ctrl + Shift + Esc	Open Task Manager directly
Ctrl + Alt + Del	Security screen (lock, Task Manager, sign out)
Ctrl + Shift + N	New folder (File Explorer)
F2 / F5	Rename / Refresh
Shift + Delete	Delete permanently (skip Recycle Bin)
Shift + F10	Shortcut (right-click) menu

5.10 MS-DOS

- **MS-DOS = Microsoft Disk Operating System** (1981, for IBM PC). Based on **QDOS / 86-DOS** (Tim Paterson, Seattle Computer Products) bought by Microsoft. IBM version = **PC-DOS**; **DR-DOS** by Digital Research.
- **CLI, single-user, single-tasking**; no virtual memory; does not truly multitask.
- File name: **8.3 format** – max **8 characters** name + 3 characters extension. Primary hard disk = drive **C:** (A: & B: = floppies).
- Uses **FAT (FAT12/FAT16)** file system. Lotus 1-2-3 was the famous DOS spreadsheet.
- Wildcards: asterisk (*) = any number of characters; question mark (?) = a single character. **DIR TOOL?.BAS** lists a group of files.
- Redirection: > redirect output, >> append output, < redirect input, | pipe.

Internal commands (inside COMMAND.COM)	External commands (separate files)
DIR (list files & sub-directories), COPY , DEL/ERASE , REN	FORMAT , DISKCOPY (exact copy of a floppy), CHKDSK
CD (change dir), MD (make dir), RD (remove dir)	XCOPY , TREE , ATTRIB , LABEL (create/change disk label)
CLS , TYPE (show file contents), DATE , TIME , VER , VOL , PROMPT	MORE , SORT , FIND , EDIT , FDISK , SCANDISK

- DOS file extensions: **.exe** executable, **.com** command, **.bat** batch, **.sys** system, **.txt** text, **.bak** backup.

5.11 UNIX, Linux & macOS

UNIX	Linux
Created 1969–71 at AT&T Bell Labs by Ken Thompson & Dennis Ritchie	Kernel created by Linus Torvalds (Finland) in 1991
Original name UNICS = UNiplexed Information & Computing Service	Named after Linus ; mascot Tux the penguin
First OS largely written in a high-level language – C (1973)	Written in C (plus some Rust now); open source (GNU GPL)
Multi-user, multitasking; runs on PCs & larger systems	Multi-user, multitasking, time-sharing; highly secure
Variants: Solaris, AIX, HP-UX, BSD	Runs servers, desktops, Android phones, all top supercomputers

- **Linux distributions (distros):** **Ubuntu**, **Debian**, **Fedora**, **Red Hat (RHEL)**, **CentOS**, **Linux Mint**, **Arch**, **Gentoo**, **SUSE**, **Kali Linux** (penetration testing & security auditing), **BOSS Linux** (India, C-DAC).
- Core of Linux = **kernel**; Linux uses **ext4** file system; command shell = **Bash**.
- **macOS** (Apple) – **UNIX-based** (Darwin/XNU kernel, BSD); Classic Mac OS from **1984**. Named "Mac OS X" (2001), "OS X" (2012), "**macOS**" (2016, Sierra). Version 11 (Big Sur, 2020) ended 10.x numbering. Built-in browser **Safari**.

- **ChromeOS** (Google, 2011) – **Linux-based** OS for **Chromebooks**, built around the Chrome browser.

5.12 Mobile Operating Systems

OS	Developer	Key point
Android	Google (Open Handset Alliance)	Linux-kernel based, open source (AOSP); apps = .apk (Android Package Kit)
iOS	Apple	iPhone only; closed source; apps = .ipa ; App Store
HarmonyOS	Huawei (China)	From 2019; HarmonyOS NEXT (v5) has no Android code
Symbian	Symbian Ltd / Nokia	Evolved from Psion EPOC ; ran on ARM; discontinued 2013
BlackBerry OS	BlackBerry (RIM)	Discontinued 2022
Bada / Tizen	Samsung	Bada discontinued; Tizen on TVs & watches
KaiOS	KaiOS Technologies	For 4G feature phones (JioPhone)
BharOS	JandK Operations (IIT Madras)	Indian AOSP-based secure OS (Jan 2023)

- **Android history:** Android Inc. founded 2003 by **Andy Rubin** & others; bought by Google **2005**; **Android 1.0 released Sept 2008** (HTC Dream). **Cupcake (1.5, 2009)** = first dessert name. Dessert names dropped publicly from **Android 10 (2019)**.
- **iOS** – launched with the first **iPhone (2007)**, earlier called "iPhone OS".
- **Safari, Chrome** = browsers, NOT operating systems; **DuckDuckGo** = search engine.

★ REMEMBER THIS

- **.apk** = Android app; **.ipa** = iOS app.
- **Symbian** came from **Psion EPOC** (asked in RRB PO 2023).
- **BharOS** – launched **19 Jan 2023**, tested by ministers **Ashwini Vaishnaw & Dharmendra**

Pradhan; "No Default Apps" (NDA) approach.

- Android is based on the **Linux kernel**; macOS & iOS are **UNIX-based**.

➤ **Android 16** (June 2025) & **Android 17** (June 2026); Android code names are now internal only.

5.13 Latest OS Versions (2025–26)

OS	Latest status (as of Oct 2026)
Windows 11	Version 26H2 released 29 Sept 2026 (enablement package on 24H2/25H2). Previous: 25H2 (30 Sept 2025)
Windows 10	Support ended 14 Oct 2025 . Free consumer ESU (Extended Security Updates) now till 12 Oct 2027
Windows Server	Windows Server 2025 (Nov 2024, LTSC)
macOS	macOS 27 Golden Gate (14 Sept 2026, Apple-silicon only). Before: macOS 26 Tahoe (15 Sept 2025) – last for Intel Macs
iOS	iOS 27 (14 Sept 2026); iOS 26 (Sept 2025, "Liquid Glass" design)
Android	Android 17 (16 June 2026); Android 16 (10 June 2025) – major releases moved to Q2 (June)
HarmonyOS	HarmonyOS 6 (Oct 2025); HarmonyOS NEXT = v5 (2024), pure native
Linux kernel	7.x series from 2026 (after 6.19); latest stable 7.2 (16 Aug 2026), 7.3 in testing
Ubuntu	26.04 LTS "Resolute Raccoon" (April 2026)

- **Apple year-based numbering (WWDC, 9 June 2025):** all Apple OSs jumped to the **next year's number** – iOS 18 → **iOS 26**, macOS 15 Sequoia → **macOS 26 Tahoe**, also iPadOS, watchOS, tvOS, visionOS 26 (like car model years).
- Windows 11 versions are named **YYH1/YYH2** (year + half): 23H2, 24H2, 25H2, 26H2.
- *Exam tip: version questions change every year – check the latest release just before the exam.*

★ REMEMBER THIS

- **Windows 10 end of support = 14 October 2025.**
- **iOS 26 / macOS 26 Tahoe** (2025) – Apple switched to **year-based** version numbers.

5.14 Practice MCQs (Previous-Year Pattern)

Q1. Which of the following is NOT system software? (SBI Clerk)

- (a) Operating system (b) Device driver
(c) Compiler (d) MS Word (e) Utility program

Ans: (d) MS Word is application software (word processor); the others are system software.

Q2. Software that is permanently stored in ROM, such as the BIOS, is called:

- (a) Middleware (b) Firmware (c) Freeware
(d) Shareware (e) Groupware

Ans: (b) Firmware is software built into ROM/flash memory of hardware.

Q3. Linux is a type of _____ software. (IBPS Clerk 2011)

- (a) shareware (b) commercial (c) proprietary
(d) open source (e) hidden type

Ans: (d) Linux (Linus Torvalds, 1991) is free and open-source under the GNU GPL.

Q4. Restarting a computer that is already switched on is called:

- (a) Cold booting (b) Warm booting
(c) Safe mode (d) Hibernation (e) POST

Ans: (b) Warm boot = restart; cold boot = start from power-off.

Q5. Which one of the following is NOT a real-time operating system? (IBPS RRB Clerk Mains 2023)

- (a) RTLinux (b) QNX (c) VxWorks (d) Palm OS
(e) FreeRTOS

Ans: (d) Palm OS was a PDA operating system; the others are RTOSs.

Q6. A signal from a hardware device indicating that it needs immediate attention from the OS is called a(n): (IBPS RRB PO 2022)

- (a) Spool (b) Interrupt (c) Deadlock
(d) Page fault (e) Thread

Ans: (b) An interrupt makes the OS pause the current work and service the device.

Q7. What is the maximum length of a file name (excluding extension) in MS-DOS?

- (a) 4 characters (b) 5 characters
- (c) 8 characters (d) 11 characters
- (e) 255 characters

Ans: (c) DOS uses the 8.3 format: 8-character name and 3-character extension.

Q8. UNIX was the first operating system to be written largely in which language? (IBPS RRB PO 2023)

- (a) C (b) C++ (c) Java (d) BASIC (e) FORTRAN

Ans: (a) Dennis Ritchie rewrote UNIX in C at Bell Labs in 1973.

Q9. Microsoft ended support for Windows 10 (end of free security updates for most users) on:

- (a) 5 October 2021 (b) 14 January 2020
- (c) 14 October 2025 (d) 30 September 2025
- (e) 12 October 2027

Ans: (c) Windows 10 support ended on 14 Oct 2025; after that only ESU updates are available.

Q10. Which mode saves your open work to the hard disk and switches the computer off completely?

- (a) Sleep (b) Hibernate (c) Restart
- (d) Safe Mode (e) Normal Mode

Ans: (b) Hibernate writes RAM contents to disk and powers off; Sleep keeps them in RAM.

CHAPTER 6 MS OFFICE & MS WORD

6.1 MS Office – Overview

- **Microsoft Office** is a **suite (package)** of **application software** for office work – documents, spreadsheets, presentations, e-mail, databases.
- **Proprietary** (closed-source, paid) software of **Microsoft**; announced by **Bill Gates in Aug 1988**; first sold in **1989 (Mac)**; **Office 1.0 for Windows – Oct 1990**.
- Cloud / subscription version: **Office 365** (launched **28 June 2011**) → renamed **Microsoft 365** (consumer plans, **April 2020**).
- Free cloud storage with a Microsoft account: **OneDrive – 5 GB**. Microsoft 365 Personal/Family: **1 TB per user** (Family = up to 6 users → 6 TB).

► Main Office Applications

Application	Used for
Word	Word processing – letters, reports (documents)
Excel	Spreadsheet – calculations, charts, data analysis
PowerPoint	Presentation (slides)
Access	Database management (DBMS) – Windows only
Outlook	E-mail, calendar, contacts, tasks
OneNote	Digital note-taking (notebooks, sections, pages)
Publisher	Desktop publishing (DTP) – retired Oct 2026
Teams	Chat, meetings & video conferencing
SharePoint / OneDrive	Sharing & cloud storage of files
Visio / Project	Diagrams & flowcharts / project management (sold separately)

► File Extensions – Old vs New

Application	Old (97–2003)	New (2007 +)
Word document	.doc	.docx
Word template	.dot	.dotx
Excel workbook	.xls	.xlsx

Application	Old (97–2003)	New (2007 +)
Excel template	.xlt	.xltx
PowerPoint	.ppt	.pptx
PowerPoint show	.pps	.ppsx
Access database	.mdb	.accdb
Visio drawing	.vsd	.vsdx

- The "x" = **XML (Office Open XML)** format, a ZIP package – smaller files, introduced in **Office 2007**.
- An "m" at the end = **macro-enabled**: .docm, .dotm, .xlsm, .pptm. Macro-free .docx/.xlsx/.pptx **cannot store macros**.
- Others: Publisher **.pub**, OneNote **.one**, Outlook data file **.pst**, Project **.mpp**.
- Office apps can also save as **PDF** and **XPS**, and open/save **OpenDocument** files (.odt, .ods, .odp).

► Versions of MS Office

Version (Year)	Key point
Office 1.0 (1990)	First Windows version – Word, Excel, PowerPoint
Office 95 (1995)	First 32-bit version (for Windows 95); version 7.0
Office 97	Office Assistant ("Clippy") , VBA in all apps
Office 2000 / XP (2001)	Y2K-ready; XP brought the Task Pane & smart tags
Office 2003	Last version with menus & toolbars
Office 2007	Ribbon + Office Button ; new .docx/.xlsx/.pptx formats
Office 2010	Backstage view (File tab replaced the Office Button)
Office 2013	Touch mode, start screen; Excel opens with 1 sheet
Office 2016 (2015)	" Tell me " box, real-time co-authoring
Office 2019 (2018)	Perpetual version; Excel funnel charts, new functions
Office 2021 (5 Oct 2021)	Dark mode , XLOOKUP, dynamic arrays

Version (Year)	Key point
Office 2024 (1 Oct 2024)	Latest one-time-purchase version; Office LTSC 2024 for businesses (Sept 2024)

- **Office 2024** comes as **Office Home 2024** (Word, Excel, PowerPoint, OneNote) and **Office Home & Business 2024** (+ Outlook, commercial use). **Publisher is not included**.
- **End of support:** Office **2016 & 2019 – 14 Oct 2025**; Office **2021 / LTSC 2021 – 13 Oct 2026**.
- There is **no** "Office 2011, Office Vista or Office 2005" for Windows (Office 2011 was a **Mac** version only).

► Microsoft 365 & Copilot (2023–26)

- **Microsoft 365** = **subscription-based cloud service (SaaS)** – always the latest apps + OneDrive + web versions (Word/Excel/PowerPoint for the web are **free** with a Microsoft account).
- **Microsoft 365 Copilot** – generative-AI assistant built into Word, Excel, PowerPoint, Outlook & Teams (announced **March 2023**).
- **16 Jan 2025** – **Copilot included** in **Microsoft 365 Personal & Family** plans (with a price increase).
- **15 Jan 2025** – the **Microsoft 365 app** (earlier "Office app") renamed "**Microsoft 365 Copilot app**"; web address **m365.cloud.microsoft** (office.com redirects).
- **Aug–Sept 2026** – it is being merged with the consumer Copilot app as the "**Microsoft Copilot app**" (web: **copilot.cloud.microsoft**).
- **Yammer** (internal social network) is now **Viva Engage** (2023).

► Office-like Suites

Microsoft	Google	Apple iWork	LibreOffice
Word	Docs	Pages	Writer
Excel	Sheets	Numbers	Calc
PowerPoint	Slides	Keynote	Impress
Access	–	–	Base

- **Google Workspace** (formerly G Suite) – web-based; **LibreOffice** – free & **open-source** (The Document Foundation); also has **Draw & Math**.

★ REMEMBER THIS

- MS Office = **application software, proprietary**; Office 365 → **Microsoft 365**.
- **Ribbon** came in **Office 2007** (not 2003); **Backstage view** in **Office 2010**.
- **Latest perpetual version = Office 2024** (Office 2019 was **not** the last).
- X in .docx = **XML**; M in .docm = **Macro**.

6.2 MS Word – Basics & Interface

- **MS Word** = **word-processing** application software (create, edit, format, print documents).
- First released **1983** as **Multi-Tool Word** (for Xenix/MS-DOS) – **Charles Simonyi & Richard Brodie**.
- Program file: **WINWORD.EXE** (type **winword** in Run box). Default new file: **Document1**; default format **.docx**.
- Early word processors: **Electric Pencil** (1976, first for PCs), **WordStar** (1978, MicroPro). Others: **WordPerfect** (Corel), **Pages** (Apple), **Writer** (LibreOffice), **Google Docs**, **WordPad / Notepad** (Windows).

► Screen Components

Component	Purpose
Title bar	Document name + Minimize, Maximize/Restore, Close buttons
Quick Access Toolbar (QAT)	Customisable; default Save, Undo, Redo/Repeat (+ AutoSave for cloud files)
Ribbon	Tabs → Groups → Commands ; replaced menus & toolbars (2007)
Dialog Box Launcher	Small arrow at bottom-right of a group; opens full dialog
Ruler	Set tabs, indents & margins
Status bar	Page no., word count , language, view buttons, zoom slider
Scroll bars	Move document up/down, left/right
Cursor / insertion point	Blinking line – where text will appear

Component	Purpose
Navigation pane	Headings, pages & search results (Ctrl+F)

- **File tab → Backstage view:** New, Open, Info (properties, protect), Save, Save As, Print, Share, Export, Close, Options.
- Ribbon tabs in Word (Microsoft 365/2021): **File, Home, Insert, Draw, Design, Layout, References, Mailings, Review, View, Help** (11). **Developer** tab is hidden by default.
- **Contextual tabs** appear only when an object is selected (e.g. **Table Design / Layout, Picture Format, Header & Footer**).
- **Tell me / Search** box (Alt+Q) – type a command name to find it.

6.3 Ribbon Tabs & Their Commands

- **Home – the default tab.**
 - **Clipboard:** Cut, Copy, Paste, **Format Painter**
 - **Font:** font, size, B/I/U, strikethrough, sub/superscript, **Change Case (Aa)**, highlight
 - **Paragraph:** bullets, numbering, alignment, line spacing, shading, borders, show ¶
 - **Styles; Editing:** Find, Replace, Select
- **Insert**
 - **Pages:** Cover Page, Blank Page, **Page Break**
 - **Tables; Illustrations:** Pictures, Shapes, Icons, **SmartArt**, Chart, Screenshot
 - **Links:** Hyperlink, **Bookmark**, Cross-reference; Comments
 - **Header & Footer, Page Number**
 - **Text:** Text Box, **WordArt**, **Drop Cap**, Date & Time, Object; **Symbols:** Equation, Symbol
- **Design – Themes, Style Sets, Colours, Fonts, Paragraph Spacing; Page Background: Watermark, Page Color, Page Borders.**
- **Layout**
 - **Page Setup:** Margins, Orientation, Size, **Columns, Breaks**, Line Numbers, Hyphenation
 - Paragraph indent & spacing; **Arrange:** Position, **Wrap Text**, Align, Rotate
- **References – Table of Contents, Footnotes/Endnotes, Citations & Bibliography, Captions (Table of Figures), Index (Mark Entry), Table of Authorities.**

- **Mailings – Envelopes, Labels, Start Mail Merge, Write & Insert Fields, Preview Results, Finish & Merge.**
- **Review**
 - **Proofing: Spelling & Grammar (Editor), Thesaurus, Word Count;** Read Aloud; Accessibility; Translate
 - **Comments, Track Changes, Accept/Reject, Compare, Restrict Editing**
- **View**
 - **Views:** Read Mode, Print Layout, Web Layout, Outline, Draft; Immersive Reader
 - Show: Ruler, Gridlines, **Navigation Pane; Zoom;** Window: New, Arrange All, **Split, Side by Side; Macros**

MEMORY TRICK: Order of Word tabs

- **"Have I Done Little Research Making Real Value?" → Home, Insert, Design, Layout, References, Mailings, Review, View.**
- Table of contents / Footnote / Citation / Index / Caption → all in **References** ("R for Research work").

6.4 Page Setup & Default Settings

Setting	Default (current Word)
Font (body text)	Aptos, 11 pt (since 2023–24; earlier Calibri 11 in 2007–2021; Times New Roman 12 in 2003)
Headings font	Aptos Display
Margins ("Normal")	1 inch on all sides (Word 2003: left/right 1.25 inch)
Page size	Letter (8.5 × 11 in) in US English; A4 (8.27 × 11.69 in) with India/UK regional settings
Orientation	Portrait (other = Landscape)
Alignment	Left
Default tab stop	Every 0.5 inch
Header / footer distance	0.5 inch from page edge
Style	Normal style
View	Print Layout
Zoom	100%; range 10% to 500%

- Margin presets: **Normal** (1"), **Narrow** (0.5"), **Moderate**, **Wide**, **Mirrored**, **Office 2003 Default**.
- **Gutter margin** – extra space on the **binding side** of pages. **Mirror margins** – inside/outside margins for **facing pages** (books, magazines).
- Different **sections** of a document **can have different margins**, orientation & headers.
- **Section breaks: Next Page, Continuous, Even Page, Odd Page** (no "Previous Page"). **Page breaks: Page, Column, Text Wrapping**.
- **Soft page break** – inserted **automatically** by Word; **hard (manual) page break** – **Ctrl+Enter**.
- Page sizes: Letter, Legal, Executive, **A3, A4, A5**, B4, B5, Tabloid, envelopes.

► Limits & Numbers (Exam Favourite)

Item	Value
Font-size drop-down list	8 to 72 pt
Maximum font size (typed)	1638 pt (minimum 1 pt; steps of 0.5)
Max columns in a table	63
Min rows × columns in a table	1 × 1
Drop Cap lines	Default 3 , max 10
Change Case (Shift+F3) cycles	3 – lowercase, UPPERCASE, Capitalize Each Word
Max file size	512 MB (text only: 32 MB)
Zoom	10% – 500%

★ REMEMBER THIS

- Default font now = **Aptos 11**; Word 2007–2021 = **Calibri 11**; Word 2003 = **Times New Roman 12**.
- Default margins = **1 inch** (2003: left & right 1.25 inch); header/footer = **0.5 inch**; tab stop = **0.5 inch**.
- **Zoom: Word 10–500%**, but Excel & PowerPoint **10–400%**.
- Max table columns = **63**; max font size = **1638**; drop cap max = **10 lines**.

6.5 Formatting & Editing Features

Feature	Meaning
Font style	Regular, Italic, Bold, Bold Italic (only these 4)
Font effects	Strikethrough, double strikethrough, superscript (x²) , subscript (H₂O) , small caps, all caps, hidden
Serif / Sans-serif	Serif fonts have small strokes at ends (Times New Roman); sans-serif have none (Arial, Calibri, Aptos)
Word wrap	Text moves to next line automatically – press Enter only at end of a paragraph
Text wrapping	How text flows around a picture (Square, Tight, Behind text...)
Indent	Space between margin and start of paragraph ; first-line / hanging indent
Format Painter	Copies formatting (single-click once, double-click to lock)
Paste Special	Paste in a chosen format – e.g. Unformatted text (Keep Text Only)
Drop Cap	Large initial capital letter at start of a paragraph
WordArt	Decorative text with effects (Transform)
Watermark	Faint text/picture behind the main text (e.g. "CONFIDENTIAL")
Thesaurus	Synonyms (and antonyms) – Shift+F7
AutoCorrect	Corrects misspelled words & typos as you type (e.g. teh → the)
AutoText / Quick Parts	Reusable stored text or graphics blocks
Spike	Collects several pieces of text (Ctrl+F3) and pastes together (Ctrl+Shift+F3)

► Proofing Underlines

Mark	Meaning
Red wavy line	Spelling error (word not in dictionary)
Blue double underline	Grammar error (Word 2013 onwards; Microsoft Editor)
Green wavy line	Grammar error in older Word (2007/2010)

Mark	Meaning
Blue wavy line	Format inconsistency / contextual spelling (older Word)
Gold/purple dotted	Editor refinements (clarity, conciseness)

► Selecting Text with Mouse & F8

- **Double-click** = word; **triple-click** = paragraph; **Ctrl + click** = sentence.
- In the **left margin (selection bar)**: single-click = line, double-click = paragraph, triple-click = **whole document**.
- **F8** (Extend mode): press 2× = word, 3× = sentence, 4× = paragraph, 5× = **whole document**.
- Select non-adjacent text: hold **Ctrl**; select a vertical block: hold **Alt** and drag.

6.6 Important Word Features

► Mail Merge (Mailings tab)

- Used to send the **same letter/document to many people** with personalised names & addresses (form letters, labels, envelopes, certificates).
- Needs **two files**: **Main document** (the letter) + **Data source** (the **mailing list** – Excel sheet, Access table, Outlook contacts, Word table, CSV).
- In the data source: **column heading = field name**; **each row = one record**.
- Document types: **Letters, E-mail Messages, Envelopes, Labels, Directory**, Normal Word Document (no "Memos").
- Select Recipients: **Type a New List / Use an Existing List / Choose from Outlook Contacts**.
- Steps: **Start Mail Merge → Select Recipients → Insert Merge Fields (Address Block, Greeting Line) → Preview Results → Finish & Merge** (last step).

MEMORY TRICK: Mail-merge steps

- **"Some Students Insert Pens Finally"** → Start, Select recipients, Insert fields, Preview, Finish & Merge.

► Other Key Features

Feature	Where / what
Track Changes	Review tab – records every edit (Ctrl+Shift+E); Accept/Reject
Comments	Review/Insert tab – notes in the margin (Ctrl+Alt+M)
Compare	Review tab – shows differences between two versions
Restrict Editing	Review > Protect; password via File > Info > Protect Document
Header / Footer	Insert tab – top/bottom area printed on every page
Table of Contents	References tab – built automatically from Heading 1, 2, 3 styles
Footnote / Endnote	Footnote at page bottom (Ctrl+Alt+F); endnote at document end (Ctrl+Alt+D)
Find & Replace	Home > Editing; Ctrl+F , Ctrl+H , Ctrl+G/F5 – one dialog, 3 tabs; finds text, formats & symbols
Macro	Recorded commands to automate repetitive tasks , in VBA (Alt+F8)
Bookmark	Named location for quick jump (Ctrl+Shift+F5)
Hyperlink	Link to web page/file/place (Ctrl+K)
Columns	Newspaper-style columns – Layout tab
SmartArt	Ready diagrams – lists, process, cycle, hierarchy

- Header/footer options: **Different First Page, Different Odd & Even Pages**.
- Macros are saved in **.docm** files or in **Normal.dotm** (global template – usable in any document); VBA editor = **Alt+F11**.

► Document Views

View	Use
Print Layout (default)	Shows page as it will print – headers, margins (Alt+Ctrl+P)
Read Mode	Full-screen reading, editing hidden
Web Layout	How the document looks as a web page
Outline	Heading levels; reorganise long documents (Alt+Ctrl+O)
Draft	Text only; no headers/footers/pictures (Alt+Ctrl+N)

View	Use
Focus / Immersive Reader	Distraction-free & reading-aid views

- **Print Preview:** File > Print (**Ctrl+P** or **Ctrl+F2**).
- **Ways to save:** File > Save / Save As, **Ctrl+S**, **F12** (**Save As**), QAT Save button; **AutoSave** for OneDrive files.
- **Save As formats:** .docx, .docm, .dotx, .dotm, .doc, .pdf, .xps, .rtf (Rich Text Format), .txt, .htm/.html, .mht, .odt, .xml.
- **Copilot in Word** (Microsoft 365): draft text from a prompt, rewrite, summarise a document.

6.7 Top MS Word Shortcuts

Keys	Action
Ctrl+N / Ctrl+O / Ctrl+S	New / Open / Save
F12	Save As
Ctrl+P (or Ctrl+F2)	Print / Print Preview
Ctrl+W or Ctrl+F4	Close document; Alt+F4 = exit Word
Ctrl+Z / Ctrl+Y	Undo / Redo (repeat)
Ctrl+B / I / U	Bold / Italic / Underline
Ctrl+E / L / R / J	Centre / Left / Right / Justify
Ctrl+1 / Ctrl+2 / Ctrl+5	Single / Double / 1.5 line spacing
Ctrl+] / Ctrl+[	Font size +1 / -1 point
Ctrl+Shift+> / <	Next larger / smaller size in list
Ctrl+= / Ctrl+Shift+=	Subscript / Superscript
Ctrl+D	Font dialog box
Shift+F3	Change Case
Ctrl+F / Ctrl+H / Ctrl+G	Find / Replace / Go To (F5 also Go To)
Ctrl+Enter	Page break
Shift+Enter	Line break (manual)
Ctrl+Shift+Enter	Column break
F7 / Shift+F7	Spelling & Grammar / Thesaurus
F1 / F4	Help / Repeat last action
Ctrl+M / Ctrl+Shift+M	Increase / decrease left indent
Ctrl+T	Hanging indent
Ctrl+Q / Ctrl+Space	Remove paragraph / character formatting

Keys	Action
Ctrl+Shift+C / V	Copy / paste formatting
Ctrl+K	Insert hyperlink
Shift+Alt+D / T	Insert current date / time
Alt+Ctrl+C / R / T	© / ® / ™ symbols
Ctrl+Shift+G	Word Count
Ctrl+Home / Ctrl+End	Start / end of document
Ctrl+A	Select all
Alt+F8 / Alt+F11	Macros / VBA editor

The complete list of Office shortcuts is in the *Shortcut Keys* chapter.

✎ MEMORY TRICK: Line spacing & scripts

- **Ctrl + 1, 2, 5** → spacing **1, 2, 1.5** ("5 is half of 10 → 1.5").
- **Ctrl + =** → **subscript** (= sits **low** on the line); add **Shift** → **superscript** (goes **up**).

★ REMEMBER THIS

- **Ctrl+Enter** = page break, **Shift+Enter** = line break, **Enter** = new paragraph.
- **F7** spelling, **Shift+F7** thesaurus, **F12** Save As, **F5** Go To, **F4** repeat, **F1** help.
- **Ctrl+H** = Replace (Ctrl+R = right align); **Ctrl+E** = centre; **Ctrl+J** = justify.
- **Red wavy** = spelling; **blue double** = grammar (new Word).
- Mailing list in mail merge = **Data source**; last step = **Finish & Merge**.

6.8 Practice MCQs (Previous-Year Pattern)

Q1. Which tab in MS Word contains Table of Contents, Footnotes, Citations & Bibliography, Captions and Index? (IBPS RRB PO 2023)

- (a) Home (b) Insert (c) References
(d) Review (e) Mailings

Ans: (c) All research-document tools are grouped on the References tab.

Q2. In mail merge, the list of names and addresses is known as the:

- (a) Main document (b) Data source
(c) Form letter (d) Template (e) Merge field

Ans: (b) The main document is merged with a data source (mailing list) to create personalised copies.

Q3. What does a red wavy underline under a word in MS Word indicate? (IBPS RRB PO 2022)

- (a) Grammar error (b) Spelling error
(c) Smart tag (d) Formatting inconsistency
(e) Hyperlink

Ans: (b) Red wavy = spelling; grammar issues are shown with a blue double underline in current Word.

Q4. Which shortcut key inserts a manual page break in MS Word? (IBPS PO 2011)

- (a) Shift+Enter (b) Alt+Enter (c) Ctrl+Enter
(d) Ctrl+Shift+Enter (e) Ctrl+B

Ans: (c) Ctrl+Enter = page break; Shift+Enter = line break; Ctrl+Shift+Enter = column break.

Q5. Match the MS Word keys: A. F7, B. F12, C. F1, D. F4 with i. Repeat last action, ii. Help, iii. Spelling & Grammar, iv. Save As. (IBPS RRB PO 2022)

- (a) A-iv, B-iii, C-ii, D-i (b) A-iii, B-iv, C-ii, D-i
(c) A-iv, B-iii, C-i, D-ii (d) A-iii, B-iv, C-i, D-ii
(e) None of these

Ans: (b) F7 spelling, F12 Save As, F1 Help, F4 repeat last action.

Q6. What is the default font of a new blank document in the latest Microsoft 365 version of Word?

- (a) Times New Roman 12 (b) Calibri 11
(c) Arial 10 (d) Aptos 11 (e) Cambria 12

Ans: (d) Aptos replaced Calibri (default 2007–2021) as the Office default font in 2023–24.

Q7. Which margin setting is used for facing pages in double-sided documents such as books and magazines? (IBPS RRB PO 2023)

- (a) Normal (b) Narrow (c) Mirrored
(d) Gutter (e) Wide

Ans: (c) Mirrored margins make inside and outside margins match on facing pages; gutter only adds binding space.

Q8. What is the maximum number of columns that can be inserted in a table in MS Word?

- (a) 43 (b) 53 (c) 63 (d) 73 (e) 255

Ans: (c) A Word table can have at most 63 columns.

Q9. The feature that shows a large capital letter at the beginning of a paragraph is called: (IBPS RRB GBO 2023)

- (a) WordArt (b) Drop Cap (c) Small Caps
(d) Watermark (e) Tab Stop

Ans: (b) Drop Cap enlarges the first letter over 3 lines by default (max 10 lines).

Q10. Which is the latest one-time-purchase (perpetual) version of Microsoft Office, released in October 2024?

- (a) Office 2019 (b) Office 2021 (c) Office 2024
(d) Office 365 (e) Office 2025

Ans: (c) Office 2024 (Home / Home & Business) was released on 1 Oct 2024; Microsoft 365 is the subscription service.

CHAPTER 7 MS EXCEL

7.1 Spreadsheet Basics

- A **spreadsheet** is a grid of **rows and columns** (like an accounting ledger) used for **calculations, budgeting, billing, data analysis & charts**.
- **MS Excel** = Microsoft's **spreadsheet application software** (proprietary). First released **1985 for Mac, 1987 for Windows**. Program file: **EXCEL.EXE**.
- **First spreadsheet: VisiCalc** (1979, **Dan Bricklin & Bob Frankston**). Popular DOS spreadsheet: **Lotus 1-2-3** (files .wk1).
- Others: **Google Sheets** (Google), **Numbers** (Apple), **Calc** (LibreOffice, open-source). Free Microsoft options: **Excel for the web** & the Excel mobile app.
- Extensions: **.xls** (97–2003) → **.xlsx** (2007 +). Latest perpetual version: **Excel 2024** (in Office 2024); subscription: **Excel in Microsoft 365**.

► Key Terms

Term	Meaning
Workbook	An Excel file ; collection of worksheets (default name Book1)
Worksheet	Single sheet of rows & columns (Sheet1); also called spreadsheet
Cell	Intersection of a row and a column – smallest/basic unit
Cell address	Column letter + row number, e.g. A1 (first cell), C10
Active cell	Currently selected cell – thick border (cell pointer)
Range	Group of cells, e.g. B1:E5 (colon = range operator)
Name Box	Shows address / name of the active cell
Formula Bar	Shows & edits contents (value/formula) of the active cell
Sheet tabs	At the bottom of the window; double-click to rename
Fill handle	Small square at cell corner – drag for AutoFill (copy or series)
Status bar	Shows Ready/Edit mode, SUM, AVERAGE, COUNT of selection, zoom

- Data types in a cell: **Numbers (values), Text (labels), Formulas**, dates/times (stored as numbers), logical (TRUE/FALSE).
- Text is **left-aligned** by default; numbers & dates are **right-aligned**.
- Anything typed appears **in both the active cell and the Formula Bar**.
- Columns: **A ... Z, AA ... AZ, BA ... XFD** (letters); rows: **1, 2, 3 ...** (numbers). Columns run **vertically**, rows **horizontally**.

