DSSSB AE/JE 2026

COMPLETE FUNDAMENTALS OF COMPUTING

Complete Theory • Detailed Hinglish Explanation • Worked Examples & Shortcuts
Solved Examples • Practical Applications • Practice Questions

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Accuracy note: Computing definitions are stated at exam level. Real products may implement layers and standards differently, so logical concepts must be separated from vendor-specific details.

Preface

This book develops computing from data representation and computer organization through hardware, operating systems, networks and databases. The sequence connects internal working, diagrams, commands, examples and exam decisions so a learner can reason instead of memorizing isolated facts.

The scope follows the five prescribed DSSSB AE/JE chapters. Advanced detail is included only where it clarifies a listed topic or prevents a common conceptual, numerical or statement-based mistake.

How to Use This Book

Read the technical explanation first, then the Hinglish Explanation. Redraw every block diagram, hierarchy and flowchart with labels. Rework every conversion and scheduling example, and attempt all twenty questions at the end of each chapter.

For every answer, verify terminology, layer, unit, data flow, address type, key or constraint. Maintain a short error log and revise the chapter formula sheet after one day, one week and before the examination.

Practice rule: Questions are original DSSSB-style practice. Each solution explains only the correct answer, as requested.

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How to use this book: Read Complete Theory, reinforce it with the Hinglish Explanation, review every formula and derivation row, then attempt all twenty questions without viewing the solutions. Questions are original DSSSB-style practice, not claimed verbatim previous-year questions.

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Computing Units and Shortcuts
1. 1 byte = 8 bits
2. 1 nibble = 4 bits
3. binary place values are powers of 2
4. hexadecimal uses 0-9 and A-F
5. distinguish decimal SI storage from binary IEC units when exact capacity matters.

CHAPTER 1 — FUNDAMENTALS OF COMPUTERS AND COMPUTER ORGANIZATION

1. Introduction

A computer is a programmable electronic system that accepts data, processes it according to stored instructions, produces information and retains results. Understanding organization means tracing how input, memory, processor and output cooperate during an instruction. This chapter also develops number systems, data representation, languages and software categories used throughout the remaining book.

2. Complete Theory

Evolution, generations and characteristics

Early calculating aids were mechanical, while electronic computers emerged from vacuum-tube machines. First-generation systems used vacuum tubes and machine language; the second used transistors; the third used integrated circuits; the fourth introduced microprocessors and personal computing; the fifth is commonly associated with highly parallel, knowledge-based and AI-oriented systems.

Generation boundaries are educational conventions rather than exact worldwide dates. Computers provide speed, accuracy, automation, diligence, storage and repeatability, but they do not independently supply correct goals or judgment.

Their output depends on program logic and input quality. Applications range from design and billing to simulation, communication, control and scientific computation.

Hinglish Explanation

Computer fast hai, intelligent human sense mein nahi. Agar input ya program wrong ho to output bhi wrong ho sakta hai - GIGO.

Generations ko main hardware technology se yaad karo: vacuum tube, transistor, IC, microprocessor, then AI-oriented systems.

Classification and real-world roles

Analog computers represent continuously varying quantities, digital computers manipulate discrete symbols, and hybrid systems combine analog measurement with digital control. General-purpose computers run many applications; special-purpose and embedded computers perform a defined function inside a larger product.

Microcomputers include desktops and portable personal systems. Workstations emphasize technical performance, mainframes support high-volume reliable transaction processing, and supercomputers maximize computational throughput for scientific workloads.

Minicomputer is a historical mid-range category. Size alone does not define a class: workload, concurrency, reliability, I/O capacity and architecture matter.

Hinglish Explanation

Laptop ko small hone ki wajah se supercomputer se compare mat karo. Category ka basis intended workload hai.

Bank ka mainframe many secure transactions handle karta hai, supercomputer weather simulation karta hai, embedded controller lift ya washing machine ke andar fixed task karta hai.