7.2 Excel Limits & Defaults

Feature	Excel 2007 onwards (current)
Rows per sheet	1,048,576 (2^{20})
Columns per sheet	16,384 (2^{14}); last column XFD
Excel 2003 (old)	65,536 rows × 256 columns; last column IV
Characters in a cell	32,767
Column width / row height	255 characters / 409 points
Sheets in a workbook	Limited only by available memory
Sheets in a new workbook	1 (since Excel 2013 ; earlier 3)
Zoom range	10% – 400% (default 100%)
Default font	Aptos Narrow 11 (2023–24 onwards; earlier Calibri 11)
Default column width	8.43 characters
Nested function levels	64
Number precision	15 digits
Panes in a window	4

★ REMEMBER THIS

- **1,048,576 rows × 16,384 columns**, last cell **XFD1048576**. Excel 2003: 65,536 × 256 (**IV**).
- Max characters in a cell = **32,767**. New workbook has **1** sheet (Book1, Sheet1).
- Address of active cell → **Name Box**; contents of active cell → **Formula Bar**.

7.3 Formulas, Functions & Cell References

- A **formula** always begins with = (**equal sign**), e.g. $**=A1+B1*2$. A **function** is a pre-built (pre-programmed) formula, e.g. $=SUM(A1:A10)**$.
- Function syntax:
=FUNCTIONNAME(arguments). Insert Function: **Shift+F3** or **fx** button. **AutoSum: Alt+=**.
- Excel **recalculates automatically** when a cell changes (**Automatic calculation**); manual recalc **F9**.
- Reference another sheet: **Sheet2!A1**; another workbook: **[Book1.xlsx]Sheet1!A1**.
- $=1A+2$ is invalid (1A is not a cell address); $=SUM(A1:A5)/(10-10)$ gives **#DIV/0!**.

► Cell Reference Types

Type	Example	On copying
Relative	A1	Row & column both change
Absolute	\$A\$1	Nothing changes (fixed)
Mixed	\$A1 / A\$1	Only the part without \$ changes

- \$ (dollar) fixes the column or row. Press **F4** to cycle $A1 \rightarrow \$A\$1 \rightarrow A\$1 \rightarrow \$A1$.

► Operator Precedence (high → low)

Order	Operator	Meaning
1	: (colon), space, , (comma)	Reference operators – range, intersection, union
2	–	Negation (e.g. –5)
3	%	Percent
4	^	Exponent (power)
5	* and /	Multiply & divide (left to right)
6	+ and –	Add & subtract
7	&	Concatenation (joins text)
8	= < > <= >= <>	Comparison (<> = not equal)

- $**=20*10/4*8 \rightarrow 200/4 = 50 \rightarrow 50*8 = 400**$ (same level $\rightarrow$ left to right).
- $**=2+3*2^2 \rightarrow 2^2 = 4 \rightarrow 3*4 = 12 \rightarrow 14**$.

🔑 MEMORY TRICK: Precedence

► "Please Excuse My Dear Aunt Sally, Come"
 $\rightarrow$ Percent, Exponent, Multiply/Divide,

Add/Subtract, Concatenate (&) – then comparison.

7.4 Common Functions

Function	Purpose / example
SUM	Adds numbers – $=SUM(A1:A10)$; $=SUM(A:B)$ adds whole columns A & B
AVERAGE	Arithmetic mean (no MEAN function)
COUNT	Counts cells containing numbers
COUNTA	Counts non-empty cells (any data)
COUNTBLANK	Counts empty cells
COUNTIF / SUMIF	Count / sum cells meeting a condition ; COUNTIFS, SUMIFS, AVERAGEIF for many
MAX / MIN	Largest / smallest value
IF	Logical test – $=IF(A1 \geq 40, "Pass", "Fail")$; also IFS, AND, OR, NOT
VLOOKUP	Vertical lookup – searches first column of a table, returns value from a column to the right
HLOOKUP	Horizontal lookup – searches first row
XLOOKUP	Modern lookup – any direction, exact match by default (M365 2020 / Excel 2021)
INDEX + MATCH	Flexible lookup combination
CONCAT / TEXTJOIN	Join text (replace old CONCATENATE); & also joins
LEFT / RIGHT / MID / LEN	Extract characters / count characters in a cell
UPPER / LOWER / PROPER / TRIM	Change case / remove extra spaces
ROUND / ROUNDUP / ROUNDDOWN	$=ROUND(3.456, 2) = 3.46$
INT / MOD / ABS / SQRT / POWER	Integer part / remainder / absolute / square root / power
CEILING / FLOOR	Round up / down to a multiple: $CEILING(14, 4) = 16$, $FLOOR(14, 4) = 12$
TODAY()	Current date only
NOW()	Current date and time

Function	Purpose / example
PMT	Loan instalment (EMI) – =PMT(rate, nper, pv)
FV / PV / NPV / IRR / RATE	Other financial functions
RANK / LARGE / SMALL	Position / k-th largest / k-th smallest

- Function categories: **Financial, Logical, Text, Date & Time, Lookup & Reference, Math & Trig, Statistical, Engineering, Cube, Information, Web** (no "Data Series" category).
- Wildcards in criteria/Find: asterisk * (any number of characters) and ? (one character).

► Error Values

Error	Cause
#DIV/0!	Division by zero or empty cell
#N/A	Value not available – lookup value not found
#NAME?	Excel does not recognise text – misspelt function/name
#REF!	Invalid cell reference (cell deleted)
#VALUE!	Wrong type of argument (text in maths)
#NUM!	Invalid number – e.g. =SQRT(-1)
#NULL!	Two ranges with space operator do not intersect
#SPILL!	Dynamic-array result blocked by non-empty cells
#CALC!	Calculation-engine error, e.g. empty array
#####	Column too narrow (or negative date/time) – not a real error

★ REMEMBER THIS

- **COUNT** = numbers only; **COUNTA** = all non-empty; **COUNTBLANK** = empty. (No "COUNTNUMBERS".)
- **TODAY()** = date only; **NOW()** = date + time. Shortcut: **Ctrl+;** date, **Ctrl+Shift+;** time.
- **&** = concatenation operator; **\$** = absolute reference; **:** = range.
- **#####** = column too narrow; **#DIV/0!** = divide by zero; **#N/A** = not found.

7.5 Ribbon Tabs & Data Tools

Tab	Key commands
Home	Wrap Text, Merge & Center , Number formats, Conditional Formatting , AutoSum, Sort & Filter
Insert	PivotTable , Table, Pictures, Charts , Sparklines , Slicer, Hyperlink, Symbols
Page Layout	Themes, Margins, Orientation, Size, Print Area , Breaks, Print Titles
Formulas	Function Library, Name Manager , Formula Auditing (Trace Precedents), Calculation
Data	Power Query, Sort, Filter , Text to Columns, Flash Fill, Remove Duplicates , Data Validation, What-If Analysis, Subtotal
Review	Spelling, Thesaurus, Comments & Notes, Protect Sheet / Workbook
View	Normal, Page Break Preview , Page Layout; Freeze Panes , Split, New Window, Zoom, Macros

► Important Features

Feature	What it does
Freeze Panes	Keeps rows/columns always visible while scrolling (View tab)
Sort / Filter	Arrange A→Z, Z→A / show only matching rows (AutoFilter Ctrl+Shift+L)
Conditional Formatting	Formats cells automatically by their value (colour scales, data bars, icon sets)
Data Validation	Restricts what can be entered (drop-down list, number range) – it is not formatting
PivotTable	Summarises large data by dragging fields to Rows, Columns, Values, Filters
Flash Fill (2013)	Fills a column by recognising a pattern (Ctrl+E)
Merge & Center	Joins selected cells into one
Wrap Text	Shows cell text on multiple lines inside the cell
Transpose	Paste Special option – rows become columns
Notes / Comments	Red triangle (note) or purple marker (threaded comment) at cell corner

Feature	What it does
Macro	Recorded VBA steps; saved in .xlsm (Alt+F8)

► What-If Analysis (Data tab)

Tool	Use
Goal Seek	Finds the input value needed to reach a desired result
Scenario Manager	Saves & compares different sets of input values
Data Table	Shows results for many input values at once (1 or 2 variables)

- **Solver** (add-in) – optimisation with constraints.
- **Forecast Sheet** – future trend from time data.

7.6 Charts

Chart	Best for
Column (default)	Comparing values across categories (vertical bars)
Bar	Comparison – horizontal bars (e.g. performance of two employees)
Line	Trends over time
Pie	Parts of a whole – only one data series
Doughnut	Like pie but can show more than one series
Area	Magnitude of change over time
XY Scatter / Bubble	Relationship between 2 (3) numeric variables
Stock, Surface, Radar	Share prices, 3-D data, multiple variables
New (2016+)	Treemap, Sunburst, Histogram, Box & Whisker, Waterfall , Funnel, Map
Combo	Two chart types in one (e.g. column + line)

- Charts are inserted from the **Insert tab** (Recommended Charts). **F11** = default chart on a **separate chart sheet**; **Alt+F1** = embedded chart on the same sheet.
- **Sparklines** = **tiny charts inside a single cell** – Line, Column, Win/Loss.
- Chart parts: chart title, axes, **legend**, data labels, gridlines, plot area, data series.

7.7 New Excel Features (2019–2026)

Feature	Key point
Dynamic arrays	One formula spills into many cells: FILTER, SORT, UNIQUE, SEQUENCE (Excel 2021)
XLOOKUP, XMATCH, LET	Excel 2021 / M365
LAMBDA	Create your own custom functions without VBA (Excel 2024 / M365)
IMAGE	Inserts a picture from a URL inside a cell (Excel 2024 / M365)
TEXTSPLIT, VSTACK, HSTACK	New text & array functions (Excel 2024)
GROUPBY, PIVOTBY, PERCENTOF	Pivot-style summaries with a formula (M365, 2024)
REGEXTEST / REGEXEXTRACT / REGEXREPLACE	Regular-expression text functions (M365, 2024–25)
TRANSLATE / DETECTLANGUAGE	Translate text between languages in a cell (M365)
Python in Excel	Run Python code in cells with =PY ; GA Sept 2024 (Windows, M365 business)
Copilot in Excel	AI: ask questions in plain language, create formulas, charts, insights
=COPILOT() function	AI prompt inside a cell, e.g. classify comments (announced Aug 2025)

★ REMEMBER THIS

- **#SPILL!** appears only with **dynamic-array** formulas.
- **Python in Excel** formula starts with **=PY**; **LAMBDA** = user-defined functions without macros.
- New default font in Excel = **Aptos Narrow 11** (earlier Calibri 11).

7.8 Top Excel Shortcuts

Keys	Action
Ctrl+N / Ctrl+O / Ctrl+S	New workbook / Open / Save
F12	Save As

Keys	Action
Ctrl+W or Ctrl+F4	Close workbook; Alt+F4 = exit Excel
F2	Edit active cell
F4	Toggle absolute/relative reference; repeat last action
Shift+F11 (or Alt+Shift+F1)	Insert new worksheet
F11 / Alt+F1	Chart on new chart sheet / embedded chart
Shift+F3	Insert Function
Alt+=	AutoSum
Ctrl+; / Ctrl+Shift+;	Current date / time
Ctrl+1	Format Cells dialog
Ctrl+9 / Ctrl+0	Hide selected rows / columns
Shift+Space / Ctrl+Space	Select entire row / column
Ctrl+A (Ctrl+Shift+Space)	Select whole sheet / current region
Ctrl+Home / Ctrl+End	Go to A1 / last used cell
Home	First cell of the current row
Ctrl+PgUp / Ctrl+PgDn	Previous / next worksheet
Ctrl+Tab or Ctrl+F6	Switch to next workbook window
Ctrl+` (grave accent)	Show formulas / values
Alt+Enter	New line inside a cell
Ctrl+D / Ctrl+R	Fill down / fill right
Ctrl+E	Flash Fill
Ctrl+T	Create a Table
Ctrl+Shift+L	Turn filter on/off
Ctrl+5	Strikethrough
F9 / Shift+F9	Calculate all workbooks / active sheet
F7	Spelling
Ctrl+K	Insert hyperlink

MEMORY TRICK: Hide rows & columns

- **Ctrl+9** hides rows ("9 looks like a row number"), **Ctrl+0** hides columns ("0 = Column – round like C").
- **Shift+Space** = row (Shift is long like a row), **Ctrl+Space** = column.

7.9 Practice MCQs (Previous-Year Pattern)

Q1. How many columns are there in a single worksheet of MS Excel (2007 and later)? (RBI Asst 2022)

- (a) 17,585 (b) 16,848 (c) 18,384 (d) 16,384 (e) 15,456

Ans: (d) A worksheet has 16,384 columns (A to XFD) and 1,048,576 rows.

Q2. What is the last column heading of a worksheet in Excel 2007 and later versions?

- (a) IV (b) AV (c) XV (d) XFD (e) ZZZ

Ans: (d) XFD is column number 16,384; IV (256) was the last column in Excel 2003.

Q3. Which function key opens the Save As dialog box to save the active workbook under a new name? (IBPS RRB PO 2023)

- (a) F10 (b) F12 (c) F9 (d) F3 (e) F5

Ans: (b) F12 = Save As in all Office applications.

Q4. The cell reference \$A\$5 is a/an: (IBPS RRB Asst 2022)

- (a) Relative reference (b) Absolute reference (c) Mixed reference (d) Circular reference (e) Range reference

Ans: (b) Dollar signs before both column and row make it absolute; A\$5 or \$A5 would be mixed.

Q5. Excel would evaluate the formula =20*10/4*8 and return: (IBPS Clerk 2011)

- (a) 400 (b) 40 (c) 6.25 (d) 232 (e) 600

Ans: (a) * and / have equal precedence and work left to right: 200/4 = 50, 50*8 = 400.

Q6. Which function counts all non-empty cells in a range?

- (a) COUNT (b) COUNTA (c) COUNTBLANK (d) COUNTIF (e) SUM

Ans: (b) COUNTA counts cells with any data; COUNT counts only numbers.

Q7. Which What-If Analysis tool finds the input value needed to achieve a desired result? (IBPS RRB GBO 2023)

- (a) Track Changes (b) Formula Auditing (c) Goal Seek (d) Pivot Table (e) Flash Fill

Ans: (c) Goal Seek works backwards from the result; Scenario Manager and Data Table are the other what-if tools.

Q8. The error value #NAME? in Excel appears when:

- (a) A number is divided by zero (b) A cell reference is deleted (c) Excel does

not recognise text in a formula, such as a misspelt function (d) The column is too narrow (e) A lookup value is not found

Ans: (c) #DIV/0! = divide by zero, #REF! = deleted reference, ##### = narrow column, #N/A = not found.

Q9. By default, how many worksheets does a new workbook contain in Excel 2013 and later versions?

(a) 3 (b) 1 (c) 2 (d) 4 (e) 255

Ans: (b) Since Excel 2013 a new workbook opens with one sheet (Sheet1); older versions had three.

Q10. Tiny charts that fit inside a single cell in MS Excel are called:

(a) Sparklines (b) Slicers (c) Pivot Charts (d) Thumbnails (e) Data Bars

Ans: (a) Sparklines (Insert tab) come in Line, Column and Win/Loss types.

CHAPTER 8 MS POWERPOINT

8.1 PowerPoint Basics

- **MS PowerPoint = presentation (graphics) software** – creates **slide shows** with text, pictures, charts, audio, video & animation. It is also called **multimedia** software.
- Created by **Robert Gaskins & Dennis Austin** at **Forethought Inc.**; released **20 April 1987** for **Macintosh** (original name "**Presenter**"). **Microsoft bought Forethought in 1987** (about \$14 million).
- Program file: **POWERPNT.EXE** (type **powerpnt** in the Run box). Default file name: **Presentation1**.
- A **presentation** is a collection of **slides**; each individual page = a **slide**.
- Similar software: **Google Slides**, **Keynote** (Apple), **Impress** (LibreOffice), **Prezi**, **Canva**.

► Key Terms

Term	Meaning
Slide	One page/screen of a presentation
Placeholder	Dotted-line box on a layout that holds title, text, picture, chart, table, video
Slide layout	Arrangement of placeholders on a slide
Theme	Set of colours, fonts, effects & background applied to all or selected slides
Template (.potx)	Ready-made design/content file used as the basis for new presentations
Slide Master	Top slide that controls fonts, colours, background, logo & placeholder positions of all slides
Handout	Printed copy for the audience – 1, 2, 3, 4, 6 or 9 slides per page (3-per-page has note lines)
Speaker notes	Notes for the presenter, typed in the Notes pane
Section	Groups slides into named parts (Home > Slides)

► Layouts & Defaults

- First slide of a new presentation = **Title Slide** layout (default); the next new slide = **Title and Content**.

- Office Theme has **11 layouts**: Title Slide, Title and Content, Section Header, **Two Content**, **Comparison**, Title Only, **Blank**, Content with Caption, Picture with Caption, Title and Vertical Text, Vertical Title and Text.
- Default slide size: **Widescreen 16:9** (13.33 × 7.5 inch) since **PowerPoint 2013**; older default **Standard 4:3**. Change via **Design > Slide Size**.
- Default orientation of slides: **Landscape**. Zoom range: **10% – 400%**.
- Font-size drop-down goes up to **96**; you can type up to **4000** pt.

8.2 Views in PowerPoint

View	Use
Normal (default)	Create & edit slides – slide pane, thumbnails pane, notes pane
Outline View	Shows only text (titles & bullets) as an outline
Slide Sorter	All slides as thumbnails – rearrange, delete, copy, hide slides; see all slides at once
Notes Page	Slide + its speaker notes as they will print
Reading View	Full-window show with status bar & simple navigation – for reading on own PC
Slide Show	Full-screen presentation to the audience (F5)
Presenter View	Presenter sees notes, next slide & timer ; audience sees only the slide (Alt+F5)

► Master Views (View tab)

Master	Controls
Slide Master	Look of all slides – put a logo here to show it on every slide
Handout Master	Layout of printed handouts (slides per page, header/footer)
Notes Master	How notes pages look when printed

- View tab → **Presentation Views (5)**: Normal, Outline View, Slide Sorter, Notes Page, Reading View. **Master Views (3)**: Slide, Handout, Notes Master.

- Status bar view buttons: **Normal, Slide Sorter, Reading View, Slide Show**.
- **Color / Grayscale / Black and White** – preview how slides print in grey.

✎ MEMORY TRICK: Five presentation views

- **"No One Sorts Notes Randomly"** → **Normal, Outline, Slide Sorter, Notes Page, Reading View**.
- Masters = **S H N** → **"Slide Has Notes"** (Slide, Handout, Notes).

8.3 Ribbon Tabs

Tab	Important commands
Home	Clipboard, New Slide, Layout , Section, Font, Paragraph, Drawing, Find/Replace
Insert	Table, Pictures, Photo Album , SmartArt, Chart, Zoom, Action, Header & Footer , Video, Audio, Screen Recording, Cameo
Design	Themes , Variants, Slide Size , Format Background, Designer
Transitions	Transition effects between slides, Effect Options, Duration, Sound , Apply To All, Advance Slide
Animations	Animation effects on objects , Animation Pane , Trigger, Animation Painter , Start/Delay
Slide Show	From Beginning / Current Slide , Custom Show, Set Up, Hide Slide, Rehearse Timings
Record	Record a narrated presentation, export to video (Microsoft 365)
Review / View	Spelling, Comments, Compare / Views, Masters, Ruler, Gridlines, Guides, Zoom

- Theme groups are on the **Design** tab; **Header & Footer** is in the **Text** group of the **Insert** tab.
- **Animation Pane** opens on the **right side** of the window.
- **AutoContent Wizard** existed only up to PowerPoint 2003.

8.4 Transitions vs Animations

Transition	Animation
Effect when moving from one slide to the next	Effect on an object (text, picture, shape) within a slide

Transition	Animation
Applied to slides	Applied to objects/placeholders
Transitions tab	Animations tab
e.g. Fade, Push, Wipe, Split, Cube, Morph	e.g. Appear, Fly In, Zoom, Pulse, Spin, Wheel

➤ Four Types of Animation

Type	Colour of icon	Example
Entrance	Green	Appear, Fade, Fly In, Wipe, Wheel
Emphasis	Yellow	Pulse, Spin, Grow/Shrink, Teeter
Exit	Red	Disappear, Fly Out, Fade
Motion Paths	Lines	Object moves along a path (lines, arcs, custom)

- Transition categories: **Subtle, Exciting, Dynamic Content. Morph** (Microsoft 365/2019+) creates smooth movement between two similar slides.
- **Trigger** – animation starts when a particular object is **clicked**. **Animation Painter** copies animation to another object.
- Animation start options: **On Click, With Previous, After Previous**.
- "Translate" is **not** an animation effect.

★ REMEMBER THIS

- **Transition = between slides; Animation = objects on a slide.**
- Logo on every slide → put it on the **Slide Master**.
- See / rearrange all slides at once → **Slide Sorter view**.
- Black slide at the end of a show = **"End of slide show, click to exit"** screen.

8.5 Slide Show, Presenting & New Features

- **Rehearse Timings** – practise and **record the time** spent on each slide (used for automatic advance).
- **Record Slide Show** – records **narration, ink & timings** (and webcam); can be exported as video.

- **Set Up Slide Show** – presented by a speaker, browsed by an individual, or **browsed at a kiosk** (loops automatically).
- **Custom Slide Show** – shows selected slides only. **Hide Slide** – slide is skipped during the show.
- **Presenter View** – private view with **notes, next slide, timer, pen & laser tools**.
- **Action buttons / Hyperlinks** – jump to another slide, file or web page.
- Can insert **audio** (.mp3, .wav, .m4a), **video** (.mp4, .wmv) and pictures (.jpg, .png, .gif).

► Newer Features

Feature	Key point
Designer / Design Ideas	Auto-suggests professional slide layouts for your content (Design tab; Microsoft 365)
Morph transition	Smooth object animation between slides
Zoom (Insert tab)	Summary/Slide/Section Zoom – jump between slides non-linearly
Cameo	Places your live camera feed on a slide (in Microsoft 365 & Office 2024)
Recording Studio	Record presentation with narration & camera, export video (Office 2024)
Copilot in PowerPoint	AI: create a presentation from a prompt or a Word file , add slides, summarise a deck (Microsoft 365)

8.6 File Formats

Extension	Type
.pptx	PowerPoint presentation (2007 onwards, default)
.ppt	PowerPoint 97–2003 presentation
.pptm	Macro-enabled presentation
.ppsx / .pps	PowerPoint Show – opens directly in Slide Show (non-editable view)
.potx / .pot	PowerPoint template
.potm / .ppsm	Macro-enabled template / show
.ppam	PowerPoint add-in
Export	PDF, MP4/WMV video, GIF, PNG/JPG images, outline .rtf

8.7 Top PowerPoint Shortcuts

Keys	Action
Ctrl+M	Insert new slide
Ctrl+N	New (blank) presentation
Ctrl+D	Duplicate selected slide/object
F5	Start slide show from beginning
Shift+F5	Start/resume from current slide
Alt+F5	Start in Presenter View
Esc	End the slide show
N / Enter / Space / →	Next slide (in show)
P / Backspace / ←	Previous slide (in show)
Number + Enter	Go to that slide (1+Enter = first slide)
B (or .) / W (or ,)	Black / white screen
Ctrl+P / Ctrl+E / Ctrl+A	Pen / eraser / arrow pointer (in show)
Ctrl+H	Hide pointer (in show)
Ctrl+Home / Ctrl+End	First / last slide (Normal view)
F7	Spelling check
Shift+F3	Change case
Shift+F4	Repeat last Find
F4	Repeat last action
Ctrl+K	Insert hyperlink
Ctrl+E	Centre-align text (Normal view)
Ctrl+Shift+> / <	Increase / decrease font size
F12	Save As

- Change Case options: **Sentence case, lowercase, UPPERCASE, Capitalize Each Word, tOGGLE cASE** (toggle case **reverses** the case of every letter).

✎ MEMORY TRICK: F5 family

- **F5** = "From" the start; **Shift+F5** = "Stay" on the current slide; **Alt+F5** = "Alternate" (Presenter) view.
- **Ctrl+M** = "More" slides; **Ctrl+N** = New file; **Ctrl+D** = Duplicate.

★ REMEMBER THIS

- New slide = **Ctrl+M** (not Ctrl+N). Duplicate slide = **Ctrl+D**.
- **F5** = from beginning; **Shift+F5** = from current slide; **Esc** = end show.
- **.ppsx** opens straight into a slide show; **.potx** = template; **.pptx** = default.
- Zoom in PowerPoint = **10% to 400%** (default 100%).

8.8 Practice MCQs (Previous-Year Pattern)

Q1. Which shortcut key is used to insert a new slide in MS PowerPoint? (IBPS RRB Clerk 2023)

- (a) Ctrl+N (b) Ctrl+M (c) Ctrl+D (d) Ctrl+S
(e) Alt+N

Ans: (b) Ctrl+M inserts a new slide; Ctrl+N creates a new presentation; Ctrl+D duplicates a slide.

Q2. Which view displays all slides as thumbnails and is most useful for rearranging slides? (IBPS Clerk 2013)

- (a) Normal (b) Slide Sorter (c) Notes Page
(d) Reading View (e) Slide Master

Ans: (b) Slide Sorter shows thumbnails of all slides for reordering, deleting or hiding.

Q3. To start a slide show from the current slide, you press: (IBPS RRB PO 2023)

- (a) F5 (b) Shift+F5 (c) Alt+F5 (d) Ctrl+F5
(e) F7

Ans: (b) F5 starts from the beginning; Shift+F5 from the current slide.

Q4. To place your company logo at the same position on every slide, you should use the:

- (a) Handout Master (b) Notes Master
(c) Slide Master (d) Slide Sorter
(e) Outline View

Ans: (c) Changes on the Slide Master apply to all slides based on it.

Q5. The special effects used to introduce a slide during a slide show are called:

- (a) Animations (b) Transitions
(c) Motion paths (d) Triggers (e) Themes

Ans: (b) Transitions work between slides; animations work on objects within a slide.

Q6. PowerPoint was originally created by Robert Gaskins and Dennis Austin at which company? (RBI Asst 2022)

- (a) Microsoft (b) Apple (c) Forethought Inc.
(d) Adobe (e) Lotus

Ans: (c) Forethought released it in April 1987 for the Mac; Microsoft bought the company the same year.

Q7. Which view displays the presentation like a slide show but within a window with the status bar and simple navigation controls? (RBI Asst 2022)

- (a) Master view (b) Notes Page
(c) Reading View (d) Presenter View
(e) Normal View

Ans: (c) Reading View is meant for reviewing a presentation on your own computer.

Q8. Which file extension opens a PowerPoint file directly in Slide Show mode?

- (a) .pptx (b) .potx (c) .ppsx (d) .pptm
(e) .ppam

Ans: (c) .ppsx (.pps in old versions) is a PowerPoint Show file.

Q9. Which of the following is NOT a type of animation in PowerPoint?

- (a) Entrance (b) Emphasis (c) Exit
(d) Motion Paths (e) Translate

Ans: (e) The four animation types are Entrance, Emphasis, Exit and Motion Paths.

Q10. The dotted-line containers on slide layouts that hold titles, text, pictures and charts are called:

- (a) Text boxes (b) Placeholders (c) Frames
(d) Masters (e) Handouts

Ans: (b) Placeholders are defined by the slide layout and Slide Master.

CHAPTER 9 MS ACCESS & DBMS

9.1 Data, Database & DBMS

- **Data** = raw facts; **Information** = processed, meaningful data.
- **Database** = an organised collection of **interrelated data (files/records)** stored so that it can be easily accessed, managed & updated.
- **DBMS (Database Management System)** = software to **create, store, retrieve, update & manage** a database. e.g. **MS Access, Oracle, MySQL, SQL Server, PostgreSQL, IBM Db2**.
- A DBMS is generally classed as **application software** (it runs on top of the OS).
- **DBA (Database Administrator)** – person responsible for the **technical management** of the database: design, security, backup & recovery, performance.
- **MS Excel is a spreadsheet, NOT a DBMS** (exam trap).

► Data Hierarchy (Smallest → Largest)

Level	Meaning
Bit	0 or 1 – smallest unit
Byte / Character	8 bits – one character
Field (column)	One item of data, e.g. Name, DOB
Record (row)	Collection of related fields about one entity
File / Table	Collection of related records
Database	Collection of related files/tables

✍ MEMORY TRICK: Data hierarchy

- "Big Boys Fight Rarely For Data" → Bit, Byte, Field, Record, File, Database.

► File System vs DBMS

Traditional File System	DBMS
High data redundancy (duplication)	Redundancy controlled / reduced
Data inconsistency common	Consistency & integrity maintained
Poor security; no user-level control	Strong security , authorisation
Difficult data sharing & concurrent access	Multi-user sharing, concurrency control

Traditional File System	DBMS
No automatic backup/recovery	Backup & recovery built in
Program–data dependence	Data independence

- **Data redundancy** = same data stored at many places → wastes space and causes **data inconsistency** (copies do not match when one is updated).
- **Data integrity** = accuracy & validity of data (enforced by constraints).
- **Concurrency control** = managing many **transactions running at the same time** so they do not corrupt data.

► Important Terms

Term	Meaning
Metadata	" Data about data " – structure, type, size of data
Data Dictionary / Catalog	Repository that stores metadata of the database
Schema	Overall logical design / blueprint of a database (rarely changes); written in DDL
Instance	Data in the database at a particular moment (snapshot)
Query	A stored question / request for information from a database
Data model	Conceptual tools to describe data, relationships, semantics & constraints
BLOB	Binary Large Object – images, audio, video stored in a DB
Cascade	Change in primary key automatically passed to related foreign-key rows

9.2 DBMS Architecture & Models

► Three-Level (ANSI/SPARC) Architecture

Level	Describes
External / View level	What each user sees (many views)
Conceptual / Logical level	What data is stored & relationships (whole database)

Level	Describes
Internal / Physical level	How data is actually stored on disk

- **Physical data independence** – change physical storage without changing the logical schema.
- **Logical data independence** – change the logical schema without changing user views (harder to achieve).
- **Tier architecture:** **1-tier** (all on one machine), **2-tier** (client application ↔ database server), **3-tier** (client ↔ application server ↔ database server; most popular, used in web apps).

► Database Models

Model	Structure	Example
Hierarchical	Tree – parent-child (one-to-many)	IBM IMS, Windows Registry
Network	Graph – a child can have many parents (many-to-many)	IDMS, CODASYL
Relational	Tables (relations) of rows & columns; E. F. Codd, 1970	Oracle, MySQL, Access, SQL Server
Object-oriented	Data stored as objects (data + methods)	db4o, ObjectDB
Object-relational	Relational + object features	PostgreSQL, Oracle

► E-R Model (Entity–Relationship)

- Proposed by **Peter Chen (1976)**; drawn as an **E-R Diagram (ERD)** showing **entities, attributes & relationships**.
- **Entity** = real-world object (Customer, Account). **Attribute** = property (Name, DOB).
- **Weak entity** – cannot be identified by its own attributes (no primary key of its own); depends on a strong entity.

ERD Symbol	Represents
Rectangle	Entity (set)
Double rectangle	Weak entity
Ellipse (oval)	Attribute
Double ellipse	Multivalued attribute
Dashed ellipse	Derived attribute (e.g. Age from DOB)

ERD Symbol	Represents
Underlined attribute	Key (primary key) attribute
Diamond	Relationship
Double diamond	Identifying relationship (weak entity)
Lines	Link entities, attributes & relationships

► Relationships (Cardinality Ratio)

- **One-to-One (1:1)** – one person ↔ one passport.
- **One-to-Many (1:N)** – one customer → many orders.
- **Many-to-One (N:1)** – many employees → one department.
- **Many-to-Many (M:N)** – students ↔ courses (needs a **junction table**).

9.3 Relational Database (RDBMS)

- **RDBMS** stores data in **tables (relations)** linked by **keys**; based on **Dr. E. F. (Ted) Codd's** relational model (IBM, 1970).
- Codd gave **12 rules** (numbered 0–12, i.e. 13 in all) that a DBMS must obey to be truly relational.
- Examples: **Oracle, MySQL, MS SQL Server, PostgreSQL, IBM Db2, MS Access, SQLite, MariaDB.**

Relational term	Common term
Relation	Table (2-D)
Tuple	Row / Record
Attribute	Column / Field
Degree	Number of attributes (columns)
Cardinality	Number of tuples (rows)
Domain	Set of allowed values of an attribute

✎ MEMORY TRICK: Degree vs Cardinality

- **"Cardinality Counts Rows; Degree Describes Columns"** → Cardinality = no. of tuples (rows); Degree = no. of attributes (columns).
- **Tuple = Row, Attribute = Column** → think **"T-Rain, A-C"** (TR & AC).

► Open Source vs Proprietary DBMS

Open source (free)	Proprietary (paid)
MySQL (community edition)	Oracle Database (most popular paid)
PostgreSQL	Microsoft SQL Server
MariaDB	IBM Db2
SQLite (most used embedded DB – phones)	SAP HANA, MS Access

9.4 Database Keys

Key	Meaning
Super key	Any set of one or more attributes that uniquely identifies a row
Candidate key	Minimal super key (no extra attribute); a table can have many
Primary key (PK)	Candidate key chosen to identify rows; unique + NOT NULL; only one per table
Alternate key	Candidate keys not chosen as PK
Composite key	Key made of two or more attributes together (e.g. Account No + Branch Code)
Foreign key (FK)	Attribute in one table that refers to the PK of another table ; links tables & enforces referential integrity
Unique key	Values must be unique but NULL allowed ; many per table

- PK may be **single or multiple columns** (composite PK) – but still **only one PK per table**.
- FK is found in the **child / dependent (referencing)** table.
- Good PK examples: **Account No., Roll No., Employee ID, Aadhaar No.**; bad PK: **Name, Street, Zip code, Department** (can repeat).
- Relation: **Primary key $\subset$ Candidate keys $\subset$ Super keys**.