Functional units and stored-program organization

The input unit converts external data into machine-readable form. Memory stores instructions, data and intermediate results.

The arithmetic logic unit performs arithmetic, comparisons and logic; the control unit directs transfers and operations. Together the ALU, control unit and registers form the CPU.

Output converts results into a useful form. In a stored-program computer, instructions and data reside in memory and are identified by addresses.

Buses carry data, addresses and control signals. Registers provide the fastest small storage: the program counter identifies the next instruction, instruction register holds the current instruction, and general registers hold operands and results.

Hinglish Explanation

Suppose aap calculator mein 25+17 enter karte ho. Input unit symbols leti hai, memory instruction/data rakhti hai, control unit steps coordinate karta hai, ALU addition karta hai, aur output 42 dikhata hai.

Registers CPU ki working table hain.

Fetch-decode-execute cycle

During fetch, the CPU places the program-counter address on the address bus, memory returns the instruction on the data bus, and the instruction enters the instruction register. The program counter normally advances.

During decode, the control unit interprets the opcode and operand addressing. Execute may perform an ALU operation, access memory, branch, or communicate with I/O.

The result is stored and status flags may change. An interrupt can temporarily redirect execution to a service routine; the previous context is saved so execution can resume.

Clock pulses synchronize many internal events, but clock rate alone does not determine total performance.

Hinglish Explanation

CPU har instruction ke liye fetch, decode, execute, store cycle repeat karta hai. Clock ko sirf speed label na samjho; architecture, cores, cache, instruction mix aur memory delay bhi performance decide karte hain.

Number systems and conversions

A positional number equals the sum of each digit multiplied by the base raised to its position. Decimal uses base 10, binary base 2, octal base 8 and hexadecimal base 16.

Convert an integer to another base by repeated division and reading remainders upward; convert a fraction by repeated multiplication and reading integer parts downward. Binary groups of three map directly to octal and groups of four to hexadecimal.

Addition follows carry rules. One's complement flips bits; two's complement adds one and is the standard representation for signed integers because it has one zero and supports uniform addition.

Overflow occurs when a fixed-width result lies outside the representable range.

Hinglish Explanation

Binary conversion mein place values 1,2,4,8... use karo.

Hex ka one digit four bits aur octal ka one digit three bits represent karta hai. Two's complement: bits invert karo, then plus one.

Final answer ko decimal mein reverse-check karo.

Data units, codes and character representation

A bit is one binary digit; a nibble is four bits and a byte is eight bits. Word length is the number of bits a processor naturally handles in a basic operation.

Unsigned n-bit integers range from 0 to 2^{n-1}; two's-complement signed values range from -2^{n-1} to $2^{n-1}-1$. BCD encodes each decimal digit separately in four bits and differs from an ordinary binary representation.

ASCII defines a historical character code set, while Unicode assigns code points for scripts and symbols worldwide. UTF-8 is a variable-length Unicode encoding compatible with ASCII for its first 128 codes.

Hinglish Explanation

12 ka binary 1100 hai, lekin BCD mein decimal digit 1 = 0001 aur 2 = 0010, so BCD 0001 0010 hoga. Unicode character ka identity code point deta hai; UTF-8 us code point ko bytes mein encode karta hai.

Programming languages and translators

Machine language consists of processor-specific binary instructions and is directly executable but difficult to write and maintain. Assembly language uses mnemonics and symbolic addresses; an assembler translates it.

High-level languages express algorithms more portably. A compiler generally translates a program into target code before execution and can optimize globally; an interpreter executes through a translation runtime, often statement by statement or via intermediate code.

Modern implementations may combine compilation and interpretation, so exam comparisons describe the classical models. Source code, object code and executable code are distinct stages.

Hinglish Explanation

Assembler assembly ko machine code banata hai. Compiler pehle larger program translate karke executable/object output de sakta hai; interpreter execution ke time translate/run karta hai.