Primary Key	Unique Key
Cannot be NULL	Can be NULL (only one NULL in SQL Server)
Only one per table	Many per table
Creates clustered index by default (SQL Server)	Creates non-clustered index

★ REMEMBER THIS

- **Primary key** = uniquely identifies each record; **cannot be NULL, cannot repeat**.
- **Foreign key** = primary key of one table appearing in another; **represents relationship** between tables.
- **Candidate key – Primary key = Alternate key**.
- **"Structured primary key"** is NOT a valid key type (IBPS Clerk 2013).

9.5 Normalization

- **Normalization** = organising tables to **reduce redundancy** and avoid **insertion, update & deletion anomalies**; proposed by **Codd**.
- **Denormalization** = deliberately adding redundancy to speed up reading.

Normal form	Condition
1NF	Atomic (single) values only; no repeating groups
2NF	1NF + no partial dependency (non-key attribute depends on whole PK)
3NF	2NF + no transitive dependency (non-key $\rightarrow$ non-key)
BCNF	Every determinant is a candidate key; stricter 3NF ("3.5 NF")
4NF / 5NF	No multivalued / no join dependency

- **BCNF = Boyce–Codd Normal Form** (Raymond Boyce & E. F. Codd) – asked in IBPS RRB Clerk 2023.

9.6 Transactions & ACID

- **Transaction** = a set of operations treated as **one logical unit of work** (e.g. fund transfer: debit A + credit B).

Property	Meaning
Atomicity	All or nothing – either all operations happen or none
Consistency	Database moves from one valid state to another
Isolation	Concurrent transactions do not interfere with each other
Durability	Once committed , changes are permanent even after a crash

- **COMMIT** – saves changes permanently.
ROLLBACK – undoes changes to the **last committed state**. **SAVEPOINT** – marks a point to roll back to.
- "Insulation" is NOT an ACID property (trap).
Isolation preserves **consistency**.

9.7 SQL – Structured Query Language

- Developed at **IBM** (1973–74) by **Donald Chamberlin & Raymond Boyce** as **SEQUEL**; based on **Codd's** relational model.
- Standard language for RDBMS – standardised by **ANSI (1986)** and **ISO (1987)** as **ISO/IEC 9075**; current edition **SQL:2023**.
- SQL is a **4GL, non-procedural (declarative)** language; it is **case-insensitive** for keywords.

Category	Purpose	Commands
DDL – Data Definition	Defines structure / schema	CREATE, ALTER, DROP, TRUNCATE, RENAME, COMMENT
DML – Data Manipulation	Changes data in tables	INSERT, UPDATE, DELETE, MERGE, LOCK TABLE
DQL – Data Query	Retrieves data	SELECT
DCL – Data Control	Access rights / authorisation	GRANT, REVOKE
TCL – Transaction Control	Manages transactions	COMMIT, ROLLBACK, SAVEPOINT, SET TRANSACTION

Many textbooks put **SELECT** under **DML** as well – in an exam, choose **DQL** if given, otherwise **DML**.

► Example Statements

- **CREATE TABLE** Account (AccNo INT PRIMARY KEY, Name VARCHAR(30), Bal DECIMAL(10,2));
- **INSERT INTO** Account VALUES (101, 'Ravi', 5000);
- **UPDATE** Account SET Bal = 6000 WHERE AccNo = 101;
- **SELECT** Name, Bal FROM Account WHERE Bal > 1000 **ORDER BY** Bal DESC;
- **GRANT SELECT ON** Account **TO** clerk1; **COMMIT**;
- Clauses: **WHERE** (filter rows), **GROUP BY** (group), **HAVING** (filter groups), **ORDER BY** (sort; default **ASC**).

- Aggregate functions: **COUNT, SUM, AVG, MIN, MAX**.

DELETE	TRUNCATE	DROP
DML	DDL	DDL
Removes selected rows (WHERE)	Removes all rows	Removes whole table (structure + data)
Can be rolled back	Usually cannot	Cannot

✎ MEMORY TRICK: SQL command groups

- DDL = "**CAD-TR**" → Create, Alter, Drop, Truncate, Rename.
- DML = "**I-U-D**" → Insert, Update, Delete.
DCL = "**Give & Remove**" → Grant, Revoke.
TCL = "**C-R-S**" → Commit, Rollback, Savepoint.

9.8 Data Warehouse, Data Mining, Big Data & NoSQL

Data Warehouse	Data Mining
Huge central store of data collected from many sources	Process of extracting hidden patterns / knowledge from large data
Subject-oriented, historical , non-volatile	Uses statistics, ML, AI
Supports OLAP & reporting	Also called KDD – Knowledge Discovery in Databases

- **Data mart** = small, department-level part of a data warehouse.
- **ETL** = Extract, Transform, Load – process to fill a data warehouse.
- **Data lake** = stores raw data of all types (structured + unstructured).

OLTP	OLAP
Online Transaction Processing	Online Analytical Processing
Day-to-day operations (ATM, billing)	Analysis & decision support
Many short INSERT/UPDATE queries	Few complex, read-heavy queries
Current, detailed data; normalised	Historical, summarised data (warehouse)

► Big Data

- Extremely large, fast & varied data sets that traditional DBMS cannot handle. Tools: **Hadoop** (HDFS, MapReduce), **Spark**.
- 5 V's: Volume, Velocity, Variety, Veracity, Value.**

► NoSQL ("Not only SQL")

Type	Example
Document	MongoDB, CouchDB
Key-value	Redis, Amazon DynamoDB
Column-family	Cassandra, HBase
Graph	Neo4j

- NoSQL = **schema-less**, horizontally scalable, handles unstructured data; SQL/RDBMS = fixed schema, tables.
- Cloud databases** – DBaaS such as Amazon RDS, Azure SQL, Google Cloud SQL.

9.9 Latest Database Versions (2025–26)

Database	Latest version
Oracle	Oracle AI Database 26ai (Oct 2025) – replaces 23ai (2024)
MySQL	MySQL 9.7 LTS (Apr 2026)
PostgreSQL	PostgreSQL 18 (Sept 2025); v19 in beta (2026)
MS SQL Server	SQL Server 2025 (GA Nov 2025, AI/vector support)
MS Access	Access 2024 (Oct 2024) & Access in Microsoft 365

9.10 Microsoft Access

- MS Access** = Microsoft's **desktop RDBMS**, part of **Microsoft 365 / Office Professional** (Windows only). First version **Access 1.0** – **1992**.
- Uses the **ACE** database engine (Access Connectivity Engine); older versions used **JET** (Joint Engine Technology).
- Combines a database engine with a GUI and **VBA** (Visual Basic for Applications) programming.

► File Extensions

Extension	Meaning
.accdb	Access database – 2007 and later (default)
.mdb	Access database – 2003 and earlier
.accde (old .mde)	Compiled, locked (execute-only) database
.accdt	Access database template
.accdr	Runtime-mode database
.laccdb (old .ldb)	Lock file created when a database is open

► The 6 Database Objects

Object	Use
Table	Stores data in rows & columns – the basic/main object
Query	Asks questions – retrieves, filters, sorts, calculates data
Form	Data entry & viewing screen (user-friendly interface)
Report	Formatted output for printing / summary
Macro	Automates tasks without coding
Module	VBA code for advanced programming

✎ MEMORY TRICK: Access objects

► "The Queen Felt Really Merry Mondays" → Table, Query, Form, Report, Macro, Module.

► Views in Access

Object	Views
Table	Datasheet view (enter data, spreadsheet-like) & Design view (define fields, data types, PK)
Query	Datasheet, Design & SQL view
Form	Form, Layout & Design view
Report	Report, Print Preview , Layout & Design view

► Data Types in Access

Data type	Stores
Short Text (old "Text")	Up to 255 characters – default data type

Data type	Stores
Long Text (old "Memo")	Long text; 65,535 chars via UI (up to 1 GB)
Number / Large Number	Numeric values for calculation
Date/Time	Dates & times (Date/Time Extended in new versions)
Currency	Money values (4 decimal places precision)
AutoNumber	Unique number auto-generated for each record – often PK
Yes/No	Boolean – Yes/No, True/False, On/Off
OLE Object	Objects like Excel sheets, images (old method)
Attachment	Files (images, documents) attached to a record
Hyperlink	Web / e-mail / file links
Calculated	Result of an expression on other fields
Lookup Wizard	Drop-down list of values from a table/list

► Queries, Properties & Other Features

- **Select query** – displays data. **Action queries** – **Make-table, Append, Update, Delete**. **Crosstab** – summary in row/column grid. **Parameter query** – asks the user for input.
- Field properties: **Field Size, Format, Input Mask, Default Value, Validation Rule, Validation Text, Required, Indexed**.
- **Relationships** window (Database Tools tab) links tables; **Enforce Referential Integrity** prevents orphan records.
- Primary key is shown by a **key icon** in Design view.
- **Navigation Pane** lists all objects – toggle with **F11**.
- Shortcuts: **Ctrl + ;** current date, **Ctrl + Shift + :** current time, **Ctrl + '** copy value from previous record, **F2** edit mode.
- Other tools: **Compact & Repair Database, Database Documenter, Table Analyzer, Form/Report/Query Wizards**.

► Access Specifications (Limits)

Item	Limit
Database (.accdb/.mdb) size	2 GB

Item	Limit
Fields in a table	255
Characters in Short Text field	255
Characters in object/field name	64
Objects in a database	32,768
Record size (excluding Long Text/OLE)	4,000 characters
Concurrent users	255
Characters in a password	14

★ REMEMBER THIS

- Access 2007+ default file = **.accdb**; Access 2003 and earlier = **.mdb**.
- **Table** stores data; **Query** asks questions; **Form** = data entry; **Report** = printing.
- **AutoNumber** = automatic unique number; default data type = **Short Text (255 chars)**.
- Long Text was earlier called **Memo**; Short Text was earlier called **Text**.
- **Oracle** is an **RDBMS** (IBPS Clerk 2014, 2017); **SQLite** = most used embedded DB.

9.11 Practice MCQs (Previous-Year Pattern)

Q1. Every row in a relational database corresponds to a complete record. The row is also referred to as a: (IBPS RRB Clerk 2023)

- (a) Attribute (b) Relation (c) Tuple (d) Field (e) Object

Ans: (c) Row = tuple/record; column = attribute/field.

Q2. _____ is a primary key of one file that also appears in another file. (IBPS Clerk 2013)

- (a) Physical key (b) Primary key (c) Foreign key (d) Logical key (e) None of these

Ans: (c) A foreign key refers to the primary key of another table and links the two tables.

Q3. In the relational model, cardinality is termed as the: (IBPS Clerk 2011)

- (a) number of tuples (b) number of attributes (c) number of tables (d) number of constraints (e) None of these

Ans: (a) Cardinality = number of rows (tuples); degree = number of columns (attributes).

Q4. Which of the following is NOT a DDL command?

- (a) CREATE (b) ALTER (c) TRUNCATE
(d) UPDATE (e) DROP

Ans: (d) UPDATE changes data, so it is a DML command.

Q5. Which command saves the changes made by a transaction permanently in the database?

- (a) ROLLBACK (b) SAVEPOINT (c) COMMIT
(d) UNDO (e) GRANT

Ans: (c) COMMIT makes changes permanent; ROLLBACK undoes them to the last commit.

Q6. The "all-or-none" property of a database transaction is called:

- (a) Isolation (b) Durability (c) Consistency
(d) Atomicity (e) Integrity

Ans: (d) Atomicity ensures either all operations of a transaction happen or none.

Q7. In an E-R diagram, a relationship is represented by a: (IBPS Clerk 2012)

- (a) ellipse (b) dashed ellipse (c) rectangle
(d) diamond (e) None of these

Ans: (d) Rectangle = entity, ellipse = attribute, diamond = relationship.

Q8. What is the default file extension of a database created in MS Access 2007 or later?

- (a) .mdb (b) .accdb (c) .dbf (d) .acc (e) .xlsx

Ans: (b) .accdb is used from Access 2007 onwards; .mdb was used up to Access 2003.

Q9. Which MS Access object is mainly used to present data in a formatted way for printing?

- (a) Table (b) Query (c) Form (d) Report
(e) Macro

Ans: (d) Reports give formatted printed output; forms are for data entry.

Q10. Boyce-Codd Normal Form (BCNF) is considered a stricter version of: (IBPS RRB Clerk 2023)

- (a) 1NF (b) 2NF (c) 3NF (d) 4NF (e) 5NF

Ans: (c) BCNF is called 3.5NF: every determinant must be a candidate key.

CHAPTER 10 NETWORKING

10.1 Computer Network – Basics

- A **computer network** = two or more **autonomous computers/devices** connected (wired or wireless) to **share resources** (printer, files, internet) and **information**.
- **ARPANET** (Advanced Research Projects Agency Network), US Dept. of Defense – **world's first** packet-switched network; first link on **29 Oct 1969**; 4 nodes: **UCLA, SRI (Stanford Research Institute), UCSB, University of Utah**.
- ARPANET adopted **TCP/IP on 1 Jan 1983** → birth of the modern **Internet** (the **largest WAN**).
- **Node** = any device (computer, printer, router, switch) connected to a network that can send/receive data.
- **Server** = powerful computer that **provides** services (most important computer in a network). **Client** = device that **requests** services.
- **NIC (Network Interface Card)** = hardware that connects a computer to a network; also called **LAN card, Ethernet card, network adapter**; carries the **MAC address**.
- **Protocol** = set of **rules (agreement)** for communication between devices.

► Network Architecture

Peer-to-Peer (P2P)	Client–Server
All computers equal ; each is client & server	Central server provides resources to clients
Decentralised / distributed ; no central control	Centralised control & security
Cheap; small networks; file sharing (BitTorrent)	Costly; scalable; banks, offices, web

► Internet vs Intranet vs Extranet

- **Internet** – public, global network – anyone can access.
- **Intranet** – private network **inside an organisation** (employees only).
- **Extranet** – part of an intranet opened to **authorised outsiders** (partners, suppliers, other companies).

10.2 Types of Networks (by Area)

Type	Range	Key points
PAN – Personal	~10 m	Bluetooth, infrared, USB, hotspot; one person's devices
LAN – Local	Up to ~1–2 km (room/building)	Fastest, lowest error rate ; private; Ethernet (802.3), Wi-Fi (802.11)
CAN – Campus	~1–5 km	Interconnected LANs of a university/office campus (Corporate Area Network)
MAN – Metropolitan	A city (~5–100 km)	Cable TV network, city Wi-Fi; fibre-optic backbone
WAN – Wide	Country / world	Internet = largest WAN ; uses telephone lines, satellites; slowest; also "long-haul network"

- **SAN (Storage Area Network)** – high-speed network giving **block-level access to storage**.
- **VPN (Virtual Private Network)** – secure, **encrypted tunnel** over the public internet (used by remote workers).
- **MANET** – Mobile Ad-hoc Network; no fixed infrastructure, topology keeps changing.
- **Wireless types**: **WPAN** (802.15 – Bluetooth, ZigBee), **WLAN** (802.11 – Wi-Fi), **WMAN** (802.16 – **WiMAX**), **WWAN** (cellular 2G–5G).

📌 MEMORY TRICK: Order of networks by area

- **"People Like Cooking Many Waffles"** → PAN < LAN < CAN < MAN < WAN (area ascending).
- Speed is the **reverse**: WAN < MAN < LAN (LAN fastest).

► Important IEEE 802 Standards

Standard	For
802.3	Ethernet (wired LAN)
802.4 / 802.5	Token Bus / Token Ring
802.11	Wi-Fi (WLAN)

Standard	For
802.15 / 802.15.1	WPAN / Bluetooth
802.15.4	ZigBee (low-power IoT)
802.16	WiMAX (Worldwide Interoperability for Microwave Access)
802.1Q	VLAN tagging

10.3 Network Topologies

Topology = physical or logical **arrangement (layout)** of nodes and links in a network. It is related to the **Physical layer**.

Topology	Advantages	Disadvantages
Bus – all nodes on one backbone cable; terminators at both ends; multipoint	Cheap, least cable, easy to add nodes	Backbone fails → whole network down ; hard fault-finding; slow with many nodes
Star – all nodes to a central hub/switch	Most popular ; one node failure does not affect others; easy to manage	Hub fails → network down; more cable
Ring – closed loop; each node has 2 neighbours; token passing	No collisions; orderly access	One break can stop the ring (unless dual ring, e.g. FDDI); hard troubleshooting
Mesh – every node linked to every other (point-to-point)	Most reliable , fault-tolerant, secure; multiple paths	Most cabling , costly, hard to install
Tree – hierarchy of stars (root node); bus + star	Scalable; easy expansion	Root/backbone failure affects branches; costly
Hybrid – mix of 2 or more topologies	Flexible, scalable, reliable	Complex design; costly

- Full mesh links = $n(n-1)/2$ (6 nodes → 15 links); each node needs $n-1$ ports.
- **Token** = small message/frame passed around a ring to grant permission to transmit (IEEE 802.5).
- **Bus** uses **CSMA/CD** (Ethernet); Wi-Fi uses **CSMA/CA**.

- Classic Ethernet (coaxial) used **bus**; modern switched Ethernet is physically a **star**.

★ REMEMBER THIS

- **Highest reliability / most cable** → **Mesh**. **Terminators / backbone / multipoint** → **Bus**.
- **Central hub / most common today** → **Star**. **Token** → **Ring**. **Hierarchical** → **Tree**.
- Bus, ring & star are mostly used in **LANs**.

10.4 Transmission Modes, Media & Switching

Mode	Direction	Example
Simplex	One way only	Keyboard → CPU, TV/radio broadcast, loudspeaker
Half-duplex	Both ways, one at a time	Walkie-talkie , CB radio
Full-duplex	Both ways simultaneously	Telephone , mobile call, video conferencing

- **Serial** transmission = 1 bit at a time (USB, long distance). **Parallel** = many bits together on many wires (short distance).
- **Multiplexing** – many signals share **one path** (many channels on one link); device = **multiplexer (MUX)**. Types: FDM, TDM, **WDM** (fibre), CDM; Wi-Fi uses **OFDM**.

► Transmission Media

Guided (wired)	Key points
Twisted pair – UTP / STP	Cheapest, most common in LAN; RJ-45 connector (RJ-11 for telephone); STP has shielding
Coaxial cable	Cable TV, old Ethernet; BNC connector
Optical fibre	Fastest , highest bandwidth; data as light (total internal reflection); immune to EMI ; undersea & backbone links

Category	Max speed	Bandwidth
Cat5	100 Mbps	100 MHz
Cat5e	1 Gbps	100 MHz
Cat6	1 Gbps (10 Gbps ≤ 55 m)	250 MHz

Category	Max speed	Bandwidth
Cat6A	10 Gbps (100 m)	500 MHz
Cat7	10 Gbps	600 MHz
Cat8	25/40 Gbps (≤ 30 m)	2000 MHz

Unguided (wireless)	Use
Radio waves (omnidirectional)	AM/FM radio, TV, Wi-Fi, mobile
Microwaves (line-of-sight)	Satellite, mobile towers, radar, point-to-point links
Infrared	Short range – TV remote, IrDA (cannot pass walls)

► Bandwidth & Data Rate

- **Bandwidth** = amount of data a medium can carry **per unit time**; data rate measured in **bps** (bits per second).
- Order: **bps < Kbps < Mbps < Gbps < Tbps** (each $\times 1000$). **Modem speed** is also in **bps**; **baud** = signal changes per second.
- **Latency** = delay; **throughput** = actual data rate achieved.

► Switching Techniques

Type	How it works	Example
Circuit switching	Dedicated path set up before communication	Traditional telephone (PSTN)
Message switching	Whole message stored & forwarded hop by hop	Telegram, early e-mail
Packet switching	Data split into packets ; each may take a different route	Internet (IP)

10.5 Networking Devices

Device	Function	OSI layer
Hub	Broadcasts data to all ports; "dumb" device; passive/active hubs	1 – Physical
Repeater	Regenerates/amplifies weak signal to extend distance	1 – Physical

Device	Function	OSI layer
Modem	Modulates (digital→analog) & demodulates (analog→digital); connects to ISP	1 – Physical
NIC	Connects a PC to the network; holds MAC address	1 & 2
Switch	Sends frames only to destination using MAC address ; "intelligent hub", multiport bridge	2 – Data Link
Bridge	Connects two LAN segments using the same protocol ; filters by MAC	2 – Data Link
Access Point (WAP)	Lets wireless devices join a wired LAN (creates WLAN)	2 – Data Link
Router	Forwards packets between different networks using IP address ; finds best path	3 – Network
Gateway	Connects networks with different protocols ; "protocol converter"	All layers (mainly 4–7)
Firewall	Filters traffic by rules; hardware/software	3, 4 or 7 (by type)

- A **Layer-3 switch** can also route. A **brouter** = bridge + router.
- Firewall types: **packet-filter** (network/transport layer), **stateful inspection**, **proxy / application-layer** firewall; **host-based** firewall protects a single computer.
- **Traceroute (tracert)** finds the routers on a path; **ping** (ICMP) tests reachability.

🔑 MEMORY TRICK: Device layers

- "Hub, Repeater, Modem – Physical; Switch & Bridge – MAC (Layer 2); Router – IP (Layer 3); Gateway – everywhere."
- "1-2-3 = H-S-R" → Layer 1 Hub, Layer 2 Switch, Layer 3 Router.

10.6 OSI Model & TCP/IP Model

- **OSI = Open Systems Interconnection**; developed by **ISO**; published **1984** (ISO 7498); **7 layers**; a **conceptual / reference** model.
- Layer 1 = Physical (bottom), Layer 7 = Application (top).

No. & Layer	Main job	Data unit / examples
7 Application	User interface; network services to apps	Data – HTTP, FTP, SMTP, DNS, Telnet, POP3
6 Presentation	Translation, encryption/decryption, compression	Data – SSL/TLS, JPEG, GIF, MIME, ASCII
5 Session	Set up, maintain & end sessions; dialogue control, synchronisation	Data – NetBIOS, RPC, NFS
4 Transport	End-to-end (process-to-process) delivery; reliability; port numbers ; "heart of OSI"	Segment (TCP) / Datagram (UDP)
3 Network	Routing , logical (IP) addressing; source-to-destination	Packet – IP, ICMP, ARP, OSPF; router
2 Data Link	Framing, MAC (physical) addressing, error detection ; node-to-node	Frame – Ethernet, PPP, CSMA/CD; switch, bridge
1 Physical	Bits on medium – cables, voltages, connectors, topology	Bit – hub, repeater, cables

MEMORY TRICK: OSI layers

- ▶ Bottom → Top: "**Please Do Not Throw Sausage Pizza Away**" → Physical, Data Link, Network, Transport, Session, Presentation, Application.
- ▶ Top → Bottom: "**All People Seem To Need Data Processing**".

- Data link has two sub-layers: **LLC** (Logical Link Control, 802.2) & **MAC** (Media Access Control).
- **Upper / host / software layers** = 5, 6, 7; **lower / media / hardware layers** = 1, 2, 3; transport (4) links them.
- ▶ **TCP/IP Model**
 - Developed by **Vint Cerf & Bob Kahn** (DARPA, US DoD) in the **1970s**; the **practical** model on which the Internet runs; also called the **Internet protocol suite** (100+ protocols).

- Original **4 layers**: **Network Access (Link) → Internet → Transport → Application**. (Some books use a 5-layer version splitting Link into Physical + Data Link.)
- TCP/IP has **no separate Session & Presentation layers** – they are merged into Application.

TCP/IP layer	OSI equivalent	Protocols
Application	Application + Presentation + Session	HTTP, FTP, SMTP, DNS, SNMP
Transport (Host-to-Host)	Transport	TCP, UDP
Internet	Network	IP, ICMP, ARP
Network Access / Link	Data Link + Physical	Ethernet, Wi-Fi

TCP	UDP
Connection-oriented	Connectionless
Reliable – acknowledgement, retransmission, ordering	Unreliable, no acknowledgement
Slower, more overhead	Faster , low overhead
Web, e-mail, file transfer	Video streaming, online gaming, VoIP, DNS

10.7 Protocols & Port Numbers

- A **port** (16-bit number, **0–65535**) identifies a **process/service** on a host; works at the **Transport layer**. **Well-known ports** = **0–1023** (assigned by **IANA**).

Protocol	Use	Port
FTP	File transfer (20 = data, 21 = control)	20, 21
SSH / SFTP	Secure remote login / secure file transfer	22
Telnet	Remote terminal login (unencrypted)	23
SMTP	Send e-mail (587 = submission, 465 = SMTPS)	25
DNS	Domain name → IP address	53
DHCP	Assigns IP automatically (67 server, 68 client)	67, 68
TFTP	Trivial FTP (UDP)	69
HTTP	Web pages	80
POP3	Receive e-mail (downloads)	110

Protocol	Use	Port
NTP	Clock time sync (David Mills, 1985)	123
IMAP	Receive e-mail (kept on server)	143
SNMP	Network management	161
HTTPS	Secure web (HTTP over TLS)	443
IMAPS / POP3S	Secure IMAP / POP3	993 / 995
RDP	Remote Desktop	3389

► Other Key Protocols

- **IP** – addressing & routing of packets (connectionless). **ICMP** – error messages, **ping**.
- **ARP** – finds **MAC address** from **IP address**; **RARP** – finds **IP** from **MAC**.
- **NAT** – translates private IPs to a public IP. **PPP / SLIP** – serial point-to-point links.
- **OSPF** – link-state routing inside a network; **BGP** – path-vector routing **between autonomous systems** (Internet backbone); **RIP** – distance-vector.
- **SSL/TLS** – encryption for HTTPS (current **TLS 1.3**). **MIME** – attachments & non-ASCII text in e-mail.

🔑 MEMORY TRICK: E-mail protocols

- **SMTP** = "Send Mail To People" (outgoing). **POP3 & IMAP** = incoming. **POP** downloads, **IMAP** keeps on server.

10.8 IP Address & MAC Address

IP Address	MAC Address
Logical address; Network layer (3)	Physical / hardware / burned-in / Ethernet address; Data Link layer (2)
IPv4 32-bit (4 bytes), dotted decimal; IPv6 128-bit (16 bytes), hexadecimal	48-bit (6 bytes) = 12 hex digits , e.g. 01:A5:BB:A7:FF:60
Assigned by ISP / router (DHCP); can change	Assigned by manufacturer in NIC; fixed (can be spoofed by software)
Command: ipconfig (Windows), ifconfig/ip (Linux)	Command: getmac or ipconfig /all

IP Address	MAC Address
Managed globally by IANA ; in Asia-Pacific (India) by APNIC	First 24 bits = OUI (maker); last 24 bits = NIC-specific

► IPv4 Classes

Class	1st octet	Default mask	Use
A	1–126	255.0.0.0	N.H.H.H – large nets
B	128–191	255.255.0.0	N.N.H.H
C	192–223	255.255.255.0	N.N.N.H – small nets
D	224–239	–	Multicast (no Net/Host ID)
E	240–255	–	Research / future

- IPv4 = **4 octets**, each **0–255**, separated by **3 dots**, e.g. **192.168.56.115**. Two parts: **Network ID + Host ID**.
- **127.x.x.x** = **loopback** (**127.0.0.1** = **localhost**, self-testing). **255.255.255.255** = broadcast.
- **Private IPs** (RFC 1918, cannot be routed on the internet): **10.0.0.0–10.255.255.255**, **172.16.0.0–172.31.255.255**, **192.168.0.0–192.168.255.255**.
- **Subnet mask** separates network & host parts; **subnetting** divides a network into smaller sub-networks. Classful addressing is now replaced by **CIDR** (e.g. /24).
- **IPv6** – 128-bit, **8 groups of 4 hex digits** separated by **colons** (e.g. 2001:db8::1); developed by **IETF**; loopback ::1; huge address space (2^{128}).
- **Unicast** = one receiver; **Multicast** = a group; **Broadcast** = all devices.

★ REMEMBER THIS

- IPv4 = **32 bits**, IPv6 = **128 bits**, MAC = **48 bits** (asked IBPS RRB PO 2023).
- Class A range asked: **1–126** (0 & 127 reserved; 127 = loopback).
- **ARP: IP → MAC**; **RARP: MAC → IP**.
- IP addresses are managed by **IANA**; MAC address concept came from **Xerox PARC** (Ethernet, Robert Metcalfe 1973).

10.9 Wireless Technologies

► Wi-Fi (IEEE 802.11)

- **Wi-Fi** = trademark of the **Wi-Fi Alliance** (1999), popularly "**Wireless Fidelity**"; WLAN technology using **radio waves**; uses **OFDM** and **CSMA/CA**.
- Original 802.11 standard – **1997** (2 Mbps). **Vic Hayes** = "Father of Wi-Fi". Hedy Lamarr co-invented **frequency hopping** (1942), a forerunner of wireless tech.
- Device needed: **WNIC** (wireless NIC); network created by a **Wireless Access Point (WAP)** / router.

Gen	Standard	Max speed	Band
Wi-Fi 1	802.11b (1999)	11 Mbps	2.4 GHz
Wi-Fi 2	802.11a (1999)	54 Mbps	5 GHz
Wi-Fi 3	802.11g (2003)	54 Mbps	2.4 GHz
Wi-Fi 4	802.11n (2009)	600 Mbps	2.4/5
Wi-Fi 5	802.11ac (2013)	~6.9 Gbps	5 GHz
Wi-Fi 6	802.11ax (2019)	9.6 Gbps	2.4/5
Wi-Fi 6E	802.11ax (2020)	9.6 Gbps	+ 6 GHz
Wi-Fi 7	802.11be (2024)	~23 Gbps*	2.4/5/6
Wi-Fi 8	802.11bn (UHR)	TBD	2.4/5/6

- **Wi-Fi 7 (Extremely High Throughput)** – **320 MHz** channels, **4096-QAM**, **Multi-Link Operation (MLO)**; Wi-Fi Alliance certification began **Jan 2024**; IEEE 802.11be-2024 published **July 2025**. *Often quoted as "up to 46 Gbps".
- **Wi-Fi 8 (802.11bn, Ultra High Reliability)** – focuses on **reliability & low latency**, not higher peak speed; IEEE final approval expected around **2028**.
- India **delicensed the lower 6 GHz band (5925–6425 MHz)** for indoor Wi-Fi in **Jan 2026** – enables Wi-Fi 6E/7 in India.

Security	Key point
WEP (1997)	Wired Equivalent Privacy – weakest , RC4
WPA (2003)	Uses TKIP
WPA2 (2004)	AES-CCMP , 128-bit
WPA3 (2018)	Strongest ; SAE handshake; 128-bit (Personal), 192-bit (Enterprise)

► Bluetooth (IEEE 802.15.1)

- Developed by **Ericsson** (**1994**, **Jaap Haartsen**); named after Danish king **Harald "Bluetooth"**; managed by **Bluetooth SIG** (1998).
- Uses **2.4 GHz ISM band**, **frequency hopping**; creates a **piconet** (1 master + up to **7** active slaves); several piconets = **scatternet**.
- Range: Class 2 ≈ **10 m** at **2.5 mW** (most phones); Class 1 ≈ **100 m** at **100 mW**.
- Versions: **4.0** – **BLE** (Low Energy, 2010), **5.0** (2016), **5.3** (2021), **6.0** (Sept 2024 – **Channel Sounding** for cm-level distance), **6.1** (2025), **6.2** (Nov 2025), **6.3** (May 2026) – latest.

► Other Short-Range Technologies

Technology	Key point
NFC (Near Field Communication)	Range ~4 cm (≤10 cm) , 13.56 MHz ; tap-to-pay cards, phones
RFID	Radio tags for identification – FASTag , library, inventory
Li-Fi (Light Fidelity)	Data via visible LED light ; coined by Prof. Harald Haas (2011); standard IEEE 802.11bb (2023)
ZigBee / Z-Wave	Low-power mesh for IoT & home automation
Infrared (IrDA)	Line-of-sight, very short range – TV remote
Wi-Fi Direct / Hotspot	Device-to-device / phone shares mobile data

10.10 Mobile Generations, 5G/6G & Satellite Internet

Gen	Technology	Key feature
1G (1979–80s)	Analog – AMPS	Voice only; first in Japan (NTT, 1979)
2G (1991)	Digital – GSM , CDMA	Digital voice, SMS ; Finland 1991. 2.5G = GPRS , 2.75G = EDGE
3G (2001)	UMTS / WCDMA , HSPA	Mobile internet, video calls; NTT DoCoMo Japan
4G (2009)	LTE , WiMAX ; all-IP	High-speed broadband, VoLTE , HD streaming
5G (2019)	5G NR ; sub-6 GHz & mmWave	Up to ~10–20 Gbps, ~1 ms latency; eMBB , URLLC , mMTC ; network slicing

Gen	Technology	Key feature
6G (~2030)	Terahertz bands, AI-native	Under research/standardisation (ITU IMT-2030)

► India – Telecom Milestones

- First mobile call in India – **31 July 1995** (Jyoti Basu, Kolkata → Sukh Ram, Delhi).
- **5G launched on 1 October 2022** by PM Narendra Modi at the **India Mobile Congress (IMC)**, New Delhi. **Jio** rolled out **5G SA (Standalone)**; **Airtel** began with **NSA (Non-Standalone)**.
- **5G SA** = 5G radio + **5G core** (enables network slicing, ultra-low latency); **NSA** = 5G radio on a **4G LTE core**.
- **Bharat 6G Vision** document released by PM on **22 March 2023** – target: India a leading 6G supplier by **2030**; **Bharat 6G Alliance** formed in 2023.
- **BSNL's indigenous ("Swadeshi") 4G stack** launched by PM on **27 Sept 2025** at Jharsuguda, Odisha with **~97,500** towers – India became one of 5 countries with its own telecom stack.

► Satellite Internet (Satcom)

- **LEO (Low Earth Orbit)** constellations give low-latency internet in remote areas: **Starlink (SpaceX)**, **Eutelsat OneWeb**, **Amazon Kuiper**; **Jio-SES** (MEO/GEO).
- **Starlink India** – received **DoT GMPCS licence (June 2025)** and **IN-SPACe authorisation (July 2025)**; ground stations set up.
- Status (Oct 2026): **commercial service NOT yet launched** – **spectrum allocation is pending**. The DCC approved most of TRAI's satcom spectrum recommendations on **3 Sept 2026**; final **Cabinet approval** is awaited. **OneWeb & Jio-SES** are also waiting for spectrum.
- India allots satcom spectrum **administratively** (not by auction).

► New-Age Networking Terms

- **SDN** (Software-Defined Networking) – separates **control plane** from **data plane**; network controlled by software.
- **NFV** (Network Function Virtualisation) – firewalls, routers etc. run as **software on general servers**.

- **Network slicing (5G)** – one physical network split into many **virtual networks** for different services.
- **IoT** – everyday devices connected to the internet; uses ZigBee, NB-IoT, Wi-Fi, 5G.

★ REMEMBER THIS

- **Wi-Fi 6 = 802.11ax, Wi-Fi 5 = 802.11ac, Wi-Fi 4 = 802.11n, Wi-Fi 7 = 802.11be, Wi-Fi 8 = 802.11bn.**
- Strongest Wi-Fi security = **WPA3**; weakest = **WEP**; **TKIP** → **WPA**.
- Latest Bluetooth = **6.3 (May 2026)**; Bluetooth power cap for common devices = **2.5 mW** (IBPS RRB Clerk 2023).
- India 5G launch = **1 Oct 2022**; Bharat 6G Vision = **March 2023**.
- **Blue** Ethernet cable is the standard colour for network connectivity (IBPS RRB 2022/23).

10.11 Practice MCQs (Previous-Year Pattern)

Q1. Hub is a network device that connects multiple devices into a single network segment. It works in which layer of the OSI model? (IBPS RRB PO 2022)

- (a) Physical Layer (b) Data Link Layer
(c) Transport Layer (d) Session Layer
(e) Application Layer

Ans: (a) A hub simply repeats bits to all ports, so it works at Layer 1 (Physical).

Q2. Routers operate at which layer of the OSI model? (IBPS RRB Officer Scale-II 2023)

- (a) Network (b) Physical (c) Data Link
(d) Transport (e) None of these

Ans: (a) Routers forward packets using IP addresses at Layer 3 (Network).

Q3. Which protocol is used to find the MAC address of a device from its IP address? (IBPS RRB Clerk 2023)

- (a) RARP (b) ARP (c) ICMP (d) DHCP (e) DNS

Ans: (b) ARP resolves IP to MAC; RARP does the reverse.

Q4. The length of an IPv6 address is: (IBPS RRB

Officer Scale-II 2023)

- (a) 32 bits (b) 48 bits (c) 64 bits (d) 128 bits
(e) 256 bits

Ans: (d) IPv6 = 128 bits; IPv4 = 32 bits; MAC = 48 bits.

Q5. In which topology are all the stations connected through a single cable known as the backbone? (RBI Asst 2022)

- (a) Bus (b) Mesh (c) Star (d) Hybrid (e) Tree

Ans: (a) Bus topology uses one backbone cable with terminators at both ends.

Q6. Encryption and compression are functions of which OSI layer? (IBPS RRB Officer Scale-II 2023)

- (a) Presentation Layer (b) Application Layer
(c) Session Layer (d) Data Link Layer
(e) Network Layer

Ans: (a) The Presentation layer (Layer 6) handles translation, encryption and compression.

Q7. Both sides can send and receive data, but only one at a time, as in a walkie-talkie. This mode is called: (IBPS RRB Clerk 2023)

- (a) Simplex (b) Half-duplex (c) Full-duplex
(d) Multiplex (e) Serial

Ans: (b) Half-duplex allows two-way communication but not at the same time.

Q8. What is the default port number of HTTPS?

- (a) 80 (b) 21 (c) 443 (d) 25 (e) 110

Ans: (c) HTTPS uses port 443; HTTP uses 80, FTP 21, SMTP 25, POP3 110.

Q9. Wi-Fi 7 is based on which IEEE standard?

- (a) 802.11ac (b) 802.11ax (c) 802.11n
(d) 802.11be (e) 802.11bn

Ans: (d) Wi-Fi 7 = 802.11be; Wi-Fi 6 = 802.11ax; Wi-Fi 8 = 802.11bn.

Q10. A device that connects networks using different protocols is a: (IBPS RRB Officer Scale-II 2023)

- (a) Switch (b) Hub (c) Gateway (d) Repeater
(e) Bridge

Ans: (c) A gateway is a protocol converter and can work at all OSI layers.

CHAPTER 11 INTERNET & E-MAIL

11.1 What is the Internet?

- **Internet = Interconnected Network** – a global **network of networks** that links billions of computers & devices using the **TCP/IP** protocol suite.
- It is **decentralised** – no single owner. Works on **packet switching** (data is broken into variable-length **packets**, each carrying **source & destination IP address**).
- Main services: **WWW, e-mail, FTP, chat/IM, VoIP, video conferencing, e-commerce, e-banking, social media, cloud**.
- Requirements: computer/phone + **modem/router** (or NIC) + **account with an ISP** + **browser**.
- Governed by voluntary bodies: **ICANN** (domain names & IP policy), **IANA** (assigns IP address blocks & root zone), **IETF** (protocol standards, RFCs), **IAB, ISOC, W3C** (web standards).

► History of the Internet

Year	Event
1962	J.C.R. Licklider – idea of a "Galactic Network"
1969	ARPANET by US DoD's ARPA – world's first packet-switched network; 4 nodes (UCLA, SRI, UCSB, Utah)
1971	E-mail with @ by Ray Tomlinson
1973–74	Vint Cerf & Bob Kahn design TCP ; word "Internet" first used (1974)
1 Jan 1983	ARPANET switches to TCP/IP → official birthday of the Internet
1983–84	DNS (Paul Mockapetris): .com, .org, .edu, .gov, .mil, .net, .int
15 Mar 1985	First .com domain – symbolics.com
1989	Tim Berners-Lee proposes the WWW at CERN (Geneva)
1990	Archie – first search engine (Alan Emtage); first browser WorldWideWeb (later Nexus)
6 Aug 1991	First website info.cern.ch goes public (ran on a NeXT computer)
1993	Mosaic – first popular graphical browser (Marc Andreessen, NCSA)
1994	W3C founded by Tim Berners-Lee

Year	Event
15 Aug 1995	Public Internet launched in India by VSNL

Title	Person
Father of the Internet	Vint Cerf (with Bob Kahn – TCP/IP)
Mother of the Internet	Radia Perlman (Spanning Tree Protocol)
Inventor of WWW, HTTP, HTML, URL	Tim Berners-Lee
Father of E-mail	Ray Tomlinson
Father of Hotmail	Sabeer Bhatia (with Jack Smith)
"Deep web" term (2001)	Michael K. Bergman
"Internet of Things" term (1999)	Kevin Ashton

★ REMEMBER THIS

- Internet began with **ARPANET (1969)**; birthday **1 January 1983**; standard protocol **TCP/IP**.
- Internet ≠ WWW. The **WWW is a service** that runs on the Internet (like e-mail, FTP).
- India: **VSNL, 15 August 1995**. First private ISP: **Satyam Infoway (Sify), 1998**. **ERNET (1986)** was India's first academic network.

11.2 Internet Users – Latest Figures (2025–26)

Indicator	Figure
World Internet users (ITU, 2025)	≈ 6 billion (about three-quarters of humanity)
People still offline (ITU, 2025)	≈ 2.2 billion
India – total Internet subscribers (TRAI, 31 Mar 2026)	1,092.79 million
India – broadband subscribers	1,065.88 million (narrowband 26.91 mn)
India – total telephone subscribers	1,330.58 million

In India over 95% of Internet subscribers use mobile (wireless) access.

11.3 Types of Internet Connections

Type	Key point
Dial-up	Telephone line + modem; max 56 kbps ; phone busy while online; analog
ISDN	Integrated Services Digital Network – digital voice + data over phone line
DSL / ADSL	Phone line; voice & data simultaneously ; ADSL = download faster than upload
Cable	Coaxial cable of cable-TV network
Leased line	Dedicated private line; fixed bandwidth; used by banks/offices
Fibre (FTTH)	Light through glass fibre; fastest ; total internal reflection
BPL	Broadband over Power Lines
Satellite	For remote areas; uplink (earth→satellite), downlink (satellite→earth)
Mobile broadband	3G/4G/5G; FWA = Fixed Wireless Access
Wi-Fi / Hotspot / Tethering	Radio waves; tethering = sharing phone data with other devices

- **Broadband** = high-speed, always-on connection (DSL, cable, fibre, 4G/5G, FWA); dial-up & ISDN are **narrowband**.
- Internet speed is measured in **bps – kbps, Mbps, Gbps**. **Downloading** = Internet → your device; **Uploading** = your device → Internet.

11.4 World Wide Web (WWW) & Web Terms

- **WWW / Web / W3** = a system of **interlinked hypertext documents (web pages)** accessed through the Internet using a **browser** and **HTTP**. Also called the "Information Superhighway".
- Invented by **Tim Berners-Lee** (British, at **CERN**) in **1989**. Standards body: **W3C (World Wide Web Consortium)**.
- Building blocks of the web: **HTML** (page language), **URL** (address), **HTTP** (transfer protocol).

Term	Meaning
Web page	A single document on the web, written in HTML ; has its own URL
Website	Collection of related, linked web pages under one domain
Home page	First / main page of a website (also the browser's start page)
Web portal	Gateway site giving many services/links in one place (e.g. india.gov.in, Yahoo)
Web server	Computer/software that stores & serves pages on HTTP request (Apache, Nginx, IIS); also called host
Static page	Fixed content; same for every visitor
Dynamic page	Content generated on the fly (e.g. bank statement, search result)
Hyperlink	Text/image which, when clicked, opens another page or file
Hypertext	Text containing links to other text
Web hosting	Renting server space to put a website online
Browsing / Surfing	Moving from one web page/site to another

► HTML, CSS & Web Development

- **HTML = HyperText Markup Language** – markup (not programming) language; tags in **angle brackets < >**, e.g. **** bold, **<a>** hyperlink, **** image. Latest standard: **HTML5** ("Living Standard" by WHATWG).
- A **text editor** (e.g. Notepad) is enough to create an HTML file (.html/.htm). A **browser** displays it.
- **CSS = Cascading Style Sheets** (look & layout); **JavaScript** = client-side scripting; **PHP = PHP: Hypertext Preprocessor** (server-side).
- **XML = eXtensible Markup Language** (stores/transport data; user-defined tags). **DHTML = Dynamic HTML**.
- **CMS = Content Management System** – **WordPress**, **Drupal**, **Joomla**. Web design tool: **Dreamweaver**. **Responsive design** = mobile-friendly.

► Web 1.0 vs Web 2.0 vs Web 3.0

Web	Nature	Examples
Web 1.0 (1990s)	Read-only, static pages	Early sites, Britannica Online

Web	Nature	Examples
Web 2.0 (2004+)	Read-write , user-generated content, social, interactive	Facebook, YouTube, Wikipedia, blogs
Web 3.0	Read-write-own ; semantic, AI & blockchain -based, decentralised	Crypto wallets, dApps, NFTs

- "Web 2.0" popularised by **Tim O'Reilly** (2004). "**Semantic Web**" idea – Tim Berners-Lee. "Web3" (blockchain) term – **Gavin Wood** (2014).

► Surface Web, Deep Web & Dark Web

Layer	Key point
Surface web	Indexed by search engines; only ≈ 4–5 % of the web
Deep web	Not indexed – net-banking, e-mail inbox, paid/password-protected pages; mostly legal
Dark web	Small, hidden part of deep web; needs special software like Tor (The Onion Router) ; anonymous; used for illegal markets

- **Darknet** = encrypted overlay network (e.g. Tor, I2P) on which the dark web runs.

11.5 URL, Domain Names & DNS

- **URL = Uniform Resource Locator** – the complete **address of a resource** on the web (web address). An **absolute URL** contains the full address.
- **URI = Uniform Resource Identifier** = URL (location) + URN (name).

Example:

https://www.mybank.bank.in/loans/home.html

Part	In the example	Meaning
Protocol / scheme	https://	How to access (http, https, ftp)
Sub-domain / host	www	Server name (optional)
Domain name	mybank.bank.in	Registered name of the site
TLD	.in	Top-level domain (country/type)
Path & file	/loans/home.html	Folder & page on the server

- A URL **must contain a protocol identifier and a domain name**; "www" is optional (exam answer often: protocol + www + domain name).
- Domain names are **not case-sensitive**; max length **253 characters** (each label ≤ 63). Read **right to left**: TLD → second-level domain → sub-domain.

► Top-Level Domains (TLDs)

TLD	Used by
.com	Commercial / profit business
.org	Non-profit organisations
.net	Network providers
.edu	Educational institutions (mainly US)
.gov	Government (US); India uses .gov.in
.mil	US military
.int	International treaty bodies (who.int)
.info / .biz	Information sites / businesses
.aero / .museum / .coop	Sponsored TLDs (air-transport, museums, co-operatives)

- **gTLD** = generic TLD (.com, .org, .net, .app, .shop ...). **ccTLD** = country-code TLD (2 letters): **.in** India, **.uk**, **.us**, **.jp**, **.cn**, **.au**, **.ca**.
- **.in** is managed by **NIXI** (National Internet Exchange of India). Indian second-level domains: **.co.in**, **.gov.in**, **.nic.in**, **.ac.in**, **.edu.in**, **.res.in**, **.org.in**, **.net.in**, **.mil.in**. IDN ccTLD: **.भारत (.bharat)**.
- Last three letters of a domain usually describe the **type of organisation**.

► .bank.in and .fin.in (RBI, 2025)

- **RBI circular (22 April 2025)**: all banks in India must move their websites to the exclusive **.bank.in** domain by **31 October 2025** – to help customers spot genuine bank sites and fight phishing.
- Exclusive registrar: **IDRBT** (Institute for Development and Research in Banking Technology, Hyderabad), authorised by **NIXI** under MeitY.
- **.fin.in** – planned for **non-bank financial entities** (NBFCs etc.). Fraud sites cannot get a

.bank.in name, so **check for .bank.in** before logging in.

► DNS – Domain Name System

- DNS translates a **domain name** → **IP address** (and back – reverse lookup). Works like the "**phone book of the Internet**"; uses **port 53**.
- Hierarchy: **Root servers** (13 named root identities A–M) → **TLD servers** → **authoritative name servers**.
- Fake DNS replies that send users to a fraud site = **DNS spoofing / pharming**.

11.6 IP Address, ISP & Protocols

► IP Address

Feature	IPv4	IPv6
Size	32-bit (4 bytes)	128-bit (16 bytes)
Format	Dotted decimal, 4 parts 0–255	8 groups of hex, separated by colons
Example	192.168.0.1	2001:db8::1
Total addresses	$2^{32} \approx 4.3$ billion	2^{128} (virtually unlimited)

- Every device on the Internet is identified by a unique **IP address**; a host finds another host by its **IP address**.
- **Static IP** = permanent; **Dynamic IP** = changes, assigned automatically by **DHCP**. Address blocks: **IANA** → regional registries (APNIC for Asia-Pacific) → ISPs.
- **MAC address** = **48-bit** physical/hardware address burnt into the **NIC**; **ARP** finds MAC from IP, **RARP** finds IP from MAC.
- IPv4 classes: **A (1–126)**, **B (128–191)**, **C (192–223)**, **D (224–239, multicast)**, **E (240–255, research)**. 127.x.x.x = **loopback**.

► ISP – Internet Service Provider

- A company that **provides Internet access** (e.g. Jio, Airtel, BSNL, Vi, ACT, Hathway).
- India's first ISP = **VSNL** (public service from **15 Aug 1995**; now Tata Communications).
- World's first commercial dial-up ISP = **The World** (Boston, 1989).
- **Online service providers** (older term): AOL, MSN, CompuServe.

► Important Internet Protocols & Ports

Protocol	Use	Port
HTTP – HyperText Transfer Protocol	Transfer web pages (browser ↔ web server)	80
HTTPS – HTTP Secure	Encrypted HTTP using SSL/TLS ; padlock icon	443
FTP – File Transfer Protocol	Upload/download files	20, 21
SFTP / TFTP	Secure FTP (over SSH) / Trivial FTP (UDP)	22 / 69
Telnet	Text-based remote login (unencrypted)	23
SSH – Secure Shell	Secure remote login	22
SMTP	Send e-mail	25 / 587
POP3 / IMAP	Receive e-mail	110 / 143
DNS	Name → IP	53
DHCP	Auto-assign IP addresses	67/68
TCP	Connection-oriented, reliable	–
UDP	Connectionless, fast, no guarantee	–
ICMP	Error reporting; used by ping	–
NTP	Clock synchronisation (David Mills, 1985)	123
VoIP / SIP	Voice calls over IP / call signalling	5060 (SIP)

- **TCP/IP** = collection of 100+ protocols; **TCP** breaks data into packets & reassembles; **IP** addresses & routes packets.
- An **HTTP request** has **3 parts**: request line, headers, body. HTTP is **stateless** (cookies add state).

HTTP code	Meaning
200	OK (success)
301	Moved permanently (redirect)
400 / 401	Bad request / Unauthorised
403	Forbidden
404	Not Found – page does not exist
500	Internal Server Error
503	Service Unavailable

MEMORY TRICK: HTTP status families

- 1xx Info, 2xx Success, 3xx Redirect, 4xx Client error, 5xx Server error → "I Sell Rice, Customers Starve".

11.7 Web Browsers & Search Engines

- A **web browser** is client software used to **view web pages** (it sends HTTP requests and renders HTML). It does not itself provide the Internet connection – the ISP does.

Browser (Year)	Key point
WorldWideWeb / Nexus (1990)	First browser – Tim Berners-Lee
Lynx (1992)	Text-based browser, still used
Mosaic (1993)	First popular graphical browser – Marc Andreessen & Eric Bina (NCSA)
Netscape Navigator (1994)	Andreessen; later owned by AOL
Internet Explorer (1995)	Microsoft; last version IE 11 ; retired 15 June 2022
Opera (1995)	Norway; built-in free VPN & ad-blocker
Safari (2003)	Apple (macOS, iOS)
Mozilla Firefox (2004)	Free & open source ; started as Phoenix (2002)
Google Chrome (2008)	Based on open-source Chromium ; most used
Epic (2010)	Hidden Reflex, Bengaluru – India's first browser
Microsoft Edge (2015)	Successor of IE; Chromium-based since 2020
Tor Browser	Anonymous browsing; access to .onion (dark web) sites
Comet (Jul 2025), ChatGPT Atlas (Oct 2025)	New AI browsers by Perplexity and OpenAI

Browser share, Sep 2026	%
Chrome	66.4
Safari	18.3
Edge	6.0
Firefox	2.8
Samsung Internet	2.3

Browser share, Sep 2026	%
Opera	1.8

► Browser Features & Shortcuts (Chrome/Edge)

Shortcut	Action
Ctrl + T / Ctrl + W	New tab / close current tab
Ctrl + Shift + T	Reopen last closed tab
Ctrl + N	New window
Ctrl + Shift + N	Incognito window (Firefox: Ctrl+Shift+P private window)
Ctrl + D	Bookmark current page
Ctrl + H / Ctrl + J	History / Downloads
Ctrl + R or F5	Reload page (Ctrl+F5 = hard reload)
Ctrl + L, Alt + D, F6	Go to address bar
Ctrl + Tab	Next tab
Alt + ← / Alt + →	Back / Forward
Ctrl + Shift + Delete	Clear browsing data
Ctrl + U / F11	View page source / Full screen
Ctrl + 0	Reset zoom to default 100%

- Bookmark / Favourite** = saved link to a page for quick access. **History** = list of visited pages. **Incognito / private mode** does not save history, cookies or form data on the device (but the ISP/website can still see activity).
- Plug-in / add-on / extension** = small program adding features (PDF viewer, ad-blocker). **Applets** = small programs (Java) run on a web page.

► Search Engines

- A **search engine** finds information on the web using a program called **web crawler / spider / bot** that visits pages and builds an **index**.
- A page returned that matches the query = a **hit**. Result page = **SERP**. Improving rank = **SEO**; paid promotion = **SEM**.

Search engine	Year	Key point
Archie	1990	First search engine – Alan Emtage (McGill Univ., Canada)
Yahoo!	1994	Jerry Yang & David Filo; started as a directory
AltaVista	1995	DEC; later bought by Yahoo

Search engine	Year	Key point
Google	1998	Larry Page & Sergey Brin (Stanford); PageRank
Baidu	2000	China's top search engine
Yandex	1997	Russia
Guruji.com	2006	India's first search engine (now closed)
DuckDuckGo	2008	Privacy – does not track users
Bing	2009	Microsoft (earlier MSN / Live Search)

- Types: **crawler-based** (Google, Bing), **human directories** (DMOZ, old Yahoo Directory), **meta-search** (queries several engines – Dogpile, MetaCrawler), **hybrid**.
- Search share, Sept 2026 (StatCounter): **Google 89.9%**, Bing 5.3%, Yahoo 1.4%, Yandex 1.3%, DuckDuckGo 0.7%.
- **AI search (2025–26)**: Google **AI Overviews**; Google **AI Mode** (launched in **India on 24 June 2025**, powered by **Gemini 2.5**; Hindi added Sept 2025); also ChatGPT Search, Perplexity, Microsoft Copilot.

★ REMEMBER THIS

- Chrome, Safari, Firefox, Edge = **browsers**; Google, Bing, Yahoo, DuckDuckGo = **search engines**.
- First browser **WorldWideWeb (Nexus)**; first graphical **Mosaic**; text browser **Lynx**; anonymous **Tor**; IE retired **15 June 2022**.
- **Ctrl+D** = bookmark; **Ctrl+Shift+N** = incognito; **Ctrl+R/F5** = reload.

11.8 Cookies, Cache & Other Internet Terms

Term	Meaning
Cookie	Small text file sent by the web server & stored on the client (user's) side by the browser; remembers login, preferences, cart; identifies return visitors
First- / third-party cookie	Set by the site you visit / by other sites (ads, tracking)
Session / persistent cookie	Deleted when browser closes / stays till expiry

Term	Meaning
Cache	Temporary local copy of pages & images → faster loading
Intranet	Private network inside an organisation using Internet technology (e.g. a bank's staff portal)
Extranet	Part of an intranet opened to authorised outsiders – partners, suppliers, customers
Internet host	Any computer connected to the Internet
Gateway	Connects networks using different protocols
Proxy server	Intermediary between user & Internet; caching, filtering, hides IP
VoIP	Voice calls over the Internet (WhatsApp call, Google Meet)
IoT	Internet of Things – everyday devices connected online (first: Coke machine, CMU, 1982)
Cloud computing	Using storage/software/servers over the Internet (Google Drive, AWS)
Patch	Free update to fix a bug/security hole
Thread	Series of linked messages on one topic (forum/e-mail)
Wiki	Site anyone can edit (Wikipedia – Jimmy Wales, 2001)
IRC / Usenet	Internet Relay Chat / early discussion newsgroups (1980)

- **Telnet** = text-based protocol for **remote access** to another computer. **Authentication** = verifying login name & password.

11.9 Internet Services – Social Media, Blogs & E-commerce

Term	Meaning
Blog (weblog)	Online journal, posts in reverse-date order (WordPress, Blogger, Medium)
Microblog	Very short posts – X (formerly Twitter)
Vlog	Video blog (YouTube)
Podcast	Series of audio files for download/streaming (iPod + broadcast)
Vodcast	Video podcast
Webinar	Web-based seminar

Term	Meaning
Social networking	Profiles, sharing & interaction online

Platform	Founder(s), Year
LinkedIn (professional)	Reid Hoffman, 2003
Facebook	Mark Zuckerberg, 2004 (parent: Meta)
Orkut (closed 2014)	Orkut Büyükkökten (Google), 2004
YouTube	Chad Hurley, Steve Chen, Jawed Karim, 2005; owned by Google
Twitter → X (July 2023)	Jack Dorsey, 2006; owned by Elon Musk
WhatsApp	Jan Koum & Brian Acton, 2009 (Meta)
Instagram	Kevin Systrom & Mike Krieger, 2010 (Meta)
Telegram	Pavel & Nikolai Durov, 2013

- First YouTube video: "**Me at the zoo**" (Jawed Karim, 23 April 2005).
- **Skype (2003) was shut down on 5 May 2025**; users moved to **Microsoft Teams (free)**. Popular video-conferencing tools now: Zoom, Google Meet, MS Teams, Webex.

► E-commerce Models

Model	Meaning	Example
B2B	Business to Business	IndiaMART, Alibaba
B2C	Business to Consumer	Amazon, Flipkart
C2C	Consumer to Consumer	OLX, eBay, Quikr
C2B	Consumer sells to Business	Freelancers, stock photos
B2G / G2B	Business ↔ Government	GeM portal, e-tenders
G2C	Government to Citizen	UMANG, DigiLocker, income-tax e-filing
G2G	Government to Government	Data sharing between ministries

- **E-commerce** = buying/selling over the Internet; **M-commerce** = through mobile; **EDI**

= **Electronic Data Interchange** (B2B document exchange).

- **ONDC** = Open Network for Digital Commerce (Govt. of India, 2022) – open network so small sellers can reach buyers on any app.
- Other services: **e-banking** (net/mobile banking, UPI), **e-governance**, **e-learning**, **e-reservation** (IRCTC), **e-news**, **e-books**.

✍ **MEMORY TRICK: Intranet vs Extranet**

► **IN**-tranet = **IN**side only; **EX**-tranet = **EX**tended to outsiders (partners); **Internet** = for everyone.

11.10 E-mail – Basics

- **E-mail = Electronic Mail** – sending digital messages over a network; like **writing a letter**, but electronic. Invented in **USA**.
- **Ray Tomlinson (BBN)** sent the **first network e-mail in 1971** on **ARPANET** and chose the **@** symbol to separate user and host. The test text was probably "**QWERTYUIOP**".
- First **free web-based e-mail: Hotmail** (4 July 1996) – **Sabeer Bhatia & Jack Smith**; bought by **Microsoft** (1997); now **Outlook.com** (2013).
- **Gmail** – launched **1 April 2004**, created by **Paul Buchheit** (Google).
- First spam e-mail: **1978** (Gary Thuerk, DEC, to ARPANET users).

► E-mail Address

- Format: **username@domainname** → e.g. **ramesh@yahoo.com** – **user name followed by domain name** (2 parts).
- **Local part** (before @, max **64** characters) + **domain part** (mail server). **@** is mandatory and allowed **only once**; **spaces are not allowed**.
- Wrong forms: ramesh@yahoo.com, yahoo.com@ramesh, ramesh@http://www.yahoo.com.

► Parts / Fields of an E-mail

Field	Purpose
From	Sender's address (filled automatically , with Date/Time)
To	Main recipient(s) – a recipient address is necessary to send

Field	Purpose
CC – Carbon Copy	Copy to others; all recipients see CC addresses ("keep in the loop")
BCC – Blind Carbon Copy	Hidden copy; BCC addresses are not visible to other recipients
Subject	One-line essence/summary of the message
Body	Main message text (plain text or rich text/HTML for bold, italics)
Attachment	File sent with the mail – paper-clip icon
Signature	Text block automatically added at the end (name, designation, phone)

- **Reply** = to sender only; **Reply All** = sender + all To/CC recipients (not BCC); **Forward** = send a received mail to someone else.
- **Address book / Contacts** = stores e-mail addresses for quick retrieval. Typing in **ALL CAPS** = shouting (bad netiquette).
- Large file? **Compress (zip)** it or share a **cloud link** (Google Drive / OneDrive).

✎ MEMORY TRICK: CC vs BCC

- **CC** = "Can see" – everyone sees everyone.
BCC = "Blind" – **no one sees BCC names**. CC is like a notice in a room; BCC is like separate sealed letters.

11.11 Mailbox Folders & Features

Folder	Contains
Inbox	Received (incoming) mails
Drafts	Unfinished / unsent mails saved for later
Outbox	Mails waiting to be sent (or failed to send)
Sent	Copies of mails already sent
Spam / Junk	Unsolicited bulk / suspicious mail (auto-deleted after 30 days in Gmail)
Trash / Deleted Items / Bin	Deleted mails; can be restored; emptied after ~30 days
Archive	Removed from inbox but kept for reference

- **Mailbox** = storage area of a user's e-mail on the server. **Flag/Star** = mark for follow-up. **Label/Folder** = organise mails.
- **E-mail client** (installed software, works offline): **MS Outlook**, Mozilla **Thunderbird**, Apple Mail. **Webmail** (via browser, any device): Gmail, Yahoo Mail, Outlook.com, Zoho Mail, Rediffmail, Proton Mail.
- Software agents: **MUA** (Mail User Agent – client used by the user), **MTA** (Mail Transfer Agent – server that relays), **MDA** (Mail Delivery Agent – puts mail in mailbox).

11.12 E-mail Protocols & Ports

Protocol	Role	Ports
SMTP – Simple Mail Transfer Protocol	Sending / outgoing mail server; push protocol	25 (server-to-server), 587 (client, STARTTLS), 465 (SSL)
POP3 – Post Office Protocol v3	Receiving – downloads mail to one device, usually deletes from server; pull	110 / 995 (SSL)
IMAP – Internet Message Access Protocol	Receiving – mail stays on server, syncs on all devices; pull	143 / 993 (SSL)
MIME – Multipurpose Internet Mail Extensions	Lets SMTP carry non-ASCII data – attachments, images, audio, video, other languages	–
HTTP/HTTPS	Used by webmail in the browser	80 / 443

- SMTP itself carries only **7-bit ASCII text**; **MIME** encodes multimedia into ASCII. **UDP, FTP, HTTP** are **not** e-mail protocols.

✎ MEMORY TRICK: Sending vs Receiving

- **SMTP** = **S**end (Push). **POP & IMAP** = **P**ick up / **I**n-box (Pull). POP = "**P**ull & **O**ff the server"; IMAP = "**I** **M**ean **A**ll **P**laces (sync)".

11.13 Popular E-mail Services (Updated)

Service	Key facts
Gmail (2004)	Paul Buchheit; 15 GB free (shared with Drive & Photos); 25 MB attachment limit to send (bigger files → Google Drive link); 500 mails/day (free)
Yahoo Mail (1997)	Yahoo (Jerry Yang & David Filo, 1994); free storage cut from 1 TB to 20 GB (2025) ; attachment 25 MB
Outlook.com (ex-Hotmail)	Microsoft; 15 GB free mailbox; MS Outlook (desktop) is an e-mail client + PIM (calendar, tasks, contacts)
AOL Mail	AOL (1983) – owned by Verizon (2015), Yahoo/Apollo (2021); sale to Bending Spoons announced Oct 2025
Zoho Mail	Indian (Zoho Corp., Chennai); 12.68 lakh Central Govt. e-mail accounts moved to Zoho-run platform (NIC) (2025)
Rediffmail	Indian; Rediff.com (1996)
Proton Mail	Switzerland; end-to-end encrypted

★ REMEMBER THIS

- First free webmail **Hotmail (1996)** – Sabeer Bhatia. Gmail – **Paul Buchheit, 1 April 2004**. Gmail attachment limit **25 MB**, free storage **15 GB**.
- **SMTP = outgoing (push); POP3/IMAP = incoming (pull); MIME = attachments/non-ASCII**. Ports: **25, 110, 143** (secure **587/465, 995, 993**).
- Deleted mail → **Trash**; unsent half-written mail → **Drafts**; waiting to go → **Outbox**; junk → **Spam**.

11.14 E-mail Security

Term	Meaning
Spam	Unsolicited bulk / junk e-mail
E-mail spoofing	Forging the "From" address so mail seems to come from a trusted sender
Phishing	Fake mail/site to steal passwords, card or bank details
Spam filter	Moves junk to Spam folder; marking "Not spam" trains it

Term	Meaning
PGP – Pretty Good Privacy	Encrypts & signs e-mail using public-key cryptography (Phil Zimmermann, 1991)
S/MIME	Secure MIME – encryption & signing using digital certificates
SSL / TLS	Encrypt the connection between mail client & server (TLS is the successor of SSL)
SPF – Sender Policy Framework	DNS record listing servers allowed to send mail for a domain
DKIM – DomainKeys Identified Mail	Adds a digital signature to outgoing mail
DMARC	Domain-based Message Authentication, Reporting & Conformance – policy using SPF + DKIM; stops spoofing

- Since **Feb 2024**, Gmail and Yahoo require bulk senders (5,000+ mails/day to Gmail) to use **SPF, DKIM and DMARC**.
- Threats spread by e-mail: **viruses, worms, Trojans, phishing, ransomware** (via attachments & links).

✍ MEMORY TRICK: Mail authentication trio

- **SPF = "Sender Permitted From"** (which server), **DKIM = "Digital Key In Mail"** (signature), **DMARC = "Do Mail Action: Reject/Quarantine"** (policy).

11.15 Practice MCQs (Previous-Year Pattern)

Q1. Internet services were launched in India for the public on:

- (a) 15 August 1990 (b) 15 August 1995
(c) 26 January 1996 (d) 15 August 1997
(e) 1 January 1983

Ans: (b) VSNL launched public Internet access in India on 15 August 1995.

Q2. The standard protocol of the Internet is: (SBI PO 2010)

- (a) TCP/IP (b) Java (c) HTML (d) Flash
(e) None of these

Ans: (a) TCP/IP is the standard protocol suite of the Internet.

Q3. An IPv4 address is a _____ number. (IBPS PO 2013)

- (a) 8-bit (b) 16-bit (c) 32-bit (d) 64-bit
(e) 128-bit

Ans: (c) IPv4 uses 32 bits; IPv6 uses 128 bits.

Q4. Which of the following must be contained in a URL? (IBPS PO 2012)

- (a) A protocol identifier (b) The letters WWW
(c) The unique registered domain name
(d) WWW and the unique registered domain name
(e) A protocol identifier, WWW and the unique registered domain name

Ans: (e) The expected exam answer: protocol identifier (http/https), www and the registered domain name.

Q5. Which of the following is a program or script that browses the web in a systematic manner to index websites? (IBPS RRB PO 2022)

- (a) Bots (b) Slurps (c) Web crawler
(d) Web scraping (e) Website

Ans: (c) A web crawler (spider) visits pages and builds the search-engine index.