Real systems hybrid ho sakte hain, but exam mein classical difference poochha jata hai.

Software categories and licensing

System software manages the platform: operating systems, drivers and many translators. Application software performs user tasks such as word processing, CAD or payroll.

Utilities maintain or protect systems, for example backup, compression and antivirus tools. Firmware is software stored in nonvolatile memory that controls hardware at a low level.

Middleware connects applications or services and hides communication complexity. Open-source software makes source code available under a license granting specified freedoms; proprietary software is controlled under restrictive terms.

Free price and open source are not identical concepts.

Hinglish Explanation

OS system software hai, AutoCAD application software, backup tool utility, router ka low-level control firmware. Open source ka matlab source aur license permissions available; sirf zero price hona open source prove nahi karta.

4. Shortcut and Formula Section

Shortcut / Formula Sheet
1. value=sum(digit x base^{position})
2. binary-to-octal group=3 bits
3. binary-to-hex group=4 bits
4. 1 nibble=4 bits
5. 1 byte=8 bits
6. unsigned n-bit range=0 to 2^{n-1}
7. signed two's-complement range=-2^{n-1} to 2^{n-1}-1
8. two's complement=one's complement+1
9. 1 KiB=2^{10} bytes
10. 1 MiB=2^{20} bytes
11. 1 GiB=2^{30} bytes
12. decimal storage prefixes use powers of 10

5. Formula Derivations and Solved Examples

Example conversion: $(101101)_2$=1x$2^{5+0x24+1x23+1x22+0x2+1}$=45. Repeated division gives 45/2 remainders 1,0,1,1,0,1 read upward as 101101. For 8-bit two's complement, -13 starts from 00001101, invert to 11110010 and add one to obtain 11110011. An 8-bit signed value ranges from -128 to +127.

6. Practical Applications

- Office automation and e-governance.
- CAD, GIS and engineering analysis.
- Banking and reservation transactions.
- Embedded controllers and smart devices.
- Scientific simulation and data processing.

7. Short Tricks

- Three binary bits map to one octal digit.
- Four binary bits map to one hex digit.
- Two's complement has one representation of zero.
- PC points to the next instruction.

8. Concept Diagram

COMPUTER FUNCTIONAL BLOCKS
Input -> Memory <-> CPU [Control Unit + ALU + Registers] -> Output
^
stored program
Instruction cycle: Fetch -> Decode -> Execute -> Store -> next instruction

9. Comparison Table

Class	Representation/workload	Typical use
Analog computer	continuous quantity	special measurement/simulation
Digital computer	discrete symbols	general computing
Mainframe	high-volume concurrent I/O	banking/large transactions
Supercomputer	maximum computation throughput	weather/science
Embedded computer	dedicated control	appliance/vehicle

10. Common Mistakes

• Equating high clock rate with complete performance.

• Confusing BCD with ordinary binary.

• Reading repeated-division remainders downward.

• Calling all free software open source.

• Treating data and information as identical.

11. Important DSSSB Exam Points

• Generations, functional units, fetch cycle, conversions, complements, coding and translator differences are high-yield.

12. Chapter Revision Sheet

Trace input through processing, memory and output. For number systems write base and place values explicitly. Distinguish hardware classes by workload and software classes by purpose.

13. Practice Questions with Solutions

Attempt each question first. The explanation discusses only the correct answer.

Q1. The defining technology of the first computer generation was

(A) vacuum tubes
(B) wrong input or logic can produce wrong output
(C) the address of the next instruction
(D) 0 to 2^{n-1}

Correct Answer: (A)

First-generation electronic systems used vacuum tubes.

Q2. GIGO means

(A) an analog computer
(B) wrong input or logic can produce wrong output
(C) the current instruction
(D) -128 to +127

Correct Answer: (B)

A computer follows supplied data and instructions.

Q3. A computer that handles continuous physical quantities is

(A) mainframe
(B) fetch, decode, execute and store
(C) an analog computer
(D) each decimal digit separately in four bits

Correct Answer: (C)

Analog representation varies continuously.