Q6. Which HTTP status code denotes "Service Unavailable"? (IBPS RRB PO 2022)

- (a) 404 (b) 403 (c) 503 (d) 400 (e) 604

Ans: (c) 503 = Service Unavailable; 404 = Not Found; 403 = Forbidden.

Q7. As per RBI's 2025 directive, banks in India must shift their websites to which exclusive domain?

- (a) .bank.com (b) .fin.in (c) .bank.in
(d) .gov.in (e) .rbi.in

Ans: (c) RBI asked all banks to migrate to .bank.in by 31 Oct 2025; .fin.in is for non-bank financial entities.

Q8. Which was the first web-based e-mail service, founded in 1996? (IBPS RRB PO 2023)

- (a) Gmail (b) Yahoo (c) Hotmail (d) Zoho
(e) Rediffmail

Ans: (c) Hotmail was launched in 1996 by Sabeer Bhatia and Jack Smith.

Q9. MIME allows _____ data to be sent through SMTP. (IBPS RRB Officer Scale-II 2023)

- (a) BCD (b) ASCII (c) non-ASCII
(d) Redundant (e) None of these

Ans: (c) SMTP carries only 7-bit ASCII; MIME adds support for attachments and non-ASCII data.

Q10. Which e-mail field sends a copy of a message to recipients whose addresses are hidden from the other recipients?

- (a) To (b) CC (c) BCC (d) Subject (e) From

Ans: (c) BCC (Blind Carbon Copy) recipients are not visible to others; CC recipients are visible.

CHAPTER 12 COMPUTER SECURITY & CYBER THREATS

12.1 Computer Security – Basics

- **Computer security / cyber security / IT security** = protecting computers, networks, programs and data from **unauthorised access, damage, theft or disruption**.
- Tools: **antivirus, firewall, encryption, passwords, biometrics, patches, backups, user awareness**.
- **Vulnerability** = weakness; **Threat** = possible danger; **Risk** = chance of harm; **Exploit** = code/technique that uses a vulnerability; **degree of harm** = potential impact of a threat.

► CIA Triad & Other Security Goals

Goal	Meaning	Achieved by
Confidentiality	Only authorised people can read data	Encryption, passwords, access control
Integrity	Data is not altered without authority	Hashing , checksums, digital signature
Availability	Data/service available when needed	Backups, redundancy, anti-DDoS
Authentication	Verifying who you are (login & password)	Password, OTP, biometrics
Authorisation	Deciding what you may access	Permissions, roles
Non-repudiation	Sender cannot deny having sent a message	Digital signature , logs

🔑 MEMORY TRICK: CIA + AAA

- **CIA** = Confidentiality, Integrity, Availability (the "security triad", not the US agency!).
- **AAA** = Authentication (who are you?) → Authorisation (what can you do?) → Accounting (what did you do? – logs).

12.2 Malware – Types

- **Malware = Malicious software** – any program designed to harm, spy on or take control of a computer **without the owner's consent**. It is

the **umbrella term**: all viruses are malware, but not all malware are viruses.

Malware	What it does
Virus	Attaches to a host program/file ; spreads when the host is run/shared; needs a host & user action
Worm	Self-replicating, stand-alone ; spreads over networks without a host ; eats memory & bandwidth
Trojan horse	Looks useful/legitimate but does harm; does not replicate ; opens access for hackers
Ransomware	Encrypts/locks files and demands ransom (often in crypto) – a "crypto-virus/crypto-Trojan"
Spyware	Secretly monitors user activity & sends data to others (e.g. Pegasus)
Keylogger	Records keystrokes (passwords, card numbers); hardware or software; a type of spyware
Adware	Shows unwanted ads/pop-ups , often tracks browsing
Rootkit	Gives administrator (root) control while hiding itself from detection
Backdoor / Trapdoor	Secret entry bypassing normal authentication (a "hole" left in software)
Botnet	" Robot network " of infected PCs (zombies/bots) controlled by a bot-herder ; used for DDoS , spam
Logic bomb	Activates when a condition is met (e.g. employee name deleted)
Time bomb	Logic bomb triggered by a date/time
Scareware	Fake "your PC is infected" alerts to make you buy/download junk
Browser hijacker	Changes home page/search engine & redirects
Fileless malware	Runs in memory (RAM) using legitimate tools; leaves no file
Spammer / Flooder	Sends bulk mail / floods traffic
Bloatware	Unwanted pre-installed software using excess resources

★ REMEMBER THIS

- Malware that does **not need a host** to spread = **Worm**. Pretends to be useful = **Trojan**. Demands money = **Ransomware**.
- Trojan **does not replicate**; virus and worm do.
- Computers in a botnet = **zombies**. Keylogger = a kind of **spyware**.
- **Pegasus** spyware – by Israel's **NSO Group**; discovered **2016**; infects **iOS & Android**.

12.3 Computer Virus

- **VIRUS** is popularly expanded as "**Vital Information Resources Under Siege**" (a backronym). Viruses are **man-made programs**.
- Term "computer virus" used by **Fred Cohen** in **1983** (his adviser **Len Adleman** suggested the name).
- **Creeper (1971, Bob Thomas, BBN)** – first self-replicating program, on ARPANET; message: "I'm the creeper, catch me if you can!". **Reaper** – first program to delete it (first "antivirus").
- **Elk Cloner (1982, Rich Skrenta, 15-yr-old)** – first virus **in the wild**; boot-sector virus for **Apple II**.
- **Brain (1986)** – first virus for **IBM PC / MS-DOS**; boot-sector virus; written by Pakistani brothers **Basit & Amjad Farooq Alvi** (Lahore).
- **Virus signature** = unique pattern used by antivirus to identify a virus. A virus that attacks antivirus software = **retrovirus**.
- Signs of infection: PC **slows down**, keeps **rebooting**, files missing/corrupt, strange pop-ups.

➤ Types of Virus

Type	Key feature (example)
Boot sector virus	Infects boot sector/MBR ; runs when PC starts (Brain, Stoned, Elk Cloner)
File infector / program virus	Infects executables – .exe, .com, .sys (Cascade, Sunday)
Macro virus	Infects documents with macros – Word, Excel ; spreads via application software (Concept 1995, Melissa)
Resident virus	Hides in RAM & infects files opened (Randex, Meve)

Type	Key feature (example)
Non-resident / direct action	Runs, infects, exits; does not stay in RAM (Vienna)
Multipartite	Infects both boot sector & files (Tequila, Flip)
Polymorphic	Changes its code/signature on every infection (Tuareg, Elkern)
Stealth virus	Hides changes it makes from antivirus
Encrypted virus	Encrypts its body to avoid detection
Overwrite virus	Overwrites & destroys file contents
Directory / cluster virus	Changes file path in directory (Dir-2)
Web-scripting virus	Malicious script in web pages (JS.Fortnight)

🔑 MEMORY TRICK: Who needs what?

- Virus = needs a **Vehicle** (host). **Worm** = **Walks alone**. **Trojan** = **Tricks you** (gift horse).

12.4 Famous Malware – Timeline

Name (Year)	Key fact
Creeper (1971)	First self-replicating program / "first virus"
Elk Cloner (1982)	First PC virus in the wild (Apple II)
Brain (1986)	First IBM-PC virus; Pakistan
Morris Worm (1988)	First Internet worm – Robert T. Morris; first conviction under US CFAA (Computer Fraud and Abuse Act)
AIDS Trojan / PC Cyborg (1989)	First ransomware – Joseph Popp, via floppy disks
Melissa (1999)	Macro virus spread by e-mail
ILOVEYOU / Love Bug (2000)	E-mail worm from the Philippines (Onel de Guzman); "LOVE-LETTER-FOR-YOU" attachment
Code Red (July 2001)	Worm attacking Microsoft IIS servers – "Hacked By Chinese!"
SQL Slammer (2003), MyDoom (2004)	Fastest-spreading worm / fastest e-mail worm
Storm Worm (2007)	Trojan/worm that built a huge botnet for spam

Name (Year)	Key fact
Conficker (2008)	Windows worm; large botnet
Stuxnet (2010)	Cyber-weapon against Iran's nuclear centrifuges (SCADA/PLC)
CryptoLocker (2013)	Ransomware demanding Bitcoin
Petya (2016) / NotPetya (2017)	Ransomware/wiper encrypting the MBR
WannaCry (May 2017)	Ransomware worm ; used EternalBlue (Windows SMB flaw); hit 150+ countries
SOVA (2022)	Android banking Trojan ; CERT-In warning to Indian bank users

12.5 Cyber Attacks & Frauds

► Phishing Family (Social Engineering)

Attack	Medium / target
Phishing	Fake e-mail/website posing as bank etc. to steal passwords, card, OTP
Spear phishing	Phishing targeted at a particular person/organisation
Whaling	Spear phishing aimed at top executives ("CEO fraud")
Vishing	Voice phishing – fraud phone calls
Smishing	SMS phishing – fraud text messages
Quishing	QR-code phishing – fake QR leads to fraud site/payment
Angler phishing	Fake customer-care accounts on social media
Pharming	Redirects users to a fake website even when the correct URL is typed (DNS poisoning)
Social engineering	Manipulating people (not machines) to reveal secrets
Baiting / Pretexting	Infected USB left as bait / invented story to get info

🔑 MEMORY TRICK: Phishing by medium

- Vishing = Voice, Smishing = SMS, Quishing = QR code, Whaling = big fish (**W**ealthy bosses), Spear = one target.

► Network & Application Attacks

Attack	Meaning
DoS	Denial of Service – floods a server so legitimate users cannot use it
DDoS	Distributed DoS – from many machines (botnet)
MITM	Man-in-the-Middle – attacker secretly intercepts/alters communication (public Wi-Fi)
Spoofing / Masquerade	Pretending to be a trusted source – IP, e-mail, caller ID, DNS, website (URL) spoofing
Sniffing / Eavesdropping	Capturing packets/monitoring traffic secretly (passive)
SQL injection	Malicious SQL code typed into input forms to read/alter the database
XSS	Cross-Site Scripting – malicious script injected into a trusted web page
Zero-day	Attack on a flaw unknown to the vendor ; no patch yet
Brute-force	Trying all password combinations ; dictionary attack uses common words
Credential stuffing	Using leaked username–password pairs on other sites
Replay attack	Valid data captured & re-sent later
Session hijacking	Stealing a logged-in session/cookie
Drive-by download	Malware downloaded just by visiting a site
Malvertising	Malware hidden in online ads
Salami attack	Steals tiny amounts from many accounts
Data diddling	Altering data before/while entering the computer
Cryptojacking	Secretly using a victim's PC to mine cryptocurrency
War-driving / Piggybacking	Searching for / using someone's unsecured Wi-Fi without permission

► Passive vs Active Attack

Passive attack	Active attack
Only observes/monitors (eavesdropping, traffic analysis , port scanning)	Modifies data or disrupts (masquerade, replay, message modification, DoS)

Passive attack	Active attack
System resources not affected	System resources affected/harmed
Hard to detect → focus on prevention (encryption)	Hard to prevent → focus on detection & recovery

► Banking & New-age Frauds (India, 2024–26)

Fraud	How it works
Skimming	Device on ATM/POS copies card data & PIN
SIM swap	Fraudster gets a duplicate SIM of your number → receives your OTPs
Juice jacking	Malware/data theft through public USB charging ports
UPI collect / QR fraud	Victim is told to "scan to receive money" – actually pays ; remember: PIN is needed only to pay, never to receive
Deepfake fraud	AI-generated fake video/voice of a relative, boss or celebrity to ask for money or promote fake investments
"Digital arrest" scam	Callers pose as police/CBI/ED/RBI/customs on video call, "arrest" victim online & extort money
Mule account	Bank account used to route fraud money (money laundering)
Fake loan / investment apps, task scams	Lure with easy loans/returns; then harass or steal

- There is no "digital arrest" under Indian law – PM's Mann Ki Baat (27 Oct 2024) advice: "**Stop – Think – Take action**", record the call and report on **1930**.

12.6 Hackers & Cyber Crime Terms

Type	Meaning
White hat	Ethical hacker / penetration tester – legal, with permission
Black hat	Cracker – illegal, for personal gain or damage
Grey hat	Hacks without permission but usually no harm; may report flaws
Blue hat	Tests software before launch
Green hat	Beginner, learning
Red hat	Vigilante – attacks black-hat hackers

Type	Meaning
Script kiddie	Unskilled; uses others' tools
Hacktivist	Hacks for political/social causes
Cyber terrorist	Attacks critical systems to cause fear/harm

- **Hacking** = unauthorised access; **Cracking** = breaking software protection/passwords.
- **Cyber stalking** = repeated online harassment/following. **Identity theft** = using someone's personal details to commit fraud.
- **Software piracy** = illegal copying/distribution of software; legal right to use software = **software licence**. **Plagiarism** = stealing others' ideas/work.
- **Cyber forensics** = law + computer science to collect & analyse digital evidence. **Cyber laundering** = electronic transfer of illegal money to hide its source.
- **Steganography** = hiding the **existence** of a message (inside an image/audio). **Honeypot** = decoy system to trap attackers.
- **Spam** = unsolicited bulk e-mail; **Spooling** (Simultaneous Peripheral Operations On-Line) is **not** an attack.

12.7 Security Measures – Antivirus, Firewall, Proxy

► Antivirus

- A **utility (system) program** that **detects, prevents & removes** malware using **signatures** and **heuristics/behaviour**. Must be **updated** regularly.
- First commercial antivirus products appeared in **1987** (e.g. McAfee VirusScan; Bernd Fix removed the Vienna virus in 1987).
- **Quarantine** = isolating a suspicious file. **Patch / update** = vendor-created fix for a security hole (vendor-created program modifications = **patches**).

Antivirus	Country / HQ
Quick Heal , eScan, K7, Guardian	India (Quick Heal – Pune)
Norton (Gen Digital), McAfee	USA
Kaspersky	Russia (Moscow)
Avast, AVG (both now Gen Digital)	Czech Republic (Prague)

Antivirus	Country / HQ
Bitdefender	Romania
ESET	Slovakia
Panda	Spain
Trend Micro	Japan
Microsoft Defender	Built into Windows

► Firewall

- Hardware or software that **monitors & filters incoming/outgoing traffic** using **rules**; barrier between a **trusted internal** network and the **untrusted Internet**. Protects against **unauthorised access / hacker intrusion** (not a full antivirus).
- Key function: **monitoring & screening packets**.

Firewall type	Key point
Packet-filtering	Checks IP address, port, protocol of each packet (network layer)
Stateful inspection	Tracks the state of connections
Proxy / application-level gateway	Works at application layer; acts on behalf of users
Circuit-level gateway	Checks TCP handshake (session layer)
Next-generation (NGFW)	Adds deep packet inspection, IPS, app control
Host-based	On one computer (Windows Defender Firewall)
Network-based	Protects a whole network (at the gateway)
WAF	Web Application Firewall – protects web apps from SQLi, XSS

- Proxy server** – intermediary between user & Internet. **Forward proxy** protects clients; **Reverse proxy** sits in front of **web servers** – protects them & improves performance (load balancing, caching).
- IDS** = Intrusion **Detection** System (alerts); **IPS** = Intrusion **P**revention System (blocks). **DMZ** = buffer zone for public servers.

12.8 Cryptography – Encryption & Digital Signatures

- Encryption** = converting **plain text** (readable) into **cipher text** (scrambled) using an **algorithm + key** – done at **sender**. **Decryption**

= cipher text → plain text – at **receiver**.

Provides **privacy/confidentiality**.

- Cryptography** = science of secret writing; **cryptanalysis** = breaking codes.

Feature	Symmetric	Asymmetric
Keys	One shared secret key	Key pair: public + private
Speed	Fast	Slower
Examples	AES, DES, 3DES, Blowfish, RC4	RSA, ECC, Diffie-Hellman, DSA
Keys for n users	$n(n-1)/2$	2n (one pair each)

- Public-key encryption: encrypt with receiver's **public key**, decrypt with receiver's **private key**.
- 20 people using symmetric keys need $20 \times 19/2 = 190$ keys.
- Hashing** (SHA-256, MD5) = one-way fixed-length digest – used to check **integrity** & store passwords.
- ATMs/card networks use **AES** and **3DES (Triple DES)** to encrypt PINs.

► Digital Signature & Digital Certificate

Item	Key point
Digital signature	Encrypted hash of a message made with sender's private key ; verified with public key → proves authenticity, integrity, non-repudiation
Digital certificate	Electronic "ID card" binding a public key to its owner; issued by a Certifying Authority (CA) ; standard X.509
CCA	Controller of Certifying Authorities (India, under IT Act 2000) licenses CAs (e.g. eMudhra, NIC)
DSC	Digital Signature Certificate – used for e-filing, MCA, GST, e-tenders
PKI	Public Key Infrastructure – system of CAs, keys & certificates

► Secure Communication

- SSL** (Secure Sockets Layer, Netscape 1995) → replaced by **TLS** (Transport Layer Security); latest **TLS 1.3** (2018). **HTTPS** = HTTP over TLS (port **443**, padlock icon).

- **VPN** (Virtual Private Network) = **encrypted tunnel** over the public Internet; hides IP; protocols IPsec, OpenVPN, WireGuard.
- Wi-Fi security: WEP (weak) → WPA → **WPA2** (AES) → **WPA3** (latest). **WPA-PSK** uses a pre-shared key of **8–63 characters**.
- E-mail security: **PGP**, **S/MIME**, SPF, DKIM, DMARC.

★ REMEMBER THIS

- Data to be encrypted = **plain text**; encrypted data = **cipher text**. Encryption = **scrambling of code**.
- Digital signature: **private key signs (encrypts)**, **public key verifies (decrypts)**.
- Digital certificate is issued by a **CA**; in India CAs are licensed by the **CCA**.
- **HTTPS** port 443; **SSL is obsolete**, TLS is used today.

12.9 Authentication – Passwords, OTP, Biometrics, Passkeys

Factor	Examples
Something you know	Password, PIN, security question
Something you have	OTP on phone, smart card, hardware token, authenticator app
Something you are	Biometrics – fingerprint, iris, face, voice

- **2FA** = two different factors (e.g. password + OTP). **MFA** = two or more factors. **OTP** = One-Time Password (**TOTP** = time-based, changes every 30 s).
- Strong password: **12+ characters**, mix of upper/lower case, digits & symbols; unique for each site; use a **password manager**.
- **CAPTCHA** = Completely Automated Public Turing test to tell Computers and Humans Apart – stops **bots/spam**. reCAPTCHA = Google's version.
- **Passkeys** = **passwordless** login based on **FIDO2/WebAuthn**; private key stays on the device, unlocked by fingerprint/face/PIN; **phishing-resistant**. Supported by Google, Apple, Microsoft.

- **SSO** (Single Sign-On) = one login for many apps (e.g. "Sign in with Google").
- **Smart token / smart card** = password-protected hardware that holds credentials – hard to misuse even if stolen.
- Biometric in India: **Aadhaar** authentication (fingerprint, iris, **face authentication**) by **UIDAI**; AePS uses fingerprint.

12.10 Indian Cyber Law – IT Act 2000

- **Information Technology Act, 2000** – India's **first cyber law**; based on **UNCITRAL Model Law on E-Commerce (1996)**. Assent 9 June 2000; in force **17 October 2000**.
- Gives legal recognition to **electronic records & digital signatures**; set up the **CCA**.
- **IT (Amendment) Act 2008** (in force **27 Oct 2009**) – added **66A–66F, 67A, 67B, 43A, 70B (CERT-In)**, introduced "electronic signature".
- **Section 66A** (offensive messages) was **struck down** by the Supreme Court in **Shreya Singhal v. Union of India (2015)**.

Section	Offence / provision	Punishment
43	Damage to computer: unauthorised access, download, virus , DoS (civil)	Compensation to victim
43A	Body corporate failing to protect sensitive data	Compensation (being replaced by DPDP Act)
65	Tampering with computer source code	3 yrs / ₹2 lakh
66	Hacking – acts of Sec 43 done dishonestly	3 yrs / ₹5 lakh
66B	Receiving stolen computer/phone	3 yrs / ₹1 lakh
66C	Identity theft – misuse of password, e-signature, ID	3 yrs + ₹1 lakh
66D	Cheating by personation using computer (phishing , fake profiles, online fraud)	3 yrs + ₹1 lakh
66E	Violation of privacy – capturing/publishing private images	3 yrs / ₹2 lakh
66F	Cyber terrorism	Life imprisonment
67	Publishing obscene material electronically	3 yrs + ₹5 lakh (first)

Section	Offence / provision	Punishment
67A / 67B	Sexually explicit material / child sexual abuse material	5 yrs + ₹10 lakh (first)
69 / 69A	Govt. power to intercept/decrypt / block websites & apps	–
70 / 70A / 70B	Protected systems / NCIIPC / CERT-In	–
72	Breach of confidentiality & privacy	2 yrs / ₹1 lakh
79	Intermediary "safe harbour" (social media, ISPs)	–

🔑 MEMORY TRICK: Section 66 family

➤ **66 Hacking** → **66B** = Bought stolen → **66C** = Credential/ID theft → **66D** = Deception (personation/phishing) → **66E** = Exposure of privacy → **66F** = Fear (terrorism, life term).

- From **1 July 2024**, IPC is replaced by **Bharatiya Nyaya Sanhita (BNS)**: stalking incl. cyber-stalking = **BNS 78** (old IPC 354D); voyeurism = **BNS 77** (old 354C); cheating by personation = **BNS 319**.
- IT Rules 2021** (Intermediary Guidelines & Digital Media Ethics Code) – grievance officer, removal of unlawful content, traceability for messaging apps.

12.11 Indian Cyber Security Institutions & Laws (2025–26)

Body / law	Key facts
CERT-In	Indian Computer Emergency Response Team – est. 2004 , under MeitY ; national nodal agency (Sec 70B)
CERT-In Directions 2022	Issued 28 Apr 2022 (in force 27 Jun 2022): report cyber incidents within 6 hours ; keep logs 180 days ; VPN providers keep user data 5 years
NCIIPC	National Critical Information Infrastructure Protection Centre (Sec 70A) – under NTRO ; protects banking, power, telecom etc.

Body / law	Key facts
I4C	Indian Cyber Crime Coordination Centre – MHA ; inaugurated 10 Jan 2020
NCRP	National Cyber Crime Reporting Portal – cybercrime.gov.in
Helpline 1930	National cyber-fraud helpline – report immediately (golden hour) so money can be frozen
Sanchar Saathi (DoT)	Portal (2023) & app (17 Jan 2025): Chakshu – report suspected fraud calls/SMS/WhatsApp; block lost/stolen phone (CEIR); see mobile connections in your name; check IMEI
Cyber Swachhta Kendra	Botnet cleaning & malware analysis centre (CERT-In)
National Cyber Security Policy	2013

- Nov 2025: DoT ordered phone makers to **pre-install the Sanchar Saathi app**; after public criticism the order was **withdrawn on 3 Dec 2025** (the app remains voluntary).
- **DPDP Act 2023 & DPDP Rules 2025**
- Digital Personal Data Protection Act, 2023** – India's first **data-protection law**; assent **11 Aug 2023**. Applies to **digital** personal data.
- Terms: **Data Principal** (the person), **Data Fiduciary** (organisation deciding purpose, e.g. a bank), **Data Processor**, **Consent Manager**, **Significant Data Fiduciary**.
- Consent** must be free, specific, informed; **verifiable parental consent** for children (**under 18**).
- Regulator: **Data Protection Board of India** (fully digital); appeals to **TDSAT**.
- Max penalty **₹250 crore** (failure of security safeguards); ₹200 crore for breach-notice / children's-data violations.
- DPDP Rules 2025 notified 13 Nov 2025** (PIB release 14 Nov): Board provisions in force at once; Consent Manager registration after **12 months (Nov 2026)**; most duties after **18 months (May 2027)**.
- Data breach: inform the Board & affected persons **without delay**; detailed report to the Board **within 72 hours**. Requests (access,

correction, erasure) to be answered within **90 days**.

► RBI – Digital Payment Security

Measure	Key point
.bank.in domain	Circular 22 Apr 2025 ; all banks to migrate by 31 Oct 2025 ; registrar IDRBT ; .fin.in for non-bank financial entities
1600xx numbers	RBI (Jan 2025): banks to use only 1600xx series for transactional/service calls; 140xx for promotional calls
Authentication Directions 2025	From 1 Apr 2026 : 2FA mandatory for digital payments, at least one factor dynamic ; banks may use biometrics, device tokens, app-based methods beyond SMS OTP ; risk-based checks for unusual payments
Cross-border card (CNP)	Indian cards used on foreign sites: extra authentication by 1 Oct 2026
Customer liability (2017)	Zero liability if unauthorised transaction is reported within 3 working days ; limited liability for 4–7 days
MuleHunter.AI	AI tool by RBI Innovation Hub to detect mule accounts (2024)

★ REMEMBER THIS

- Report cyber fraud: **1930 / cybercrime.gov.in**. Report suspected fraud calls/SMS: **Chakshu** on **Sanchar Saathi**.
- CERT-In = **2004**, MeitY, **6-hour** reporting rule (2022). I4C = **MHA**.
- IT Act **2000** (amended **2008**); **66C** = identity theft, **66D** = phishing/personation, **66F** = cyber terrorism (life).
- DPDP Act **2023**; Rules **Nov 2025**; max penalty **₹250 crore**.
- Never share **OTP, PIN, CVV, password** – banks/RBI never ask for them.

12.12 Practice MCQs (Previous-Year Pattern)

Q1. Which malware does not require a host program to spread? (IBPS RRB PO 2023)

- (a) Ransomware (b) Adware (c) Worm
(d) Spyware (e) Trojan

Ans: (c) A worm is a stand-alone, self-replicating program that spreads over networks without a host.

Q2. Which of the following is a type of malware that presents itself as legitimate software? (IBPS RRB PO 2022)

- (a) Ransomware (b) Fileless malware
(c) Spyware (d) Adware (e) Trojan

Ans: (e) A Trojan horse looks useful but secretly performs harmful actions; it does not replicate.

Q3. What kind of phishing attack uses malicious e-mails to target particular people or organisations to steal sensitive data? (IBPS RRB Clerk 2023)

- (a) Angler (b) Whaling (c) Spear (d) Vishing
(e) Smishing

Ans: (c) Spear phishing is aimed at specific individuals or organisations; whaling targets top executives.

Q4. _____ is a form of fraud that attempts to steal personal banking information through text messages.

- (a) Skimming (b) Phishing (c) Smishing
(d) Ransomware (e) Vishing

Ans: (c) Smishing = SMS phishing; vishing uses voice calls.

Q5. Brain, the first virus for IBM PCs (1986), was a:

- (a) Macro virus (b) Boot sector virus (c) Worm
(d) Polymorphic virus (e) Logic bomb

Ans: (b) Brain infected the boot sector of floppy disks; it was written by the Alvi brothers of Pakistan.

Q6. In a digital signature, the private key is used for _____ and the public key for _____. (SBI IT Officer 2012)

- (a) encryption, decryption
(b) decryption, encryption
(c) plaintext, ciphertext
(d) ciphertext, plaintext (e) None of these

Ans: (a) The sender signs (encrypts the hash) with the private key; anyone verifies with the public key.

Q7. A firewall that is installed on a computer and monitors the traffic to and from that computer only is called: (IBPS RRB PO 2022)

- (a) Network firewall (b) Host-based firewall
(c) Simplex firewall (d) Complex firewall
(e) Universal firewall

Ans: (b) A host-based firewall protects a single device; a network firewall protects an entire network.

Q8. Which section of the IT Act, 2000 deals with punishment for cheating by personation using a computer resource (e.g. phishing)?

- (a) Section 43 (b) Section 66C (c) Section 66D
(d) Section 66F (e) Section 67

Ans: (c) 66C = identity theft; 66D = cheating by personation; 66F = cyber terrorism.

Q9. As per CERT-In directions of April 2022, cyber incidents must be reported to CERT-In within:

- (a) 1 hour (b) 6 hours (c) 24 hours
(d) 72 hours (e) 7 days

Ans: (b) CERT-In requires reporting within 6 hours of noticing the incident and keeping logs for 180 days.

Q10. What is the national helpline number for reporting cyber financial fraud in India?

- (a) 100 (b) 112 (c) 1930 (d) 1098 (e) 181

Ans: (c) Dial 1930 or use cybercrime.gov.in, run by I4C under the Ministry of Home Affairs.

CHAPTER 13 NUMBER SYSTEM & DATA REPRESENTATION

13.1 Number Systems – Basics

- A **number system** is a way of representing quantities using a set of symbols (digits).
- **Base (radix)** = number of different digits used in the system. Largest digit = **base – 1**.
- All four systems are **positional**: value of a digit = digit $\times$ (base)^{position} (positions 0, 1, 2... from right of the point; -1, -2... after it).
- Computers internally use **binary (base 2)** because electronic circuits have **two states – ON (1) / OFF (0)**.
- **Decimal** = Hindu-Arabic system (most commonly used by humans). **Aryabhata** (5th century) used **place-value notation**.
- **G. W. Leibniz** described the modern **binary number system** (1703).

System	Base	Digits used
Binary	2	0, 1
Octal	8	0 – 7
Decimal	10	0 – 9
Hexadecimal	16	0 – 9, A=10, B=11, C=12, D=13, E=14, F=15

- Number written with base as subscript: $(1010)_2$, $(12)_8$, $(10)_{10}$, $(A)_{16}$ – all equal ten.
- **LSB** = Least Significant Bit (rightmost); **MSB** = Most Significant Bit (leftmost; used as **sign bit** in signed numbers).
- **1 octal digit = 3 bits; 1 hex digit = 4 bits (a nibble); 2 hex digits = 1 byte.**
- Uses of hex: **memory addresses**, **MAC addresses**, **HTML colour codes** (#FF0000 = red), **Unicode code points**. Octal: **Unix/Linux file permissions** (chmod 755).

► Equivalents Table (learn by heart)

Decimal	Binary	Octal	Hex
0	0000	0	0
1	0001	1	1
2	0010	2	2
3	0011	3	3
4	0100	4	4
5	0101	5	5
6	0110	6	6

Decimal	Binary	Octal	Hex
7	0111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F

✎ MEMORY TRICK: Binary place values

- **8-4-2-1** for a nibble; for a byte: **128 64 32 16 8 4 2 1**. Write these over the bits and add where bit = 1.
- n bits give **2ⁿ** combinations: 4 bits → 16, 7 bits → 128, 8 bits → 256. Largest n-bit number = **2ⁿ – 1** (8 bits → 255).

13.2 Conversions – Methods & Worked Examples

Conversion	Method
Decimal → Binary / Octal / Hex	Repeated division by 2 / 8 / 16; write remainders bottom to top (last remainder = MSB)
Binary / Octal / Hex → Decimal	Multiply each digit by base^{position} and add
Binary → Octal	Group 3 bits from the right (pad 0s on left)
Binary → Hex	Group 4 bits from the right
Octal → Binary	Each octal digit → 3 bits
Hex → Binary	Each hex digit → 4 bits
Octal ↔ Hex	Go via binary (octal → binary → regroup in 4s)
Decimal fraction → Binary	Repeated multiplication by 2 ; take integer parts top to bottom

► Example 1: $(25)_{10} \rightarrow$ Binary

Division	Quotient	Remainder
$25 \div 2$	12	1 (LSB)
$12 \div 2$	6	0

Division	Quotient	Remainder
$6 \div 2$	3	0
$3 \div 2$	1	1
$1 \div 2$	0	1 (MSB)

Read remainders bottom to top: $(25)_{10} = (11001)_2$.

► **Example 2: $(101101)_2 \rightarrow$ Decimal**

$1 \times 32 + 0 \times 16 + 1 \times 8 + 1 \times 4 + 0 \times 2 + 1 \times 1 = 32 + 8 + 4 + 1 = (45)_{10}$.

► **Example 3: $(156)_{10} \rightarrow$ Octal and $(450)_{10} \rightarrow$ Hex**

Step	$156 \div 8$	$450 \div 16$
1	19 r 4	28 r 2
2	2 r 3	1 r 12 = C
3	0 r 2	0 r 1
Answer	$(234)_8$	$(1C2)_{16}$

► **Example 4: Other conversions**

Question	Working	Answer
$(234)_8 \rightarrow$ decimal	$2 \times 64 + 3 \times 8 + 4$	156
$(2AF)_{16} \rightarrow$ decimal	$2 \times 256 + 10 \times 16 + 15$	687
$(1101011)_2 \rightarrow$ octal	001 101 011	$(153)_8$
$(1101011)_2 \rightarrow$ hex	0110 1011	$(6B)_{16}$
$(57)_8 \rightarrow$ binary	5 = 101, 7 = 111	$(101111)_2$
$(3F)_{16} \rightarrow$ binary	3 = 0011, F = 1111	$(00111111)_2$
$(75)_8 \rightarrow$ hex	111 101 $\rightarrow$ 0011 1101	$(3D)_{16}$
$(0.625)_{10} \rightarrow$ binary	.625 $\times$ 2 = 1.25 $\rightarrow$ 1; .25 $\times$ 2 = 0.5 $\rightarrow$ 0; .5 $\times$ 2 = 1.0 $\rightarrow$ 1	$(0.101)_2$

★ **REMEMBER THIS**

- Decimal $\rightarrow$ any base: **divide**; any base $\rightarrow$ decimal: **multiply & add**.
- Binary $\rightarrow$ Octal: groups of **3**; Binary $\rightarrow$ Hex: groups of **4**.
- Hex has **6 letters (A–F)**; F = 15; $(FF)_{16} = 255 = (11111111)_2 = (377)_8$.
- $(10)_{10} = (1010)_2$ – asked in IBPS RRB PO Mains 2023.

13.3 Binary Arithmetic

Addition	Subtraction	Multiplication
$0 + 0 = 0$	$0 - 0 = 0$	$0 \times 0 = 0$
$0 + 1 = 1$	$1 - 0 = 1$	$0 \times 1 = 0$
$1 + 0 = 1$	$1 - 1 = 0$	$1 \times 0 = 0$
$1 + 1 = 0$, carry 1 (10)	$0 - 1 = 1$, borrow 1	$1 \times 1 = 1$
$1 + 1 + 1 = 1$, carry 1 (11)		

- Example (add): $1011 + 1101 = 11000$ (11 + 13 = 24).
- Example (subtract): $1010 - 0011 = 0111$ (10 – 3 = 7).
- Example (multiply): $111 \times 101 = 100011$ (7 $\times$ 5 = 35).
- A **half adder** adds 2 bits (Sum = A XOR B, Carry = A AND B); a **full adder** adds 3 bits (A, B, carry-in). Computers subtract by **adding the 2's complement**.

13.4 Complements & Signed Numbers

Complement	Rule	Example
1's (binary)	Invert every bit ($0 \leftrightarrow 1$)	110100 $\rightarrow$ 001011
2's (binary)	1's complement + 1	00101100 $\rightarrow$ 11010011 + 1 = 11010100
9's (decimal)	Subtract each digit from 9	28 $\rightarrow$ 99 – 28 = 71
10's (decimal)	9's complement + 1	455 $\rightarrow$ 544 + 1 = 545
7's / 8's (octal)	7's: subtract from 7; 8's = 7's + 1	$(42500)_8 \rightarrow$ 8's = 35300

- In general a base-r system has **r's** and **(r–1)'s** complements.
- **Shortcut for 2's complement**: copy bits from the right up to and including the **first 1**, then invert the rest.
- Signed numbers: **MSB = sign bit** (0 = +, 1 = –). Three methods: **sign-magnitude, 1's complement, 2's complement**.
- Computers use **2's complement** (only one zero; easy subtraction). –5 in 8-bit = **11111011**.

8-bit representation	Range
Unsigned	0 to 255
Sign-magnitude / 1's complement	–127 to +127 (two zeros: +0, –0)
2's complement	–128 to +127 (general: -2^{n-1} to $2^{n-1}-1$)

13.5 Data Units & Binary Codes

- **Bit** = binary digit (0/1); **Nibble** = 4 bits; **Byte** = 8 bits (octet); **Word** = CPU's natural unit (16/32/64 bits). A byte holds values **0–255**.
- **Parity bit** – extra bit added for **error detection**: **even parity** (total 1s even) or **odd parity**.

Code	Bits	Key point
BCD (Binary Coded Decimal)	4 per decimal digit	Weighted 8421 code; introduced by IBM . 59 → 0101 1001 . Codes 1010–1111 unused
Excess-3 (XS-3)	4	BCD + 3 (5 → 1000); self-complementing
Gray code	Any	Only one bit changes between successive numbers (reflected code)
ASCII	7 (128 chars)	American Standard Code for Information Interchange (1963); most common on PCs
Extended ASCII	8 (256 chars)	Adds 128 symbols/accented letters (e.g. ISO 8859-1)
EBCDIC	8 (256 chars)	Extended Binary Coded Decimal Interchange Code – IBM mainframes (1964)
ISCII	8	Indian Script Code for Information Interchange (BIS, 1991) – Indian scripts
Unicode	Code points need 21 bits	Universal character set for all languages ; UTF-8 / UTF-16 / UTF-32

► ASCII – must-know values

Character	Decimal	Note
Space	32	First printable character
! (exclamation)	33	

Character	Decimal	Note
'0' – '9'	48 – 57	Digit = 48 + value
'A' – 'Z'	65 – 90	A = 65 (Hex 41, binary 1000001)
'a' – 'z'	97 – 122	Lower case = upper case + 32
DEL	127	Last ASCII code

- Codes **0–31 (and 127)** are non-printable **control characters** (e.g. 10 = Line Feed, 13 = Carriage Return); **32–126** = 95 printable characters.
- ASCII is a **fixed-length** code. When a key is pressed, the keystroke is converted to bits using **ASCII** (IBPS PO 2013).

► Unicode

- Maintained by the **Unicode Consortium** (founded 1991; **Unicode 1.0 – 1991**). Unicode is **not an abbreviation**.
- Gives every character a unique **code point** written **U+hex**: from **U+0000 to U+10FFFF** → **1,114,112** code points in **17 planes** (Plane 0 = **BMP**, Basic Multilingual Plane) – needs **21 bits**.
- First **128 code points** = **ASCII**, so Unicode is backward-compatible. Supports **Chinese, Japanese, Indian scripts, maths symbols, emoji**. e.g. ₹ = **U+20B9**.
- **Latest: Unicode 17.0** (9 Sep 2025, 4,803 new characters, total 159,801); **Unicode 18.0** (Sep 2026) adds **13,007** characters (total **172,808**) incl. new scripts such as Jurchen and Seal script.

Encoding	Bytes per character	Key point
UTF-8	1 to 4 (variable)	ASCII-compatible; most used on the web
UTF-16	2 or 4	Used inside Windows, Java; 4 bytes via surrogate pairs
UTF-32	4 (fixed)	Simple but uses most space

📌 MEMORY TRICK: Bits of character codes

- "BCD-4, ASCII-7, EBCDIC-8, Unicode-21" → **4 – 7 – 8 – 21** bits.
- ASCII **7 bits** → **128**; Extended ASCII / EBCDIC **8 bits** → **256**.

13.6 Logic Gates

- A **logic gate** is the basic building block of a digital circuit: it takes one or more binary inputs and gives **one output** according to a logic rule. Built from **transistors / diodes**.
- **NOT** has only **one** input; **AND**, **OR**, **NAND**, **NOR**, **XOR**, **XNOR** take **two or more** inputs.
- **Basic gates**: **AND**, **OR**, **NOT**. **Universal gates**: **NAND & NOR** – any other gate/circuit can be built from them alone. **Exclusive gates**: **XOR**, **XNOR**.

Gate	Expression	Output for AB = 00, 01, 10, 11
AND	$Y = A \cdot B$	0, 0, 0, 1 (1 only if all inputs 1)
OR	$Y = A + B$	0, 1, 1, 1 (1 if any input 1)
NAND	$Y = (A \cdot B)'$	1, 1, 1, 0 (opposite of AND)
NOR	$Y = (A + B)'$	1, 0, 0, 0 (opposite of OR)
XOR	$Y = A \oplus B$	0, 1, 1, 0 (1 if inputs differ)
XNOR	$Y = (A \oplus B)'$	1, 0, 0, 1 (1 if inputs same)
NOT	$Y = A' (\bar{A})$	$A = 0 \rightarrow 1$; $A = 1 \rightarrow 0$ (inverter)

MEMORY TRICK: Gate outputs

- **AND** = "All" – output 1 only when **all** inputs are 1. **OR** = "Any" – 1 when **any** input is 1.
- **N** in front (NAND, NOR, XNOR) = **Not** → simply **flip** the output column.
- **XOR** = "odd one" – 1 when the number of 1s is **odd**; **XNOR** = equality detector.

13.7 Boolean Algebra Basics

- Developed by **George Boole** (1854). **Claude Shannon** (1937) showed it can be used to design **switching circuits** – the basis of digital logic.
- Only two values: **0 (False)** and **1 (True)**. Operators: **· (AND)**, **+ (OR)**, **' or bar (NOT)**.

Law	Form
Identity	$A + 0 = A$; $A \cdot 1 = A$
Null (Dominance)	$A + 1 = 1$; $A \cdot 0 = 0$
Idempotent	$A + A = A$; $A \cdot A = A$

Law	Form
Complement	$A + A' = 1$; $A \cdot A' = 0$
Involution	$(A')' = A$
Commutative	$A + B = B + A$; $A \cdot B = B \cdot A$
Distributive	$A \cdot (B + C) = A \cdot B + A \cdot C$
Absorption	$A + A \cdot B = A$; $A \cdot (A + B) = A$
De Morgan's	$(A \cdot B)' = A' + B'$; $(A + B)' = A' \cdot B'$

- Useful result: **$A + A'B = A + B$** .
- De Morgan's theorem is why **NAND** = "bubbled OR" and **NOR** = "bubbled AND".

★ REMEMBER THIS

- **Universal gates** = **NAND** and **NOR**. Basic gates = **AND**, **OR**, **NOT**.
- **XOR** output is **1** when inputs are **different**; **XNOR** when inputs are **same**.
- **ASCII 65** = 'A', 97 = 'a'; ASCII = **7-bit**, **128** chars; EBCDIC = **8-bit**, **256** chars (IBM).
- **Unicode** supports Chinese/Japanese/Indian scripts; code points up to **U+10FFFF** (21 bits).
- **BCD** = **8421 code**, 4 bits per decimal digit. A **hex digit** = **4 bits**; an **octal digit** = **3 bits**.
- **2's complement** = **1's complement + 1**; used by computers for negative numbers.

13.8 Practice MCQs (Previous-Year Pattern)

Q1. The binary equivalent of decimal number 98 is: (IBPS Clerk 2012)

- (a) 1110001 (b) 1110100 (c) 1100010
(d) 1111001 (e) None of these

Ans: (c) $98 = 64 + 32 + 2 \rightarrow 1100010$.

Q2. Conversion of octal number $(125)_8$ to its decimal equivalent is: (SBI Clerk 2009)

- (a) $(90)_{10}$ (b) $(85)_{10}$ (c) $(87)_{10}$ (d) $(99)_{10}$
(e) None of these

Ans: (b) $1 \times 64 + 2 \times 8 + 5 \times 1 = 64 + 16 + 5 = 85$.

Q3. Conversion of binary number $(1001001)_2$ to hexadecimal is: (SBI PO 2011)

- (a) $(40)_{16}$ (b) $(39)_{16}$ (c) $(49)_{16}$ (d) $(42)_{16}$
(e) None of these

Ans: (c) Group in 4s from right: $0100 \mid 1001 = 4 \mid 9 \rightarrow (49)_{16}$.

Q4. What is the decimal value of $(2AF)_{16}$?

- (a) 655 (b) 687 (c) 701 (d) 675 (e) 719

Ans: (b) $2 \times 256 + 10 \times 16 + 15 = 512 + 160 + 15 = 687$.

Q5. The hexadecimal equivalent of octal number $(75)_8$ is:

- (a) $(3D)_{16}$ (b) $(4B)_{16}$ (c) $(3B)_{16}$ (d) $(75)_{16}$
(e) $(61)_{16}$

Ans: (a) $75_8 = 111\ 101_2 = 0011\ 1101_2 = 3D_{16}$ (= 61 decimal).

Q6. Multiplication of $(111)_2$ by $(101)_2$ is: (Allahabad Bank PO 2011)

- (a) $(110011)_2$ (b) $(100011)_2$ (c) $(111100)_2$
(d) $(000101)_2$ (e) None of these

Ans: (b) $7 \times 5 = 35 = 100011_2$.

Q7. The 2's complement of the 8-bit binary number 00101100 is:

- (a) 11010011 (b) 11010100 (c) 00101101
(d) 11010010 (e) 10101100

Ans: (b) 1's complement $11010011 + 1 = 11010100$.

Q8. Which character has the ASCII decimal value 65? (IBPS RRB PO 2023)

- (a) a (b) B (c) A (d) @ (e) Z

Ans: (c) Upper-case A = 65 (B = 66); lower-case a = 97.

Q9. Which of the following are called universal gates?

- (a) AND and OR (b) XOR and XNOR
(c) NAND and NOR (d) AND and NOT
(e) OR and NOT

Ans: (c) Any logic circuit can be built using only NAND gates or only NOR gates.

Q10. Which of the following character sets supports Japanese and Chinese fonts? (IBPS Clerk Mains 2017)

- (a) EBCDIC (b) ASCII (c) BCD
(d) Extended ASCII (e) UNICODE

Ans: (e) Unicode covers the scripts of all major languages, with code points up to U+10FFFF.

CHAPTER 14 PROGRAMMING BASICS

14.1 Program & Programming Language

- **Program** = a set of instructions telling the computer what to do. **Programming / coding** = writing these instructions in a programming language.
- **Programming language** = a set of **keywords, symbols & rules (syntax)** used to write instructions that a computer can execute.
- **Syntax** = grammar rules of a language.
Reserved words / keywords = words set aside by the language for its own use (if, while, for, return).
- **Source code** = human-readable program written by the programmer. **Object code** = machine-code output of the compiler.
Executable = ready-to-run program (.exe) that needs no change.
- **Documentation** = written description of a program's functions & use.
- **Machine-independent (portable)** = high-level languages. **Machine-dependent (CPU-dependent)** = machine & assembly language – each computer model has its **own unique machine language**.

14.2 Generations of Programming Languages

Generation	Type	Examples / key point
1GL (1940s)	Machine language	Binary 0 & 1 ; directly understood by CPU; fastest; no translator
2GL (1950s)	Assembly language	Uses mnemonics (ADD, MOV, SUB); needs assembler
3GL (1950s–)	High-level, procedural	FORTRAN, COBOL, BASIC, Pascal, C, C++, Java, Python
4GL (1970s–)	Non-procedural, close to English; database & reports	SQL , MATLAB, FOCUS, report generators
5GL (1980s–)	Logic / constraint-based, for AI	Prolog , Mercury, OPS5

- **Low-level languages** = Machine + Assembly (1GL, 2GL). **High-level languages** = 3GL onwards.
- C is often called a **middle-level language** – high-level syntax but can handle low-level work (memory, hardware).
- Many books list scripting languages (Python, Perl, Ruby) under 4GL; in the standard classification they are **3GL**. For exams: **4GL = SQL**, **5GL = Prolog**.

Low-level language	High-level language
Close to the machine	Close to human language (English-like)
Machine-dependent; not portable	Machine-independent; portable
Hard to write, read & debug	Easy to write, read & debug
Fast; efficient memory use	Slower; needs compiler/interpreter
Machine code needs no translator; assembly needs assembler	e.g. C, Java, Python, COBOL

MEMORY TRICK: Generations

- **"My Aunt Hates Silly Puzzles"** → Machine (1GL), Assembly (2GL), High-level (3GL), SQL (4GL), Prolog (5GL).

14.3 Translators – Compiler, Interpreter, Assembler

Translator	Converts	Examples
Assembler	Assembly (mnemonic) code → machine code	MASM, NASM
Compiler	Whole high-level program → object/machine code at once	C, C++, COBOL, FORTRAN, Go
Interpreter	High-level program → executes line by line	Python, BASIC, Ruby, JavaScript (browser)

Compiler	Interpreter
Translates the whole program in one go	Translates & runs one statement at a time

Compiler	Interpreter
Creates an object code file	No object code file
Execution faster (compile once, run many times)	Execution slower (translated every run)
Shows all errors after compiling; debugging harder	Stops at the first error ; debugging easier
Needs more memory during compilation	Needs less memory; source needed each time

- **Java uses both:** **javac** compiler → **bytecode** (.class) → **JVM** interprets / JIT-compiles it. Hence "**Write Once, Run Anywhere**" (WORA).
- **Linker** – combines object modules & library files into one executable. **Loader** – loads the executable into **RAM**.
- Chain: **Source code** → **Compiler** → **Object code** → **Linker** → **Executable** → **Loader** → **RAM** → **CPU**.
- **Mnemonic / symbolic code** = instructions written in English-like abbreviations instead of binary (assembly).

★ REMEMBER THIS

- Only language **directly understood by the CPU** = **machine language** (binary).
- A compiler takes **source code** and produces **object code**.
- Translator for assembly language = **assembler**. Translator slower in execution = **interpreter**.
- Errors pointed out by the compiler = **syntax errors**.

14.4 Algorithm, Flowchart & Pseudocode

- **Algorithm** = a **step-by-step procedure** to solve a problem in a finite number of steps (word comes from mathematician **al-Khwarizmi**). Must be finite, definite & effective, with input & output.
- **Flowchart** = **pictorial / diagrammatic** representation of an algorithm using standard symbols.
- **Pseudocode** = **cross between human language and a programming language**; informal, no strict syntax (IBPS PO 2012).

- **Control structures:** **Sequence** (one after another), **Selection / decision** (if-else, switch), **Iteration / looping** (for, while – repeating statements).

► Flowchart Symbols

Symbol (shape)	Used for
Oval / Ellipse (Terminal)	Start / Stop (begin & end)
Parallelogram	Input / Output (read, print)
Rectangle	Process (calculation, assignment)
Diamond / Rhombus	Decision (Yes/No, True/False)
Arrow (flow line)	Direction of flow
Small circle	On-page connector
Pentagon (home-plate)	Off-page connector
Rectangle with double side lines	Predefined process / sub-routine
Hexagon	Preparation (loop initialisation)
Wavy-bottom rectangle	Document / printout

✎ MEMORY TRICK: Flowchart shapes

- "**O-P-R-D**" → **O**val = Over/Start, **P**arallelogram = Put in/out (I/O), **R**ectangle = Run a process, **D**iamond = Decide.

14.5 Errors, Bugs & Debugging

Error type	Meaning / example
Syntax error	Breaks language grammar (missing semicolon, misspelt keyword); found by compiler
Logical error	Program runs but gives wrong result due to a mistake in the algorithm; hardest to find
Run-time error	Occurs while running (divide by zero, file not found)
Semantic error	Statement is valid but meaning is wrong (wrong variable used)

- **Bug** = error/defect in a program; **Debugging** = finding & removing bugs; tool = **debugger**.

- Term popularised by **Grace Hopper's team (1947)** – a real **moth** found in the **Harvard Mark II** relay.
- **Testing** – checking that a program works as intended. **Patch** – fix for a known bug.
- Bug in exam keys (SBI PO 2009) = **logical error in a program**.

14.6 Programming Paradigms & OOP

Procedural (POP)	Object-Oriented (OOP)
Program divided into functions	Program divided into objects
Top-down approach	Bottom-up approach
Data moves freely; less secure	Data hidden (encapsulation); more secure
e.g. C, FORTRAN, Pascal, COBOL	e.g. C++, Java, Python, C#, Smalltalk

► OOP Concepts

Concept	Meaning
Class	Blueprint / template that defines data & methods (e.g. Car)
Object	Instance of a class ; real-world entity (e.g. my red Car)
Encapsulation	Wrapping data & methods into one unit; data hiding
Abstraction	Showing only essential features , hiding details
Inheritance	New (child) class acquires properties of an existing (parent) class – reusability
Polymorphism	"Many forms" – same name, different behaviour (overloading, overriding)
Message passing	Objects communicate by calling methods

✍ **MEMORY TRICK: Four pillars of OOP**

► **"A PIE"** → **Abstraction, Polymorphism, Inheritance, Encapsulation**.

- **First OOP language** = **Simula** (1967, Ole-Johan Dahl & Kristen Nygaard, Norway). **Pure OOP language** = **Smalltalk** (Alan Kay, Xerox PARC – he coined "object-oriented").

- Other paradigms: **Functional** (LISP, Haskell – reflects the way people think mathematically), **Logic** (Prolog), **Event-driven** (Visual Basic, JavaScript), **Scripting** (Python, JavaScript, PHP).

14.7 Popular Languages – Creators & Years

Language (year)	Creator	Key point
FORTRAN (1957)	John Backus , IBM	Formula Translation ; first widely used HLL; scientific
LISP (1958)	John McCarthy	List Processing; AI
COBOL (1959)	CODASYL committee (Grace Hopper's ideas)	Common Business-Oriented Language ; business , banks
BASIC (1964)	John Kemeny & Thomas Kurtz	Beginner's All-purpose Symbolic Instruction Code
Simula (1967)	Dahl & Nygaard	First OOP language
LOGO (1967)	Feurzeig, Papert, Solomon	Turtle graphics; teaching children
Pascal (1970)	Niklaus Wirth	Structured; teaching; named after Blaise Pascal
C (1972)	Dennis Ritchie , Bell Labs	Used to write UNIX ; successor of B (Ken Thompson)
Prolog (1972)	Alain Colmerauer	Programming in Logic; AI (5GL)
SQL (1974)	Chamberlin & Boyce, IBM	Structured Query Language; databases (4GL)
Ada (1980)	Jean Ichbiah (US DoD)	Named after Ada Lovelace ; based on Pascal; embedded & real-time
C++ (1983)	Bjarne Stroustrup , Bell Labs	First called "C with Classes" (1979); OOP
Perl (1987)	Larry Wall	Text processing, scripting
Python (1991)	Guido van Rossum	Named after Monty Python ; AI, data science
Visual Basic (1991)	Microsoft	Event-driven, GUI programs
Java (1995)	James Gosling , Sun (now Oracle)	Original name Oak ; WORA; applets, Android

Language (year)	Creator	Key point
JavaScript (1995)	Brendan Eich , Netscape	Client-side web scripting; written in 10 days
PHP (1995)	Rasmus Lerdorf	PHP: Hypertext Preprocessor ; server-side
Ruby (1995)	Yukihiro Matsumoto	Ruby on Rails web framework
C# (2000)	Anders Hejlsberg , Microsoft	.NET language
Go (2009)	Griesemer, Pike & Thompson, Google	Also called Golang; cloud
Kotlin (2011)	JetBrains	Google's preferred Android language (2019)
Rust (2015)	Graydon Hoare (Mozilla)	Memory-safe systems language
Swift (2014)	Chris Lattner , Apple	iOS & macOS apps

- Others: **Erlang** – Joe Armstrong (Ericsson); **Hack** – Facebook (2014); **Scala** – Martin Odersky (OOP + functional); **R** – Ross Ihaka & Robert Gentleman (statistics); **TypeScript** – Microsoft (2012); **AngularJS** – Miško Hevery (Google).
- Kathleen Booth** (1947) is credited with the **first assembly language**; **David Wheeler** wrote EDSAC's "initial orders" assembler (1949).
- Arthur Samuel** coined "**machine learning**" (1959); **John McCarthy** coined "AI" (1956).

► Language – Use (Quick Answers)

Asked as	Answer
Scientific / engineering language	FORTRAN
Business / commercial language	COBOL
AI languages	LISP, Prolog (now Python)
Internet / applets / WORA	Java
Mnemonics used in	Assembly language
Embedded & real-time systems	Ada, C
Game development	C++ (also C#)

Asked as	Answer
Data science / ML, Orange data-mining tool	Python
Android apps	Kotlin, Java
NOT a programming language	LOTUS, Bing, A+ (in exam options), Safari

★ REMEMBER THIS

- **C** – Dennis Ritchie; **C++** – Bjarne Stroustrup; **Java** – James Gosling; **Python** – Guido van Rossum; **JavaScript** – Brendan Eich; **PHP** – Rasmus Lerdorf.
- **FORTRAN (1957, John Backus, IBM)** = first high-level language in wide use.
- **COBOL** = business; the "CO" means **Common**.
- First OOP = **Simula**; pure OOP = **Smalltalk**.

14.8 Web Languages, Markup vs Programming

Language	Full form / role
HTML (1991)	HyperText Markup Language – structure of web pages using tags (e.g. = bold); Tim Berners-Lee; current standard HTML5
CSS (1996)	Cascading Style Sheets – look : colour, font, layout (Håkon Wium Lie)
JavaScript	Makes pages interactive ; client-side; server-side with Node.js
PHP	Server-side scripting; LAMP stack (Linux, Apache, MySQL, PHP); WordPress
XML (1998)	eXtensible Markup Language – stores & carries data ; user-defined tags
SQL	Structured Query Language – query & manage databases (SELECT, INSERT, UPDATE, DELETE)

Markup language	Programming language
Describes structure / presentation of content	Gives logic & instructions to perform tasks
Uses tags ; no variables, loops, logic	Has variables, conditions, loops, functions
HTML, XML, Markdown, LaTeX	C, Java, Python, JavaScript

- **Client-side** scripts run in the **browser** (JavaScript); **server-side** scripts run on the **web server** (PHP, Python, Java, Node.js).
- HTML is **not** a programming language – it is a **markup** language.

14.9 Latest Trends (2025–26)

Rank	TIOBE Index – Sept 2026
1	Python
2	C
3	C++
4	Java
5	C#
6	JavaScript
7	Visual Basic
8	SQL
9	R
10	Rust

TIOBE Index, Sept 2026. Python has been No. 1 since Oct 2021.

- **Python 3.15** released **9 Oct 2026** (yearly release every October; 3.14 came in Oct 2025).
- **Java 25** (Sept 2025) is the current **LTS** (long-term support) release; **JDK 27** released **Sept 2026** (new Java version every 6 months).
- **AI coding assistants** write, explain & debug code from plain-English prompts – e.g. **GitHub Copilot** (2021), **Claude Code** (Anthropic), **Cursor**, **Gemini Code Assist**, **OpenAI Codex**.
- **"Vibe coding"** – building software by describing it to an AI in natural language; term coined by **Andrej Karpathy** (Feb 2025); named **Collins Dictionary Word of the Year 2025**.
- **Low-code / No-code** platforms (Microsoft Power Apps, etc.) let non-programmers build apps with drag-and-drop.

14.10 Practice MCQs (Previous-Year Pattern)

Q1. Which language can be understood directly by the CPU without translation? (IBPS RRB GBO 2023)

- (a) C (b) Machine language (c) Java
(d) Assembly language (e) Python

Ans: (b) Machine language (binary 0/1) is the only language the CPU executes directly.

Q2. C++ language was developed by: (IBPS Clerk 2012)

- (a) Dennis Ritchie (b) Charles Babbage
(c) Niklaus Wirth (d) Bjarne Stroustrup
(e) John McCarthy

Ans: (d) Bjarne Stroustrup created C++ ("C with Classes") at Bell Labs.

Q3. _____ is a cross between human language and a programming language. (IBPS PO 2012)

- (a) Pseudocode (b) Java
(c) The Java virtual machine (d) The compiler
(e) None of these

Ans: (a) Pseudocode describes an algorithm in English-like statements without strict syntax.

Q4. In a flowchart, which symbol is used for a decision (Yes/No)?

- (a) Oval (b) Rectangle (c) Parallelogram
(d) Diamond (e) Circle

Ans: (d) Diamond = decision; oval = start/stop; parallelogram = I/O; rectangle = process.

Q5. The translator program used for assembly language is called a(n): (IBPS Clerk 2011)

- (a) compiler (b) assembler (c) interpreter
(d) linker (e) loader

Ans: (b) An assembler converts mnemonic assembly code into machine code.

Q6. A mistake in an algorithm that causes incorrect results is called a: (IBPS RRB Clerk 2012)

- (a) logical error (b) syntax error
(c) procedural error (d) compiler error
(e) machine error

Ans: (a) The program runs but gives wrong output – a logical error.

Q7. In OOP, wrapping data and the functions that work on it into a single unit (class) is called:

- (a) Inheritance (b) Polymorphism
(c) Encapsulation (d) Abstraction
(e) Compilation

Ans: (c) Encapsulation binds data and methods together and hides data from outside.

Q8. What is the full form of PHP? (IBPS RRB PO 2022)

- (a) PHP: Hypertext Preprocessor
(b) PHP: Hypertext Processor
(c) PHP: Hypertext Postprocessor

- (d) PHP: Hyper Preprocessor
- (e) Personal Hyper Processor

Ans: (a) PHP is a recursive acronym – PHP: Hypertext Preprocessor (originally Personal Home Page).

Q9. SQL is an example of which generation of programming language?

- (a) First (b) Second (c) Third (d) Fourth
- (e) Fifth

Ans: (d) SQL is a non-procedural 4GL; Prolog is a 5GL.

Q10. Which language was ranked No. 1 in the TIOBE Index in 2025–26?

- (a) Java (b) C (c) JavaScript (d) Python
- (e) C++

Ans: (d) Python has topped the TIOBE Index since October 2021 and still led in Sept 2026.

CHAPTER 15 LATEST TECHNOLOGIES: AI, CLOUD, IOT, BLOCKCHAIN & DIGITAL BANKING

15.1 Artificial Intelligence (AI) – Basics

- **AI** = ability of a machine to **think, learn and decide like a human** (reasoning, learning, perception, language).
- **John McCarthy** – "**Father of AI**"; coined the term at the **Dartmouth Conference, 1956**. He also created **LISP** (1958).
- **Alan Turing** – "Computing Machinery and Intelligence" (1950) → **Turing Test** (can a machine imitate a human in conversation?).
- Languages used for AI: **Python** (most popular), **LISP, Prolog, R, Java, Julia**.
- IBM's **Deep Blue** beat chess champion **Garry Kasparov** (1997); IBM **Watson** won the quiz show Jeopardy! (2011); Google DeepMind's **AlphaGo** beat Lee Sedol at Go (2016).

► AI ⊃ ML ⊃ Deep Learning ⊃ GenAI

Term	Meaning
Machine Learning (ML)	Sub-field of AI; system learns from data without being explicitly programmed (term by Arthur Samuel , 1959)
Supervised learning	Learns from labelled data (e.g. spam / not spam)
Unsupervised learning	Finds patterns in unlabelled data (clustering customers)
Reinforcement learning	Learns by reward & penalty (games, robots)
Deep Learning (DL)	ML using many-layered artificial neural networks (images, speech)
NLP	Natural Language Processing – computers understand human language (chatbots, translation)
Computer Vision	Machines "see" images/video – face recognition, OCR, cheque reading
Generative AI (GenAI)	Creates new text, images, audio, code, video
LLM	Large Language Model – huge neural network trained on text (GPT, Gemini, Claude, Llama)
Transformer	Neural-network design behind LLMs (Google paper "Attention Is All You Need", 2017)

Term	Meaning
Prompt / Token	Prompt = instruction to the AI; token = small chunk of text the model reads
Hallucination	AI confidently gives false / made-up information
RAG	Retrieval-Augmented Generation – LLM looks up trusted documents before answering
Agentic AI / AI agent	AI that plans and carries out multi-step tasks on its own using tools
Multimodal AI	Handles text + image + audio + video together
Deepfake	AI-made fake video/audio of a real person – big fraud risk

► Types of AI (by capability)

Type	Meaning / Example
Narrow / Weak AI (ANI)	Does one specific task . All AI today – Siri, Alexa, ChatGPT, Deep Blue, self-driving cars, fraud detection
General / Strong AI (AGI)	Human-level intelligence across all tasks – does not exist yet (research goal)
Super AI (ASI)	Smarter than humans – only theoretical

★ REMEMBER THIS

- **Father of AI = John McCarthy** (1956). Turing Test = **Alan Turing** (1950).
- Example of **Narrow AI** → **Siri** / any voice assistant. Deep Blue is also **narrow AI** (only chess).
- **ChatGPT = Chat Generative Pre-trained Transformer** – **OpenAI**, launched **30 Nov 2022**.
- **Hallucination** = AI makes up facts; **Deepfake** = AI-faked face/voice.

15.2 Popular AI Tools & Models (as of Oct 2026)

Tool / Model	Company	Key point
Siri (2011)	Apple	First mainstream voice assistant (iPhone 4S)
Alexa (2014)	Amazon	Echo smart speaker
Cortana (2014)	Microsoft	Retired; replaced by Copilot
Google Assistant (2016)	Google	Being replaced by Gemini
Bixby (2017)	Samsung	Galaxy phones
ChatGPT (Nov 2022)	OpenAI (CEO Sam Altman)	GPT-5 (Aug 2025) → GPT-6 generation (Sept 2026)
Gemini (Dec 2023)	Google DeepMind	Bard renamed Gemini (Feb 2024); Gemini 3 series (from Nov 2025)
Claude (2023)	Anthropic	Claude Opus 5.5 (Sept 2026); strong in coding & agents
Copilot (2023)	Microsoft	Bing Chat renamed Copilot; built into Windows & Microsoft 365
Llama (2023)	Meta	Open-weight model family (Llama 4, 2025)
Grok (2023)	xAI (Elon Musk)	Uses live data from X ; Grok 4 (July 2025)
DeepSeek (R1, Jan 2025)	DeepSeek (China)	Low-cost open model; V4 (Apr 2026)
Qwen	Alibaba (China)	Open-weight LLM family
Midjourney / DALL-E / Sora	Midjourney / OpenAI	Text-to-image (DALL-E) and text-to-video (Sora)

AI versions change every few months – remember the company–product pairs; check the latest version before the exam.

► India & AI

Initiative	Key facts
IndiaAI Mission	Approved by Cabinet March 2024 ; outlay ₹10,371.92 crore (≈₹10,372 cr) for 5 years; under MeitY

Initiative	Key facts
7 pillars	Compute, Innovation Centre (foundation models), AIKosh (datasets), Application Development, FutureSkills, Startup Financing, Safe & Trusted AI
GPU compute	Target 10,000 GPUs → 38,000+ GPUs onboarded at subsidised ~₹65/hour (2025)
AIKosh	National dataset & model platform – 3,000+ datasets, 240+ AI models (Oct 2025)
Sarvam AI	Bengaluru startup; first firm chosen (2025) to build India's sovereign LLM ; launched 30B & 105B models (Feb 2026)
BharatGen	Govt-funded consortium (IIT Bombay-led); Param2 – 17B-parameter, 22 Indian languages (Feb 2026)
Krutrim	Ola's AI venture (Bhavish Aggarwal) – India's first AI unicorn (2024)
BHASHINI	MeitY's AI translation platform for Indian languages (2022)
INDIAai portal	indiaai.gov.in – national AI portal (launched 30 May 2020 , MeitY + NASSCOM)
AIRAWAT	AI supercomputer at C-DAC Pune
India AI Impact Summit	16–21 Feb 2026 , Bharat Mandapam, New Delhi – first global AI summit in the Global South
AI Governance Guidelines	MeitY, Nov 2025 – 7 " Sutras "; no separate AI law; proposes AI Governance Group, TPEC, AI Safety Institute (AISi)
CAIR	Centre for AI & Robotics, DRDO , Bengaluru (1986)

- **7 Sutras:** Trust is the Foundation; People First; Innovation over Restraint; Fairness & Equity; Accountability; Understandable by Design; **Safety, Resilience & Sustainability.**
- AI CoEs under IndiaAI: **Healthcare, Agriculture, Sustainable Cities**; Budget 2025 added an AI CoE for **Education (₹500 crore)**.
- World: **EU AI Act** (in force Aug 2024) – world's **first comprehensive AI law**, risk-based; **EU General-Purpose AI Code of Practice** (July 2025).

► **AI in Banking**

Use	Example
Fraud detection	Spots unusual card/UPI transactions in real time; RBI's MuleHunter.AI finds mule accounts (RBIH, 2024)
Chatbots / virtual assistants	SBI SIA , HDFC EVA , ICICI iPal , Bank of Baroda ADI
Credit scoring	Uses alternative data to assess loans faster
KYC & document checks	OCR + face-match in Video KYC
RPA	Robotic Process Automation – software "bots" doing repetitive back-office work
AML / risk	Anti-money-laundering alerts, market-risk models

- RBI **FREE-AI** framework (Aug 2025) – Framework for **Responsible & Ethical Enablement of AI** in the financial sector.

✍ **MEMORY TRICK: Chatbot names of banks**

► "SIA Eats ADI's iPal" → **SIA** = SBI, **EVA** = HDFC, **ADI** = Bank of Baroda, **iPal** = ICICI.

15.3 Cloud Computing

- **Cloud computing** = on-demand delivery of computing services – **servers, storage, databases, networking, software** – over the **Internet**, on a **pay-as-you-go** basis.
- Idea of computing as a utility: **J.C.R. Licklider** (1960s, ARPANET "Intergalactic Network") and **John McCarthy** (1961). Term "cloud computing" popularised in **2006** (Google, Amazon EC2).
- Key features (NIST): **on-demand self-service**, broad network access, resource pooling, **rapid elasticity**, measured service.
- Uses **virtualisation** – one physical server runs many **virtual machines (VMs)**.

► **Service Models**

Model	What you get	Examples
IaaS – Infrastructure as a Service	Virtual servers, storage, network; most control for user	AWS EC2, Azure VMs, Google Compute Engine

Model	What you get	Examples
PaaS – Platform as a Service	Platform/tools to develop & deploy apps	Google App Engine, Heroku, Azure App Service
SaaS – Software as a Service	Ready-to-use software via browser; least control	Gmail, Microsoft 365, Google Workspace, Salesforce, Zoom

- Other "as a Service": **FaaS** (serverless – AWS Lambda), **DaaS** (Desktop), **STaaS** (Storage), **SECaaS** (Security), **AlaaS**. **HaaS** is **not** one of the three standard models.
- Pyramid (user control): **IaaS > PaaS > SaaS**; number of users: **SaaS** is the most widely used.

► **Deployment Models**

Model	Meaning
Public cloud	Shared by many customers; owned by provider (AWS, Azure, Google Cloud)
Private cloud	Used by one organisation only; more secure (banks)
Hybrid cloud	Mix of public + private
Community cloud	Shared by organisations with common needs (e.g. banks, govt depts)
Multi-cloud	Using services of more than one provider
Sovereign cloud	Data kept inside the country's borders under its laws (trend 2025–26)

► **Major Providers & Indian Initiatives**

- Top 3 providers: **AWS** (Amazon, largest), **Microsoft Azure**, **Google Cloud**; others – Oracle Cloud, IBM Cloud, Alibaba Cloud.
- Cloud storage: **Google Drive** (15 GB free), **OneDrive** (5 GB free; built into Windows), **iCloud** (Apple), **Dropbox**.
- **MeghRaj = GI Cloud** – Government of India cloud initiative of **MeitY** (2014); services empanelled by MeitY.
- Indian providers: **Jio Cloud**, **Yotta**, **CtrlS**, **Sify**; NIC runs **National Cloud** for govt.

► Edge, Fog & Related Computing

Term	Meaning
Edge computing	Data processed near the source (device/sensor) → low latency
Fog computing	Layer between edge and cloud (local gateways); term by Cisco
Grid computing	Many computers in different places work together on one big task
Serverless	Developer runs code; provider manages servers fully
Virtualisation	Software creates virtual versions of hardware; hypervisor manages VMs

15.4 IoT, Big Data & Other Emerging Technologies

► Internet of Things (IoT)

- **IoT** = network of physical objects ("things") with **sensors, software & connectivity** that collect and exchange data.
- Term coined by **Kevin Ashton** in **1999** (at Procter & Gamble / MIT Auto-ID Centre).
- Main parts: **sensors/actuators**, connectivity (**Wi-Fi, Bluetooth, Zigbee, LoRa, 5G, NB-IoT**), cloud/edge processing, user app.
- Examples: smart home (smart bulbs, Alexa), smartwatches, **smart meters**, connected cars, **FASTag**, smart agriculture, **IIoT** (Industrial IoT).
- IoT in banking: connected ATMs, wearables for payments, telematics-based insurance.

► Big Data & Data Science

- **Big Data** = data sets too large/complex for traditional tools. **5 V's: Volume, Velocity, Variety, Veracity, Value.**
- Tools: **Hadoop** (HDFS + MapReduce; Apache), **Spark**, NoSQL databases (MongoDB, Cassandra).
- **Data mining** = finding patterns in large data; **data warehouse** = central store of historical data for analysis.
- **Bioinformatics** = use of computers to collect and analyse **biological data** (DNA, proteins).

► AR / VR / Metaverse & More

Technology	Meaning / Example
VR – Virtual Reality	Fully immersive , computer-made world; headset (Meta Quest, Apple Vision Pro); main sense = vision

Technology	Meaning / Example
AR – Augmented Reality	Overlays digital info on the real world (Pokémon GO, Google Lens, Snapchat filters)
MR / XR	Mixed Reality (real + virtual interact); XR = Extended Reality (AR+VR+MR)
Metaverse	Shared 3-D virtual world; term from novel <i>Snow Crash</i> (Neal Stephenson, 1992)
Digital Twin	Live virtual copy of a physical object/system (factory, city, jet engine)
3-D Printing	Additive manufacturing – object built layer by layer
Drone / UAV	Unmanned Aerial Vehicle – delivery, mapping, SVAMITVA land survey
GIS	Geographical Information System – used for digital land records

► Robotics

- Word "**robot**" – from Czech "**robota**" (forced labour), play **R.U.R.** (1920) by **Karel Čapek**. "**Robotics**" – coined by **Isaac Asimov** (Three Laws of Robotics).
- **Father of Robotics** = **Joseph Engelberger**; first industrial robot **Unimate** (Devol & Engelberger) – used at **General Motors, 1961**.
- **Sensors** sense the surroundings; **actuators/motors** produce movement; **controller** = brain.
- Famous robots: **Sophia** (Hanson Robotics; **Saudi Arabian citizenship, Oct 2017**), **ASIMO** (Honda), **Roomba** (iRobot), **Optimus** (Tesla humanoid).
- Indian: **Vyommitra** (ISRO half-humanoid for **Gaganyaan**), **Daksh** (DRDO bomb disposal), **Manav** (India's first 3D-printed humanoid), **Brabo** (Tata industrial robot).

► 5G (basics)

- **5G** launched in India on **1 Oct 2022** (PM Modi, India Mobile Congress). Speeds up to ~10–20 Gbps, latency ~1 ms; supports massive IoT.
- 5G use-types: **eMBB** (fast broadband), **URLLC** (ultra-reliable low latency), **mMTC** (massive IoT). India is working on **6G (Bharat 6G Vision, 2023)**.

15.5 Quantum Computing

- Uses **qubits** (quantum bits) that can be **0 and 1 at the same time (superposition)** and linked through **entanglement** → solves some problems far faster.
- Risk: a large quantum computer could break today's **RSA** encryption → move to **post-quantum cryptography** (NIST standards, Aug 2024).
- **Quantum supremacy / advantage** – Google **Sycamore** (53 qubits, 2019).

Milestone	Key point
Google Willow (Dec 2024)	105-qubit chip; big step in quantum error correction
Microsoft Majorana 1 (Feb 2025)	First chip using topological qubits
National Quantum Mission (NQM)	Approved April 2023 ; ₹6,003.65 crore , 2023-24 to 2030-31; under DST ; target 50–1,000 qubit computers in 8 years
QpiAI-Indus (Apr 2025)	25-qubit – India's first full-stack quantum computer (QpiAI, Bengaluru, under NQM)
Amaravati Quantum Valley	Andhra Pradesh hub; IBM Quantum System Two (156-qubit Heron) with TCS – being commissioned 2026

15.6 Blockchain, Cryptocurrency & CBDC

► Blockchain

- **Blockchain** = a **decentralised, distributed digital ledger** on a **peer-to-peer network**; records are grouped in **blocks** linked by **cryptographic hashes** → **immutable** (cannot be changed later).
- Type of **DLT (Distributed Ledger Technology)**. Every node keeps a copy; new blocks added by **consensus** (Proof of Work – Bitcoin; Proof of Stake – Ethereum since 2022).
- **Smart contract** – self-executing code on a blockchain (popularised by **Ethereum**, Vitalik Buterin, 2015).
- Uses: cryptocurrency, trade finance, supply chain, land records, voting, KYC sharing, cross-border payments.

- Types: **Public** (Bitcoin, Ethereum), **Private/permissioned** (Hyperledger Fabric), **Consortium** (group of banks).
 - **NFT** = Non-Fungible Token – unique digital asset recorded on a blockchain.
- **Cryptocurrency**
- Digital currency secured by **cryptography**, usually **decentralised** (no central bank). Thousands exist (over 10,000).
 - **Bitcoin (BTC)** – by **Satoshi Nakamoto** (pseudonym); white paper **2008**, launched **3 Jan 2009**; max supply **21 million**; smallest unit **Satoshi** (10^{-8} BTC). Uses **blockchain** + Proof of Work ("mining").
 - Others: **Ethereum (Ether)**, Ripple (XRP), Solana, Dogecoin, Litecoin; **stablecoins** (USDT, USDC) pegged to a currency.
 - In India crypto is **not legal tender**; gains taxed at **30% + 1% TDS** (from 2022). Exchanges must register with **FIU-IND**.

► CBDC – Digital Rupee (₹)

Point	Fact
What	Central Bank Digital Currency – digital form of legal tender issued by RBI ; liability of RBI
Legal basis	Union Budget 2022-23; RBI Act amended (2022)
₹-W (Wholesale)	Pilot 1 Nov 2022 – settlement of govt securities by banks
₹-R (Retail)	Pilot 1 Dec 2022 – Mumbai, New Delhi, Bengaluru, Bhubaneswar; token-based wallet
Features added	Interoperable with UPI QR (2023); offline & programmable ₹ (2024)
Circulation	About ₹1,016 crore (March 2025, RBI Annual Report)

★ REMEMBER THIS

- Blockchain = **distributed ledger on a peer-to-peer network** (IBPS RRB 2023). Technology behind Bitcoin = **Blockchain**.
- Smallest unit of Bitcoin = **Satoshi**. Bitcoin creator = **Satoshi Nakamoto**.
- ₹ pilots: **Wholesale – 1 Nov 2022, Retail – 1 Dec 2022**. CBDC is **legal tender**; crypto is **not**.
- IoT term coined by **Kevin Ashton (1999)**.

15.7 Digital Payment Systems in India

NPCI (National Payments Corporation of India) – umbrella body for retail payments, set up **2008** by RBI & IBA under the **Payment and Settlement Systems Act, 2007**; HQ **Mumbai**. It runs UPI, IMPS, RuPay, NACH, AePS, NETC (FASTag), Bharat Connect (via NBBL) and CTS.

► Fund Transfer Systems

System	Run by	Key facts
NEFT – National Electronic Funds Transfer	RBI	Launched Nov 2005 ; half-hourly batches ; 24×7×365 since 16 Dec 2019 ; no minimum/maximum (RBI)
RTGS – Real Time Gross Settlement	RBI	Started 2004 ; min ₹2 lakh , no max; one-by-one real-time; 24×7 since 14 Dec 2020
IMPS – Immediate Payment Service	NPCI	2010 ; instant 24×7; via mobile/MMID/account; limit ₹5 lakh
UPI – Unified Payments Interface	NPCI	11 Apr 2016 (pilot), live Aug 2016; VPA/UPI ID + UPI PIN (4 or 6 digits)
NACH – National Automated Clearing House	NPCI	Bulk/repetitive payments – salary, pension, subsidies (DBT), EMI e-mandates ; replaced ECS
CTS – Cheque Truncation System	NPCI/RBI	Cheque image sent instead of physical cheque; started 2008 (Delhi); now pan-India
AePS – Aadhaar enabled Payment System	NPCI	Cash withdrawal, deposit, balance via Aadhaar + fingerprint at Micro-ATM / BC
Bharat Connect (old BBPS)	NBBL (NPCI subsidiary)	Bill payments (power, gas, DTH, FASTag, loan EMI); BBPS renamed Bharat Connect (Aug 2024)
NETC FASTag	NPCI + NHAI (IHMCL)	RFID tag for toll payment; mandatory from 15 Feb 2021

System	Run by	Key facts
RuPay	NPCI	India's own card network (2012); RuPay credit card on UPI (2022)
BHIM	NPCI	Bharat Interface for Money – UPI app launched 30 Dec 2016

📌 MEMORY TRICK: NEFT vs RTGS vs IMPS

- "NEFT = Next batch, RTGS = Right now & Rich (₹2 lakh+), IMPS = Instant on Mobile".
- RBI runs **N & R** (NEFT, RTGS); NPCI runs **I & U** (IMPS, UPI).

► UPI – Features & Latest

Feature (year)	What it does
UPI 2.0 (Aug 2018)	Overdraft account link, one-time mandate, invoice in inbox, signed intent/QR
UPI AutoPay (2020)	Recurring e-mandates (subscriptions, EMIs)
UPI 123PAY (Mar 2022)	UPI for feature phones (IVR, missed call, app, sound); limit ₹10,000
UPI Lite (Sept 2022)	On-device wallet , no PIN for small payments – ₹1,000 per txn , ₹5,000 wallet (Dec 2024)
UPI Lite X (2023)	Offline payments using NFC
RuPay credit card on UPI (2022)	Pay merchants via UPI from a credit card
Credit Line on UPI (Sept 2023)	Pre-sanctioned bank credit line linked to UPI
Hello! UPI / conversational (2023)	Voice-based UPI payments in Indian languages
UPI Circle (Aug 2024)	Primary user lets up to 5 secondary users pay; full delegation ≤ ₹15,000/month , ₹5,000/txn
Biometric UPI (Oct 2025)	Approve payments with phone fingerprint/face instead of PIN; Aadhaar face authentication to set UPI PIN
UPI on smart glasses (Oct 2025)	UPI Lite payments by voice on wearable glasses

- **Limits:** P2P ₹1 lakh/txn. From **15 Sept 2025**, ₹5 lakh/txn (₹10 lakh/day) for capital markets, insurance, travel, GeM, loan EMIs; tax, hospital & education payments also ₹5 lakh.
- **Record: 2,451 crore (24.51 billion)** transactions worth ₹29.82 lakh crore in **Aug 2026** (all-time high). **Sept 2026:** 24.07 billion, ₹29.37 lakh crore; daily average crossed **80 crore (800 million)** for the first time.
- FY 2025-26: **24,162 crore** transactions. **741 banks** live on UPI (July 2026). UPI ≈ **49% of world real-time payments** (IMF, 2024).
- Top UPI apps: **PhonePe** (~48%), **Google Pay** (~35–37%), **Paytm**.
- UPI abroad (11 countries, Aug 2026): **Bhutan (first)**, Nepal, Singapore (PayNow link), UAE, France, Sri Lanka, Mauritius, Qatar, Cambodia, Greece, Maldives. Run by **NIPL** (NPCI International).

UPI volumes are released by NPCI on the 1st of every month – update the record before your exam.

15.8 Digital Public Infrastructure (India Stack) & Digital Banking

Platform	Key facts
Aadhaar	12-digit ID by UIDAI (2009); first issued 29 Sept 2010 ; biometric + demographic
e-KYC	Paperless KYC using Aadhaar OTP/biometric
V-CIP / Video KYC	Video-based Customer Identification Process – allowed by RBI in Jan 2020
CKYC	Central KYC Records Registry – run by CERSAI ; 14-digit KYC number
DigiLocker	MeitY cloud locker for digital documents; launched 1 July 2015 ; documents valid as originals (IT Rules 2016)
Account Aggregator (AA)	RBI-regulated NBFC-AA (framework 2016; live Sept 2021); shares financial data with consent (DEPA)
ONDC	Open Network for Digital Commerce – DPIIT, incorporated Dec 2021; open e-commerce network
OCEN	Open Credit Enablement Network (iSPIRT, 2020) – common language for lenders & platforms

Platform	Key facts
ULI	Unified Lending Interface – by RBI Innovation Hub (RBIH) ; pilot Aug 2023, named ULI Aug 2024 – "UPI for credit"
UMANG	Single app for many govt services (2017)
GeM	Government e-Marketplace (2016) – public procurement
JAM Trinity	Jan Dhan – Aadhaar – Mobile → Direct Benefit Transfer (DBT)

► Payments Banks & Digital Banking Rules

- **Payments banks** – idea of **Nachiket Mor Committee**; RBI licences 2015. Can accept deposits **up to ₹2 lakh per customer**, issue debit cards; **cannot lend** or issue credit cards. e.g. **Airtel** (first, 2017), India Post (IPPB), Fino, Paytm (barred by RBI from new deposits, 2024), Jio.
- **Digital Banking Units (DBUs)** – 75 DBUs in 75 districts launched **Oct 2022**.
- **RBI (Digital Lending) Directions, 2025** (8 May 2025): loan must be disbursed/repaid **directly between borrower & bank/NBFC**; **Key Fact Statement (KFS)** with **APR** compulsory; **cooling-off period**; lending apps (DLAs) reported to RBI – public **DLA directory** on RBI website.
- **Positive Pay System** (Jan 2021) – for cheques of **₹50,000 and above** the drawer re-confirms key details to the bank; banks may make it mandatory for **₹5 lakh+**.
- **Tokenisation** of card data (Oct 2022) – merchants cannot store card numbers.
- **Sachet portal** (RBI) – complaints against illegal deposit schemes; **cybercrime helpline 1930** (I4C).

★ REMEMBER THIS

- **NPCI – 2008, Mumbai**; runs UPI, IMPS, RuPay, NACH, AePS, FASTag, Bharat Connect.
- **NEFT & RTGS** are run by **RBI**; RTGS minimum = **₹2 lakh**.
- **UPI** launched **11 April 2016**; **BHIM** app – **30 Dec 2016**; **UPI 123PAY** – feature phones.

- **BBPS → Bharat Connect (2024).** ULI = RBIH's lending platform. **ONDC** = DPIIT.
- Payments bank deposit limit = ₹2 lakh; cannot give loans.

15.9 E-Governance & E-Commerce (Quick Facts)

- **NeGP** – National e-Governance Plan approved **2006**; **Digital India** launched **1 July 2015**.
- Types: **G2C** (e-District, DigiLocker), **G2B** (GST portal, MCA21), **G2G** (e-Office), **G2E** (employee services).
- State projects: **Bhoomi** (Karnataka land records), **e-Seva** (Andhra Pradesh/Telangana), **Saral** (Haryana).
- E-commerce models: **B2C** (Amazon, Flipkart), **B2B** (IndiaMART, Alibaba), **C2C** (OLX, Quikr, eBay), **C2B** (Shutterstock, freelancing), **B2G/G2B** (GeM).
- **QR code** – 2-D matrix barcode invented by **Denso Wave** (Toyota group, Japan) in **1994**; QR = **Quick Response**.
- **BharatNet** – optical-fibre broadband to all **gram panchayats**.

15.10 Practice MCQs (Previous-Year Pattern)

Q1. Which technology is used in Bitcoin? (IBPS RRB PO 2022)

- (a) Artificial Intelligence (b) Big Data
(c) Machine Learning (d) Blockchain
(e) Virtual Reality

Ans: (d) Bitcoin transactions are recorded on a public blockchain (distributed ledger).

Q2. Which involves overlaying visual, auditory or other sensory information onto the real world to enhance one's experience? (RBI Asst 2022)

- (a) VR (b) AR (c) PR (d) FC (e) PC

Ans: (b) Augmented Reality adds digital content on top of the real world; VR is fully virtual.

Q3. Which of the following is NOT a standard cloud service model?

- (a) IaaS (b) PaaS (c) SaaS (d) HaaS
(e) None of these

Ans: (d) The three standard (NIST) models are IaaS, PaaS and SaaS.

Q4. Gmail and Microsoft 365 used through a web browser are examples of:

- (a) IaaS (b) PaaS (c) SaaS (d) Private cloud
(e) Edge computing

Ans: (c) Ready-to-use software delivered over the Internet is Software as a Service.

Q5. The term "Internet of Things" was coined by:

- (a) Tim Berners-Lee (b) Kevin Ashton
(c) John McCarthy (d) Vint Cerf
(e) Satoshi Nakamoto

Ans: (b) Kevin Ashton used the term in 1999.

Q6. Who is known as the Father of Artificial Intelligence?

- (a) Alan Turing (b) Charles Babbage
(c) John McCarthy (d) Marvin Minsky
(e) Geoffrey Hinton

Ans: (c) John McCarthy coined the term "Artificial Intelligence" in 1956.

Q7. Which payment system has a minimum transaction amount of ₹2 lakh?

- (a) NEFT (b) IMPS (c) UPI (d) RTGS (e) NACH

Ans: (d) RTGS is meant for high-value transfers; minimum ₹2 lakh, no upper limit.

Q8. UPI 123PAY is designed mainly for:

- (a) Credit card users (b) Feature phone users
(c) Foreign tourists
(d) Corporate bulk payments
(e) Offline NFC wallets

Ans: (b) UPI 123PAY (2022) lets feature-phone users pay through IVR, missed call, app or sound-based methods.

Q9. India's retail Digital Rupee (₹-R) pilot was launched by RBI on:

- (a) 1 November 2022 (b) 1 December 2022
(c) 1 April 2023 (d) 15 August 2022
(e) 1 January 2023

Ans: (b) Wholesale ₹-W started on 1 Nov 2022; retail ₹-R on 1 Dec 2022.

Q10. The IndiaAI dataset platform launched under the IndiaAI Mission is called:

- (a) BHASHINI (b) AIKosh (c) AIRAWAT
(d) MeghRaj (e) DigiLocker

Ans: (b) AIKosh hosts datasets and AI models for Indian developers; MeghRaj is the GI Cloud.

CHAPTER 16 KEYBOARD SHORTCUTS

16.1 Keyboard Basics for Shortcuts

- A **shortcut key** (hot key) = a key or **combination of keys** that performs a command quickly without the mouse.
- **Modifier keys: Ctrl, Shift, Alt (and Win, Fn)** – they do nothing alone; they change the action of another key.
- **Toggle keys: Caps Lock, Num Lock, Scroll Lock** – press once ON, again OFF.
- **Access keys / KeyTips:** press **Alt** in Office to show letters on the Ribbon (Alt+H = Home tab, Alt+N = Insert tab).
- Notation "Ctrl+C" = hold **Ctrl**, press **C**. "Alt, H, B" = press keys **one after another**.
- On laptops function keys may need **Fn** (e.g. Fn+F5) – controlled by **Fn Lock**.
- Shortcuts below are for **Windows 11** and **Microsoft 365 / Office 2024** (most also work in Office 2016–2021).

16.2 Function Keys F1–F12

Key	General / Windows	MS Office use
F1	Help	Help in all Office apps
F2	Rename selected file/folder	Excel: edit active cell ; Word: move text
F3	Search (File Explorer); browser Find	Excel: Paste Name; Word: insert AutoText
F4	Explorer: address bar; Alt+F4 closes window	Repeat last action (Word/Excel/PPT); Excel: \$ absolute reference toggle
F5	Refresh / Reload	PowerPoint: start slide show ; Word/Excel: Go To
F6	Cycle through screen elements; browser address bar	Move between panes / Ribbon
F7	Caret browsing (Chrome/Edge)	Spelling & Grammar check
F8	Old Windows: Safe Mode menu at boot	Word: Extend selection ; Excel: Extend mode
F9	—	Excel: calculate all sheets; Word: update field

Key	General / Windows	MS Office use
F10	Activate menu bar	Show KeyTips (same as Alt)
F11	Full screen (browser)	Excel: chart on new chart sheet
F12	Browser Developer Tools	Save As (Word, Excel, PowerPoint)

✎ MEMORY TRICK: Function-key memory hooks

- **F1 = "First aid" (Help)**, **F2 = "Two names" (Rename/Edit)**, **F5 = "Fresh" (Refresh / Show)**, **F7 = "Spell-7"**, **F12 = "Save As"**.
- **Shift+F7 = Thesaurus**, **Shift+F3 = Change Case**, **Shift+F5 = show from current slide**, **Shift+F11 = new sheet**.

16.3 General Editing Shortcuts (Most Programs)

Shortcut	Action
Ctrl+A	Select all
Ctrl+C	Copy (to Clipboard)
Ctrl+X	Cut
Ctrl+V	Paste (also Shift+Insert)
Ctrl+Z	Undo
Ctrl+Y	Redo / repeat
Ctrl+S	Save
Ctrl+N	New document / window
Ctrl+O	Open
Ctrl+P	Print
Ctrl+W / Ctrl+F4	Close current document / tab
Ctrl+F	Find
Ctrl+H	Replace (Office); History (browser)
Ctrl+B / I / U	Bold / Italic / Underline
Ctrl+K	Insert hyperlink
Ctrl+Home / Ctrl+End	Go to start / end of document
Home / End	Start / end of line
Ctrl+Backspace / Ctrl+Delete	Delete one word left / right

Shortcut	Action
Shift+Arrow	Extend selection one character / line
Ctrl+Shift+Arrow	Select word by word
Alt+F4	Close the program / window
Esc	Cancel / close dialog

★ REMEMBER THIS

- ▶ **Ctrl+Z = Undo, Ctrl+Y = Redo** (RBI Asst 2022).
- ▶ Clipboard is also called **Pasteboard**; **Win+V** opens Clipboard **history**.
- ▶ **Ctrl+Enter = page break** in Word (IBPS RRB PO 2023).
- ▶ **Shift+Delete** = delete **permanently** (skips Recycle Bin).

16.4 Windows 11 Shortcuts

▶ Windows Logo Key (Win) Shortcuts

Shortcut	Action
Win	Open / close Start menu (also Ctrl+Esc)
Win+D	Show / hide desktop
Win+M	Minimise all windows
Win+Shift+M	Restore minimised windows
Win+E	Open File Explorer
Win+L	Lock the computer
Win+R	Open Run dialog box
Win+I	Open Settings
Win+S	Open Search
Win+A	Open Quick Settings / action centre
Win+N	Notification centre & calendar
Win+V	Clipboard history
Win+Shift+S	Snipping Tool – capture part of screen
Win+PrtScn	Full-screen screenshot saved to Pictures > Screenshots
Win+. (period) or Win+;	Emoji panel
Win+Tab	Task View (all windows & desktops)
Win+Ctrl+D	New virtual desktop

Shortcut	Action
Win+Ctrl+Left / Right	Switch virtual desktops
Win+Ctrl+F4	Close current virtual desktop
Win+Left / Right	Snap window to left / right half
Win+Up / Down	Maximise / minimise active window
Win+Home	Minimise all except active window
Win+, (comma)	Peek at desktop
Win+1...9	Open app pinned at that taskbar position
Win+X	Quick Link (power-user) menu
Win+P	Project – choose display mode
Win+K	Cast to wireless display
Win+H	Voice typing (dictation)
Win+G	Xbox Game Bar
Win+U	Settings > Accessibility
Win+Pause	Settings > System > About
Win+Plus / Win+Minus	Magnifier zoom in / out
Win+F	Feedback Hub (not file search any more)

▶ Other Windows & File Explorer Shortcuts

Shortcut	Action
Alt+Tab	Switch between open apps/windows
Alt+Esc	Cycle windows in the order they were opened
Alt+F4	Close active window; on desktop → Shut Down dialog
Ctrl+Shift+Esc	Open Task Manager directly
Ctrl+Alt+Delete	Security screen – Lock, Switch user, Sign out, Task Manager
Alt+Spacebar	Window (title-bar) menu – Restore, Move, Size
Alt+Enter	Properties of selected item
Shift+F10	Context (right-click) menu
F2	Rename selected item
F3	Search for a file or folder
F5	Refresh window
F11	Maximise / restore Explorer window
Ctrl+Shift+N	Create new folder
Ctrl+D / Delete	Move item to Recycle Bin

Shortcut	Action
Shift+Delete	Delete permanently
Alt+Left / Alt+Right	Back / Forward
Alt+Up	Go up one folder level
Ctrl+E / Ctrl+F	Go to Explorer search box
Alt+D / Ctrl+L	Go to address bar
Ctrl+Shift+drag	Create shortcut of item
PrtScn	Capture screen (opens Snipping Tool in Win 11)
Num Lock held 5 s	Turn Toggle Keys sound on/off
Shift pressed 5 times	Sticky Keys

✎ MEMORY TRICK: Win-key letters

- Desktop, Explorer, Lock, Minimise, Run, I = settings (Install/configure), V = clipboard (paste = V), Search, Project, K = cast (Konnect), H = Hear (dictation), X = eXpert menu.

16.5 MS Word Shortcuts

► Formatting

Shortcut	Action
Ctrl+B / Ctrl+I / Ctrl+U	Bold / Italic / Underline
Ctrl+Shift+D	Double underline
Ctrl+Shift+W	Underline words only
Ctrl+=	Subscript (H ₂ O)
Ctrl+Shift+= (Ctrl+Shift+Plus)	Superscript (x ²)
Ctrl+D	Open Font dialog box
Ctrl+Shift+> / Ctrl+Shift+<	Increase / decrease font size
Ctrl+] / Ctrl+[	Increase / decrease font size by 1 point
Shift+F3	Change case (UPPER, lower, Title)
Ctrl+Shift+A	All CAPITALS
Ctrl+Shift+K	Small caps
Ctrl+Spacebar	Remove character formatting
Ctrl+Q	Remove paragraph formatting
Ctrl+E / L / R / J	Centre / Left / Right / Justify
Ctrl+1 / Ctrl+2 / Ctrl+5	Single / Double / 1.5 line spacing

Shortcut	Action
Ctrl+0 (zero)	Add/remove 12 pt space before paragraph
Ctrl+M / Ctrl+Shift+M	Indent / remove indent
Ctrl+T / Ctrl+Shift+T	Hanging indent / reduce it
Ctrl+Shift+L	Apply bulleted list
Ctrl+Shift+N	Apply Normal style
Ctrl+Alt+1 / 2 / 3	Heading 1 / 2 / 3
Ctrl+Alt+C / Ctrl+Alt+V	Copy / paste formatting (Microsoft 365, 2024+)
Ctrl+Shift+V	Paste text only (Microsoft 365, 2024+)

Older Word (2021 and earlier): Ctrl+Shift+C / Ctrl+Shift+V = copy/paste formatting and Alt+Ctrl+C = @ symbol. In Microsoft 365 / Office 2024 these keys were reassigned; type (c) to get @.

► Editing, Insert & Navigation

Shortcut	Action
Ctrl+Enter	Page break
Shift+Enter	Line break (new line, same paragraph)
Ctrl+Shift+Enter	Column break
Ctrl+Shift+Spacebar	Non-breaking space
Alt+Shift+D / Alt+Shift+T	Insert current date / time
Alt+Ctrl+R / Alt+Ctrl+T	® registered / ™ trademark symbol
Alt+Ctrl+M	Insert comment
Ctrl+Shift+E	Track Changes on/off
Ctrl+F9	Insert empty field
F4	Repeat last action
F5 / Ctrl+G	Go To (page, bookmark)
Ctrl+F	Navigation pane search
Ctrl+H	Find & Replace
F7	Spelling & Grammar
Shift+F7	Thesaurus
Ctrl+Shift+G	Word Count dialog
F8	Extend selection (press 2× word, 3× sentence, 4× paragraph, 5× document)
Ctrl+F2	Print Preview
F12	Save As
Ctrl+F1	Show / hide the Ribbon

Shortcut	Action
Ctrl+Alt+P / O / N	Print Layout / Outline / Draft view
Ctrl+Alt+S	Split document window
Ctrl+F3 / Ctrl+Shift+F3	Cut to Spike / paste Spike contents
Alt+F9	Show all field codes / results
Alt+Q	"Tell me" / Search box

✎ MEMORY TRICK: Word alignment & spacing

- "E-L-R-J" = cEntre, Left, Right, Justify. (C is taken by Copy, so Centre = E.)
- Line spacing 1, 2, 5 → Ctrl+1 = single, Ctrl+2 = double, Ctrl+5 = 1.5.

16.6 MS Excel Shortcuts

► Data Entry & Editing

Shortcut	Action
Ctrl+; (semicolon)	Insert current date
Ctrl+Shift+; (= Ctrl+Shift+:)	Insert current time
F2	Edit the active cell
F4	Toggle absolute/relative reference (\$A\$1 → A\$1 → \$A1 → A1); else repeat
Alt+=	AutoSum
Alt+Enter	New line within a cell
Ctrl+Enter	Fill selected cells with same entry
Ctrl+D / Ctrl+R	Fill down / fill right
Ctrl+E	Flash Fill
Ctrl+' (apostrophe)	Copy formula from cell above
Ctrl+` (grave accent)	Show formulas / values
Shift+F3	Insert Function dialog
F9 / Shift+F9	Calculate all workbooks / active sheet
Ctrl+Alt+V	Paste Special
Ctrl+K	Insert hyperlink
Shift+F2	Add/edit cell note/comment
F7	Spelling
Ctrl+T (or Ctrl+L)	Create Table

Shortcut	Action
Ctrl+Shift+L	Filter on/off

► Navigation, Selection & Sheets

Shortcut	Action
Ctrl+Arrow key	Jump to edge of data region
Ctrl+Home	Go to cell A1
Ctrl+End	Go to last used cell
Ctrl+Page Down / Page Up	Next / previous sheet
Alt+Page Down / Page Up	One screen right / left
Ctrl+Spacebar	Select entire column
Shift+Spacebar	Select entire row
Ctrl+A (or Ctrl+Shift+Spacebar)	Select current region / whole sheet
F5 / Ctrl+G	Go To dialog
Shift+F11 (or Alt+Shift+F1)	Insert new worksheet
Ctrl+N	New workbook
Ctrl+Tab / Ctrl+F6	Switch between open workbooks
Ctrl+F4	Close workbook window
Alt+F4	Close Excel
F12	Save As
Ctrl+F2	Print Preview

► Formatting, Rows/Columns & Charts

Shortcut	Action
Ctrl+1	Format Cells dialog
Ctrl+2 / 3 / 4	Bold / Italic / Underline (same as B / I / U)
Ctrl+5	Strikethrough
Ctrl+Shift+\$	Currency format
Ctrl+Shift+%	Percentage format
Ctrl+Shift+&	Apply outline border
Ctrl+Shift+_	Remove outline border
Ctrl+9 / Ctrl+0	Hide rows / hide columns
Ctrl+Shift+9	Unhide rows
Ctrl+Shift+Plus (+)	Insert cells/rows/columns
Ctrl+Minus (-)	Delete cells/rows/columns
F11	Chart on a separate chart sheet

Shortcut	Action
Alt+F1	Embedded chart on same sheet
Ctrl+Shift+U	Expand / collapse formula bar
Alt+F8 / Alt+F11	Macro dialog / VBA editor

★ REMEMBER THIS

- Excel: **Ctrl+;** = date, **Ctrl+Shift+;** = time; functions **TODAY()** and **NOW()**.
- **F4** in a formula = **absolute reference (\$)**; **F2** = edit cell; **F12** = Save As (RBI Asst 2022).
- **Ctrl+9** hides rows, **Ctrl+0** hides columns (IBPS Clerk 2012).
- **F11** = chart on new chart sheet (default **clustered column**); **Shift+F11** = new worksheet.
- **Ctrl+F6** = switch to next workbook window (IBPS RRB PO 2023).

► During a Slide Show

Key	Action
N, Enter, Space, →, ↓, Page Down	Next slide / animation
P, Backspace, ←, ↑, Page Up	Previous slide
Number + Enter	Go to that slide (1+Enter = first slide)
Home / End	First / last slide
B or . (period)	Black screen
W or , (comma)	White screen
Ctrl+P / Ctrl+A	Pointer to pen / back to arrow
Ctrl+L	Laser pointer
E	Erase ink drawings
Ctrl+H	Hide pointer
Ctrl+S	All Slides dialog
Esc (or Ctrl+Break, Hyphen)	End the slide show
F1	List of slide-show controls

16.7 MS PowerPoint Shortcuts

Shortcut	Action
Ctrl+N	New presentation
Ctrl+M	Insert new slide
Ctrl+D	Duplicate selected slide / object
F5	Start slide show from beginning
Shift+F5	Start show from current slide
Alt+F5	Start in Presenter View
Ctrl+G / Ctrl+Shift+G	Group / ungroup objects
Ctrl+K	Insert hyperlink
Ctrl+E / L / R / J	Centre / left / right / justify
Ctrl+Shift+> / <	Increase / decrease font size
Shift+F3	Change case
F7	Spelling
F4	Repeat last action
Shift+F4	Repeat last Find
Ctrl+Shift+C / V	Copy / paste formatting
Ctrl+Alt+V	Paste Special
Ctrl+Shift+F (or Ctrl+T)	Font dialog

✎ MEMORY TRICK: PowerPoint must-knows

- **M** = More slides (Ctrl+M), **N** = New presentation (Ctrl+N), **D** = Duplicate (Ctrl+D).
- **F5** = from first slide, **Shift+F5** = from current slide; **B** = Black, **W** = White.

16.8 Web Browser Shortcuts (Chrome / Edge / Firefox)

Shortcut	Action
Ctrl+T	New tab
Ctrl+Shift+T	Reopen last closed tab
Ctrl+W / Ctrl+F4	Close current tab
Ctrl+Shift+W	Close window
Ctrl+N	New window
Ctrl+Shift+N	Incognito window (Chrome; InPrivate in Edge)
Ctrl+Shift+P	Private window (Firefox); InPrivate in Edge = Ctrl+Shift+N
Ctrl+Tab / Ctrl+Shift+Tab	Next / previous tab
Ctrl+1...8 / Ctrl+9	Go to tab 1-8 / last tab

Shortcut	Action
Ctrl+H	History
Ctrl+J	Downloads
Ctrl+D	Bookmark current page
Ctrl+Shift+B	Show / hide bookmarks bar
Ctrl+Shift+Delete	Clear browsing data
F5 / Ctrl+R	Reload page
Ctrl+F5 / Shift+F5 / Ctrl+Shift+R	Hard reload (ignore cache)
Esc	Stop loading
Ctrl+L / Alt+D / F6	Go to address bar
Ctrl+K / Ctrl+E	Search from address bar
Alt+Left / Alt+Right	Back / Forward
Alt+Home	Home page
Ctrl+F / F3	Find on page
Ctrl+Plus / Minus / 0	Zoom in / out / reset
Ctrl+U	View page source
F11	Full screen
F12 / Ctrl+Shift+I	Developer Tools
Shift+Esc	Chrome Task Manager

★ REMEMBER THIS

- Browser **Ctrl+T** = new tab, **Ctrl+W** = close tab, **Ctrl+Shift+T** = reopen closed tab.
- **Ctrl+H** = History, **Ctrl+J** = Downloads, **Ctrl+D** = Bookmark.
- **Ctrl+Shift+N** = Incognito (Chrome) / InPrivate (Edge); **Ctrl+Shift+P** = Private window (Firefox).
- **F11** = full-screen mode in most browsers.

16.9 Practice MCQs (Previous-Year Pattern)

Q1. Which function key is used to save the active workbook under a new name using the Save As dialog box? (RBI Asst 2022)

- (a) F10 (b) F12 (c) F9 (d) F3 (e) F5

Ans: (b) F12 opens Save As in Word, Excel and PowerPoint.

Q2. What is the shortcut key of Redo? (RBI Asst 2022)

- (a) Ctrl+L (b) Ctrl+P (c) Ctrl+R (d) Ctrl+Z
(e) Ctrl+Y

Ans: (e) Ctrl+Y redoes (or repeats) the last action; Ctrl+Z undoes it.

Q3. Which shortcut key is used to switch between open apps in Windows? (IBPS RRB PO 2022)

- (a) Ctrl+Shift (b) Alt+Ctrl (c) Ctrl+Tab
(d) Alt+Tab (e) Ctrl+S

Ans: (d) Alt+Tab switches between open windows; Ctrl+Tab switches tabs inside a program.

Q4. In MS Word, the shortcut key to insert a page break is: (IBPS RRB PO 2023)

- (a) Shift+Enter (b) Ctrl+Enter (c) Alt+Enter
(d) Ctrl+Shift+Enter (e) Ctrl+B

Ans: (b) Ctrl+Enter = page break; Shift+Enter = line break; Ctrl+Shift+Enter = column break.

Q5. In MS Excel, which shortcut inserts the current date in a cell?

- (a) Ctrl+Shift+; (b) Ctrl+; (c) Alt+Shift+D
(d) Ctrl+D (e) Ctrl+T

Ans: (b) Ctrl+; enters today's date; Ctrl+Shift+; enters the current time.

Q6. Pressing Ctrl+9 in MS Excel: (IBPS Clerk 2012)

- (a) Prints 9 (b) Prints the sheet
(c) Inserts 9 cells (d) Hides the selected rows
(e) Hides the selected columns

Ans: (d) Ctrl+9 hides rows; Ctrl+0 hides columns.

Q7. Which shortcut starts a PowerPoint slide show from the current slide? (IBPS RRB PO 2023)

- (a) F5 (b) Shift+F5 (c) Alt+F5 (d) Ctrl+F5
(e) Ctrl+M

Ans: (b) F5 starts from the first slide; Shift+F5 from the current slide; Alt+F5 opens Presenter View.

Q8. Which Windows shortcut opens the Clipboard history?

- (a) Ctrl+V (b) Win+C (c) Win+V
(d) Ctrl+Shift+V (e) Win+Shift+S

Ans: (c) Win+V shows the clipboard history; Win+Shift+S opens the screen snip tool.

Q9. In MS Word, Shift+F7 opens:

- (a) Spelling & Grammar (b) Thesaurus
(c) Word Count (d) Font dialog
(e) Change Case

Ans: (b) F7 = Spelling & Grammar; Shift+F7 = Thesaurus; Shift+F3 = Change Case.

Q10. Which shortcut reopens the last closed tab in Google Chrome?

- (a) Ctrl+T (b) Ctrl+Shift+N (c) Ctrl+Shift+T
(d) Ctrl+W (e) Alt+T

Ans: (c) Ctrl+Shift+T reopens closed tabs; Ctrl+T opens a new tab; Ctrl+W closes a tab.

CHAPTER 17 ABBREVIATIONS & FILE EXTENSIONS

17.1 How to Learn Abbreviations

- Abbreviation questions are asked in **almost every** bank exam (1–3 marks). Learn them **group-wise** (memory, network, banking) and revise this alphabetical list before the exam.
- Some words are **not abbreviations** – **Google** (from "googol" = 10^{100}), **Windows**, **Yahoo** (the founders' joke backronym), **Virus** – the long forms seen in some books are jokes/backronyms.
- **Unicode** is a character-encoding standard, not an acronym; its code space needs **21 bits** (UTF-8, UTF-16, UTF-32 encodings).
- Watch the commonly confused words: **Graphics** Interchange Format (GIF), **Photographic** (JPEG), **Moving** Picture (MPEG), **Printed** Circuit Board (PCB), **Erasable** PROM (EPROM), **Services** Digital Network (ISDN).

✎ MEMORY TRICK: Confusing pairs

- **PPP = Point-to-Point Protocol**, **P2P = Peer-to-Peer** – "Point has 3 P's".
- **bps (small b) = bits**, **Bps (capital B) = Bytes** per second.
- **ARP**: IP → MAC address; **RARP**: MAC → IP address.
- **IMAP** keeps mail on the server; **POP3** downloads it; **SMTP** sends it.

17.2 Important Abbreviations A–Z

► 0–9, A

Abbreviation	Full form
2FA	Two-Factor Authentication
3GP	3GPP file format (mobile video)
3GPP	3rd Generation Partnership Project
5G NR	5G New Radio
AAA	Authentication, Authorisation & Accounting
ACID	Atomicity, Consistency, Isolation, Durability
ADF	Automatic Document Feeder
ADSL	Asymmetric Digital Subscriber Line
AePS	Aadhaar enabled Payment System

Abbreviation	Full form
AES	Advanced Encryption Standard
AGI	Artificial General Intelligence
AGP	Accelerated Graphics Port
AI	Artificial Intelligence
ALGOL	ALGOrithmic Language
ALU	Arithmetic Logic Unit
AMD	Advanced Micro Devices
ANSI	American National Standards Institute
API	Application Programming Interface
APK	Android Package Kit
APT	Advanced Persistent Threat
AR	Augmented Reality
ARP	Address Resolution Protocol
ARPA	Advanced Research Projects Agency
ARPANET	Advanced Research Projects Agency Network
AS	Autonomous System
ASCII	American Standard Code for Information Interchange
ASIC	Application-Specific Integrated Circuit
ASP	Active Server Pages
ATM	Automated Teller Machine (banking); Asynchronous Transfer Mode (networking)
AVI	Audio Video Interleave
AWS	Amazon Web Services

► B – C

Abbreviation	Full form
B2B / B2C	Business to Business / Business to Consumer
BASIC	Beginner's All-purpose Symbolic Instruction Code
BBPS	Bharat Bill Payment System (now Bharat Connect)
BCC	Blind Carbon Copy
BCD	Binary Coded Decimal
BCR	Bar Code Reader
BGP	Border Gateway Protocol
BHIM	Bharat Interface for Money
BIOS	Basic Input Output System

Abbreviation	Full form
BIPS	Billion Instructions Per Second
BIS	Bureau of Indian Standards
BMP	Bitmap
bps	bits per second
Bps	Bytes per second
BRD	Blu-ray Disc
BSNL	Bharat Sanchar Nigam Limited
BYOD	Bring Your Own Device
CAD / CAM	Computer-Aided Design / Computer-Aided Manufacturing
CADD	Computer-Aided Design and Drafting
CAN	Campus Area Network
CAPTCHA	Completely Automated Public Turing test to tell Computers and Humans Apart
CBDC	Central Bank Digital Currency
CBS	Core Banking Solution
CC	Carbon Copy
C-DAC	Centre for Development of Advanced Computing
CDMA	Code Division Multiple Access
CDN	Content Delivery Network
CD-R / CD-RW	Compact Disc Recordable / ReWritable
CD-ROM	Compact Disc Read Only Memory
CERT-In	Indian Computer Emergency Response Team
CISC	Complex Instruction Set Computer
CKYC	Central Know Your Customer
CLI	Command Line Interface
CMD	Command (prompt)
CMOS	Complementary Metal Oxide Semiconductor
CMYK	Cyan, Magenta, Yellow, Key (Black)
COBOL	COmmon Business Oriented Language
CPU	Central Processing Unit
CRM	Customer Relationship Management
CRT	Cathode Ray Tube
CSS	Cascading Style Sheets
CTS	Cheque Truncation System
CUI	Character User Interface
CVV	Card Verification Value
CXL	Compute Express Link

► D – E

Abbreviation	Full form
DBMS	Database Management System
DBT	Direct Benefit Transfer
DDL / DML	Data Definition Language / Data Manipulation Language
DDoS	Distributed Denial of Service
DDR SDRAM	Double Data Rate Synchronous Dynamic RAM
DHCP	Dynamic Host Configuration Protocol
DHTML	Dynamic HyperText Markup Language
DIMM	Dual In-line Memory Module
DL	Deep Learning
DLT	Distributed Ledger Technology
DNA (Microsoft)	Distributed interNet Applications Architecture
DNS	Domain Name System
DoS	Denial of Service
DOS	Disk Operating System
DPDP	Digital Personal Data Protection (Act, 2023)
DPI	Dots Per Inch; also Digital Public Infrastructure
DRAM	Dynamic Random Access Memory
DSL	Digital Subscriber Line
DVD	Digital Versatile Disc
DVD-R / DVD-RW	DVD Recordable / DVD ReWritable
DVR	Digital Video Recorder
EB	Exabyte (10 ¹⁸ bytes)
EBCDIC	Extended Binary Coded Decimal Interchange Code
ECS	Electronic Clearing Service
EDI	Electronic Data Interchange
EDP	Electronic Data Processing
EDR	Endpoint Detection and Response
EDSAC	Electronic Delay Storage Automatic Calculator
EDVAC	Electronic Discrete Variable Automatic Computer
EEPROM	Electrically Erasable Programmable ROM
EFT	Electronic Funds Transfer
e-KYC	Electronic Know Your Customer

Abbreviation	Full form
EMV	Europay, Mastercard, Visa (chip-card standard)
ENIAC	Electronic Numerical Integrator and Computer
EPROM	Erasable Programmable ROM
EROM	Erasable Read Only Memory
ERP	Enterprise Resource Planning
eSIM	embedded Subscriber Identity Module

► F – H

Abbreviation	Full form
FAT	File Allocation Table
FDC	Floppy Disk Controller
FDD	Floppy Disk Drive
FIDO	Fast IDentity Online (passwordless login standard)
FIFO	First In First Out
FLOPS	Floating-point Operations Per Second
FM	Frequency Modulation
FORTRAN	FORmula TRANslation
FPGA	Field-Programmable Gate Array
FPS	Frames Per Second
FTP	File Transfer Protocol
FTTH	Fibre To The Home
GB	Gigabyte
Gbps	Gigabits per second
GBps	Gigabytes per second
GeM	Government e-Marketplace
GenAI	Generative Artificial Intelligence
GHz	Gigahertz
GIF	Graphics Interchange Format
GIGO	Garbage In, Garbage Out
GIS	Geographic Information System
GML	Geography Markup Language
GPRS	General Packet Radio Service
GPS	Global Positioning System
GPT	Generative Pre-trained Transformer
GPU	Graphics Processing Unit
GSM	Global System for Mobile communications
GUI	Graphical User Interface
HAMR	Heat-Assisted Magnetic Recording (hard disks)

Abbreviation	Full form
HBM	High Bandwidth Memory
HD	Hard Disk; also High Definition
HDD	Hard Disk Drive
HDMI	High-Definition Multimedia Interface
HDTV	High-Definition Television
HP	Hewlett-Packard
HSDPA	High Speed Downlink Packet Access
HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol
HTTPS	HyperText Transfer Protocol Secure
HVD	Holographic Versatile Disc

► I – K

Abbreviation	Full form
I4C	Indian Cyber Crime Coordination Centre
IaaS	Infrastructure as a Service
IBM	International Business Machines
IC	Integrated Circuit
ICANN	Internet Corporation for Assigned Names and Numbers
ICMP	Internet Control Message Protocol
ICT	Information and Communication Technology
IDE	Integrated Development Environment
IDRBT	Institute for Development and Research in Banking Technology
IDS / IPS	Intrusion Detection System / Intrusion Prevention System
IEEE	Institute of Electrical and Electronics Engineers
IFSC	Indian Financial System Code (11 characters)
IMAP	Internet Message Access Protocol
IMAP4	Internet Message Access Protocol version 4
IMEI	International Mobile Equipment Identity
IMPS	Immediate Payment Service
INTEL	INTEgrated ELEctronics
I/O	Input / Output
IOP	Input Output Processor
IoT	Internet of Things
IP	Internet Protocol

Abbreviation	Full form
IPv4 / IPv6	Internet Protocol version 4 (32-bit) / version 6 (128-bit)
IRC	Internet Relay Chat
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
ISP	Internet Service Provider
IT	Information Technology
IVR	Interactive Voice Response
J2EE	Java 2 Platform, Enterprise Edition (now Jakarta EE)
JAD	Java Application Descriptor
JAR	Java ARchive
JPEG	Joint Photographic Experts Group
JS	JavaScript
JSON	JavaScript Object Notation
JSP	JavaServer Pages
KB	Kilobyte
Kbps	Kilobits per second
KBps	Kilobytes per second
KYC	Know Your Customer

► L – M

Abbreviation	Full form
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LEO	Low Earth Orbit (satellite internet, e.g. Starlink)
LIFO	Last In First Out
LISP	LISt Processing
LLL	Low Level Language
LLM	Large Language Model
LTE	Long Term Evolution (4G)
MAC	Media Access Control (address, 48-bit)
MAN	Metropolitan Area Network
MANET	Mobile Ad hoc Network
MB	Megabyte
Mbps	Megabits per second
MBps	Megabytes per second
MeitY	Ministry of Electronics and Information Technology
MFA	Multi-Factor Authentication

Abbreviation	Full form
MHz	Megahertz
MICR	Magnetic Ink Character Recognition
MIDI	Musical Instrument Digital Interface
MIME	Multipurpose Internet Mail Extensions
MIPS	Million Instructions Per Second
ML	Machine Learning
MMID	Mobile Money Identifier
MMS	Multimedia Messaging Service
MODEM	MOdulator–DEModulator
MP3	MPEG-1 Audio Layer III
MP4	MPEG-4 Part 14
MPEG	Moving Picture Experts Group
MS-DOS	Microsoft Disk Operating System

► N – O

Abbreviation	Full form
NACH	National Automated Clearing House
NAS	Network Attached Storage
NAT	Network Address Translation
NEFT	National Electronic Funds Transfer
NFC	Near Field Communication
NFT	Non-Fungible Token
NIC	Network Interface Card; also National Informatics Centre
NLP	Natural Language Processing
NPCI	National Payments Corporation of India
NPU	Neural Processing Unit
NTFS	New Technology File System
NTP	Network Time Protocol
NVMe	Non-Volatile Memory Express
OCEN	Open Credit Enablement Network
OCR	Optical Character Recognition
OLED	Organic Light Emitting Diode
OMR	Optical Mark Recognition
ONDC	Open Network for Digital Commerce
OOP	Object-Oriented Programming
O-RAN	Open Radio Access Network
OS	Operating System
OSI	Open Systems Interconnection
OSS	Open Source Software
OTP	One Time Password

Abbreviation	Full form
OTT	Over-The-Top (media)

► P – R

Abbreviation	Full form
P2M	Person-to-Merchant
P2P	Peer-to-Peer; in UPI: Person-to-Person
PaaS	Platform as a Service
PAN	Personal Area Network; also Permanent Account Number
PB	Petabyte (10 ¹⁵ bytes)
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
PCI DSS	Payment Card Industry Data Security Standard
PCIe	PCI Express
PDA	Personal Digital Assistant
PDF	Portable Document Format
PHP	PHP: Hypertext Preprocessor (originally Personal Home Page)
PIN	Personal Identification Number
PING	Packet InterNet Groper
PKI	Public Key Infrastructure
PNG	Portable Network Graphics
PnP	Plug and Play
POP3	Post Office Protocol version 3
POS	Point of Sale
POST	Power-On Self-Test
PPP	Point-to-Point Protocol
PROM	Programmable Read Only Memory
PSU	Power Supply Unit
QR	Quick Response (code)
RAG	Retrieval-Augmented Generation
RAID	Redundant Array of Independent Disks
RAM	Random Access Memory
RARP	Reverse Address Resolution Protocol
RDBMS	Relational Database Management System
RFID	Radio Frequency IDentification
RIP	Routing Information Protocol
RISC	Reduced Instruction Set Computer
ROM	Read Only Memory
RPA	Robotic Process Automation

Abbreviation	Full form
RPM	Revolutions Per Minute
RSA	Rivest–Shamir–Adleman (encryption)
RTF	Rich Text Format
RTGS	Real Time Gross Settlement
RuPay	Rupee + Payment (NPCI card scheme)

► S – T

Abbreviation	Full form
SaaS	Software as a Service
SAM	Sequential Access Method
SAN	Storage Area Network
SASE	Secure Access Service Edge
SATA	Serial Advanced Technology Attachment
SD card	Secure Digital card
SDK	Software Development Kit
SDLC	Software Development Life Cycle
SEO	Search Engine Optimisation
SFTP	SSH (Secure) File Transfer Protocol
SIEM	Security Information and Event Management
SIM	Subscriber Identity Module
SIP	Session Initiation Protocol
SIU	Serial Interface Unit
S/MIME	Secure/Multipurpose Internet Mail Extensions
SMPS	Switched-Mode Power Supply
SMS	Short Message Service
SMTP	Simple Mail Transfer Protocol
SNAP	SubNetwork Access Protocol
SNMP	Simple Network Management Protocol
SNOBOL	StriNg Oriented and symBOLic Language
SOC	Security Operations Centre
SoC	System on a Chip
SQL	Structured Query Language
SRAM	Static Random Access Memory
SSD	Solid State Drive
SSH	Secure Shell
SSL	Secure Sockets Layer
SSO	Single Sign-On
SW	Software

Abbreviation	Full form
TAPI	Telephony Application Programming Interface
TB	Terabyte
TBps	Terabytes per second
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol / Internet Protocol
Telnet	Teletype Network (remote login protocol)
TFT	Thin Film Transistor
TFTP	Trivial File Transfer Protocol
TIFF	Tagged Image File Format
TIPS	Trillion Instructions Per Second
TLD	Top-Level Domain
TLS	Transport Layer Security
TPU	Tensor Processing Unit (Google)

► U – V

Abbreviation	Full form
UDP	User Datagram Protocol
UEFI	Unified Extensible Firmware Interface
UFS	Universal Flash Storage
UHF / VHF	Ultra High Frequency / Very High Frequency
UIDAI	Unique Identification Authority of India
UI / UX	User Interface / User Experience
ULI	Unified Lending Interface
UMANG	Unified Mobile Application for New-age Governance
UMTS	Universal Mobile Telecommunications System (3G)
UNIVAC	UNIVersal Automatic Computer
UPI	Unified Payments Interface
UPS	Uninterruptible Power Supply
URL	Uniform Resource Locator
USB	Universal Serial Bus
USSD	Unstructured Supplementary Service Data (*99#)
UWB	Ultra-Wideband
VAN	Value Added Network
VCD	Video Compact Disc
V-CIP	Video-based Customer Identification Process

Abbreviation	Full form
VDU	Visual Display Unit
VGA	Video Graphics Array
VM	Virtual Machine
VoIP	Voice over Internet Protocol
VoLTE	Voice over LTE
VPA	Virtual Payment Address (UPI ID)
VPN	Virtual Private Network
VR	Virtual Reality
VRAM	Video Random Access Memory
VRML	Virtual Reality Modelling Language

► W – Z

Abbreviation	Full form
WAN	Wide Area Network
WAP	Wireless Application Protocol
WBMP	Wireless Bitmap
Wi-Fi	Wireless Fidelity (popular expansion; trademark of Wi-Fi Alliance)
WiMAX	Worldwide Interoperability for Microwave Access
WINS	Windows Internet Name Service
WLAN	Wireless Local Area Network
WML	Wireless Markup Language
WORM	Write Once, Read Many
WPA	Wi-Fi Protected Access (WPA3 latest)
WWW	World Wide Web
WYSIWYG	What You See Is What You Get
XDR	Extended Detection and Response
XHTML	eXtensible HyperText Markup Language
XMF	eXtensible Music Format
XML	eXtensible Markup Language
XMS	eXtended Memory Specification
XP (Windows)	eXPerience
XSL	eXtensible Stylesheet Language
XSS	Cross-Site Scripting
XT (IBM PC)	eXtended Technology
ZB / YB	Zettabyte (10 ²¹) / Yottabyte (10 ²⁴)

17.3 Banking & Digital-India Abbreviations (Quick Revision)

Abbreviation	Full form
NPCI	National Payments Corporation of India
UPI / VPA	Unified Payments Interface / Virtual Payment Address
NEFT / RTGS	National Electronic Funds Transfer / Real Time Gross Settlement
IMPS / MMID	Immediate Payment Service / Mobile Money Identifier
AePS	Aadhaar enabled Payment System
NACH / ECS	National Automated Clearing House / Electronic Clearing Service
CTS	Cheque Truncation System
BBPS / NBBL	Bharat Bill Payment System / NPCI Bharat BillPay Ltd
NETC	National Electronic Toll Collection (FASTag)
CBDC / ₹	Central Bank Digital Currency / Digital Rupee
ULI / OCEN	Unified Lending Interface / Open Credit Enablement Network
ONDC	Open Network for Digital Commerce
AA	Account Aggregator
KYC / e-KYC / CKYC	Know Your Customer / electronic KYC / Central KYC
V-CIP	Video-based Customer Identification Process
CERSAI	Central Registry of Securitisation Asset Reconstruction and Security Interest of India
RBIH	Reserve Bank Innovation Hub
IFSC / MICR	Indian Financial System Code / Magnetic Ink Character Recognition
DPDP	Digital Personal Data Protection (Act 2023)
CERT-In / I4C	Indian Computer Emergency Response Team / Indian Cyber Crime Coordination Centre
MeitY / NIC	Ministry of Electronics & IT / National Informatics Centre
JAM	Jan Dhan – Aadhaar – Mobile

★ REMEMBER THIS

- **CMYK** – K stands for **Key (Black)**, not "Block".
- **ENIAC** = Electronic Numerical Integrator and **Computer**; **EDSAC** = Electronic Delay Storage Automatic **Calculator**.
- **ICANN** = Internet Corporation for **Assigned** Names and Numbers.
- **SSD** = Solid State Drive; **NVMe** = Non-Volatile Memory **Express**.
- **GPT** (in ChatGPT) = **Generative Pre-trained Transformer**; **LLM** = Large Language Model.

17.4 File Extensions

► Documents & Office Files

Extension	File type
.doc / .docx	Word document (2003 & earlier / 2007 & later)
.dot / .dotx	Word template
.docm	Word macro-enabled document
.xls / .xlsx	Excel workbook (2003 & earlier / 2007 & later)
.xlsm / .xltx / .xlsb	Excel macro-enabled / template / binary workbook
.csv	Comma-Separated Values (plain-text table)
.ppt / .pptx	PowerPoint presentation (2003 / 2007+)
.pps / .ppsx	PowerPoint slide show (opens directly in show)
.potx	PowerPoint template
.mdb / .accdb	Access database (2003 & earlier / 2007 & later)
.pub	Microsoft Publisher file
.one	OneNote notebook
.txt	Plain text (Notepad)
.rtf	Rich Text Format (WordPad)
.pdf	Portable Document Format (Adobe)
.odt / .ods / .odp	OpenDocument text / spreadsheet / presentation (LibreOffice)
.123	Lotus 1-2-3 spreadsheet
.epub	E-book

► Images & Graphics

Extension	File type
.jpg / .jpeg	Joint Photographic Experts Group – compressed photo (lossy)
.png	Portable Network Graphics – lossless, transparency
.gif	Graphics Interchange Format – animation, 256 colours
.bmp	Bitmap image (uncompressed)
.tif / .tiff	Tagged Image File Format (scanning, printing)
.svg	Scalable Vector Graphics
.webp / .heic	Google web image / Apple iPhone photo format
.ico	Icon file
.psd	Adobe Photoshop document
.ai	Adobe Illustrator file
.cdr	CorelDRAW file
.raw	Unprocessed camera image

► Audio & Video

Extension	File type
.mp3	MPEG-1 Audio Layer III (compressed audio)
.wav	Waveform audio (uncompressed)
.wma / .wmv	Windows Media Audio / Windows Media Video
.aac / .flac / .m4a	Advanced Audio Coding / lossless audio / MPEG-4 audio
.mid / .midi	Musical Instrument Digital Interface
.mp4	MPEG-4 Part 14 video container (audio + video)
.avi	Audio Video Interleave (Microsoft)
.mkv	Matroska video
.mov	Apple QuickTime movie
.flv	Flash video
.vob	Video Object (DVD video)
.3gp	Mobile video format by 3GPP
.mpeg / .mpg	Moving Picture Experts Group video

► Programs, System & Compressed Files

Extension	File type
.exe	Executable program (Windows)

Extension	File type
.com	Command (executable) file – MS-DOS
.bat	Batch file (list of commands)
.msi	Windows Installer package
.dll	Dynamic Link Library
.sys / .drv / .vxd	System file / device driver / virtual device driver
.ini / .cfg / .config	Initialisation / configuration file
.bak / .tmp	Backup file / temporary file
.log / .dat	Log file / data file
.iso / .img	Disk image file
.bin	Binary file
.lib / .obj	Library file / object (compiled) file
.ttf / .otf / .fnt	TrueType / OpenType / font file
.zip	Compressed archive (ZIP format)
.rar	Roshal ARchive (WinRAR)
.7z / .tar / .gz	7-Zip / tape archive / gzip (Linux)
.cab	Windows Cabinet (compressed) file
.apk / .aab	Android Package Kit / Android App Bundle
.ipa	iOS app package
.dmg	macOS disk image

► Programming & Web Files

Extension	File type
.c / .h	C source / header file
.cpp	C++ source file
.cs	C# source file
.java / .class / .jar	Java source / compiled bytecode / Java ARchive
.py	Python script
.js / .ts	JavaScript / TypeScript
.pl	Perl script
.vbs	VBScript file
.php	PHP script (Hypertext Preprocessor)
.asp / .aspx / .jsp	Active Server Pages / ASP.NET / JavaServer Pages
.htm / .html	HyperText Markup Language web page
.xhtml / .xml	eXtensible HTML / eXtensible Markup Language
.css	Cascading Style Sheets

Extension	File type
.json	JavaScript Object Notation (data)
.sql	SQL (Structured Query Language) script
.wml	Wireless Markup Language page
.gml	Geography Markup Language
.sh	Shell script (Linux/Unix)

★ REMEMBER THIS

- **.docx / .xlsx / .pptx** = Office **2007 and later** (XML-based); **.doc / .xls / .ppt** = 2003 and earlier.
- Access 2007+ = **.accdb** (not .mdbx). PowerPoint show = **.ppsx**.
- **.exe, .com, .bat** are executable – the commonest carriers of malware in e-mail attachments.
- **.rar** = Roshal ARchive (Eugene Roshal); **.zip** = ZIP archive (Phil Katz, PKZIP).

17.5 Practice MCQs (Previous-Year Pattern)

Q1. What is the full form of GIF? (IBPS RRB PO 2023)

- (a) Graphical Interchange Format
- (b) Graphics Interchange Format
- (c) Graphic Interface File
- (d) Graphics Image File
- (e) General Image Format

Ans: (b) GIF = Graphics Interchange Format (CompuServe, 1987).

Q2. In CMYK colour model used by printers, K stands for:

- (a) Kelvin (b) Khaki (c) Kernel (d) Key (Black)
- (e) Block

Ans: (d) CMYK = Cyan, Magenta, Yellow, Key (black).

Q3. Expand the second "S" in CSS. (IBPS RRB Clerk 2023)

- (a) Style (b) Sheet (c) Save (d) Single
- (e) Space

Ans: (b) CSS = Cascading Style Sheets; the second S is Sheets.

Q4. SSO, which lets a user log in once to access many applications, stands for: (RBI Asst 2022)

- (a) Single Sign-On (b) Secure Sign-On
- (c) System Security Option

(d) Single Security Operation (e) Shared Sign-On

Ans: (a) Single Sign-On uses one set of credentials for multiple applications.

Q5. What does ICANN stand for?

- (a) International Corporation for Assigned Network Names (b) Internet Council for Allocated Names and Numbers
- (c) International Committee for Addresses and Network Numbers (d) Internet Corporation of Assign Names & Networks
- (e) Internet Corporation for Assigned Names and Numbers

Ans: (e) ICANN coordinates domain names and IP address allocation worldwide.

Q6. Which file extension is used by Microsoft Access 2007 and later databases?

- (a) .mdb (b) .mdbx (c) .accdb (d) .adb
- (e) .dbx

Ans: (c) .accdb replaced .mdb from Access 2007.

Q7. The full form of NPU, found in new "AI PCs", is:

- (a) Network Processing Unit
- (b) Numeric Processing Unit
- (c) Neural Processing Unit
- (d) New Processing Unit
- (e) Native Program Unit

Ans: (c) An NPU is a chip block designed to run AI/neural-network tasks efficiently.

Q8. In banking, V-CIP stands for:

- (a) Virtual Customer Information Portal
- (b) Video-based Customer Identification Process
- (c) Verified Card Identification Protocol
- (d) Visual Credit Information Process
- (e) Video Customer Interface Program

Ans: (b) RBI allowed V-CIP (video KYC) in January 2020.

Q9. Which of the following pairs is correctly matched?

- (a) PPP – Peer to Peer Protocol
- (b) PCB – Printer Circuit Board (c) EPROM – Erasable Programmable ROM
- (d) ISDN – Integrated Servers Digital Network
- (e) JPEG – Joint Picture Expert Group

Ans: (c) PPP = Point-to-Point Protocol; PCB = Printed; ISDN = Services; JPEG = Photographic Experts.

Q10. A file with extension .rar is a:

- (a) Raster image (b) Compressed archive
- (c) Rich text document (d) Audio file
- (e) Executable

Ans: (b) .rar = Roshal ARchive, a compressed archive format created by Eugene Roshal.

Nandyal Banking Coaching Center