Q4. A bank's very high-volume centralized transaction workload commonly suits a

(A) ALU, control unit and registers
(B) 45
(C) character codes
(D) mainframe

Correct Answer: (D)

Mainframes emphasize reliable concurrent I/O and transactions.

Q5. The CPU primarily contains

(A) ALU, control unit and registers
(B) the address of the next instruction
(C) four binary bits
(D) a variable-length Unicode encoding

Correct Answer: (A)

These blocks perform operations and coordinate instruction execution.

Q6. The program counter holds

(A) the current instruction
(B) the address of the next instruction
(C) inverting bits and adding one
(D) assembler

Correct Answer: (B)

It controls sequential instruction fetching unless a branch changes it.

Q7. The instruction register holds

(A) fetch, decode, execute and store
(B) 0 to 2^{n-1}
(C) the current instruction
(D) translates a program before execution

Correct Answer: (C)

The fetched instruction is decoded from this register.

Q8. The normal instruction sequence is

(A) 45
(B) -128 to +127
(C) nonvolatile memory
(D) fetch, decode, execute and store

Correct Answer: (D)

The CPU repeatedly follows these stages.

Q9. $(101101)_2$ equals decimal

(A) 45
(B) four binary bits
(C) each decimal digit separately in four bits
(D) source availability and license permissions

Correct Answer: (A)

Place-value expansion gives 32+8+4+1.

Q10. One hexadecimal digit represents

(A) inverting bits and adding one
(B) four binary bits
(C) character codes
(D) vacuum tubes

Correct Answer: (B)

Hexadecimal base 16 equals 2^4.

Q11. Two's complement is formed by

(A) 0 to 2^{n-1}
(B) a variable-length Unicode encoding
(C) inverting bits and adding one
(D) wrong input or logic can produce wrong output

Correct Answer: (C)

It is one's complement plus one.

Q12. The unsigned range of n bits is

(A) -128 to +127
(B) assembler
(C) an analog computer
(D) 0 to 2^{n-1}

Correct Answer: (D)

All bit patterns represent nonnegative values.

Q13. An 8-bit two's-complement range is

(A) -128 to +127
(B) each decimal digit separately in four bits
(C) translates a program before execution
(D) mainframe

Correct Answer: (A)

The range is -2^7 to 2^{7-1}.

Q14. BCD represents

(A) character codes
(B) each decimal digit separately in four bits
(C) nonvolatile memory
(D) ALU, control unit and registers

Correct Answer: (B)

It is not the same as pure binary conversion.

Q15. ASCII originally defines

(A) a variable-length Unicode encoding
(B) source availability and license permissions
(C) character codes
(D) the address of the next instruction

Correct Answer: (C)

It maps characters and control symbols to numeric codes.

Q16. UTF-8 is

(A) assembler
(B) vacuum tubes
(C) the current instruction
(D) a variable-length Unicode encoding

Correct Answer: (D)

It encodes Unicode code points into one or more bytes.

Q17. Assembly language is translated by an

(A) assembler
(B) translates a program before execution
(C) wrong input or logic can produce wrong output
(D) fetch, decode, execute and store

Correct Answer: (A)

The assembler converts mnemonics to machine instructions.

Q18. A classical compiler generally

(A) nonvolatile memory
(B) translates a program before execution
(C) an analog computer
(D) 45

Correct Answer: (B)

It produces target or intermediate code before normal running.

Q19. Firmware is commonly stored in

(A) source availability and license permissions
(B) mainframe
(C) nonvolatile memory
(D) four binary bits

Correct Answer: (C)

It must remain available when power is removed.

Q20. Open-source software is defined primarily by

(A) vacuum tubes
(B) ALU, control unit and registers
(C) inverting bits and adding one
(D) source availability and license permissions

Correct Answer: (D)

Price alone does not determine open-source status.

Quick Revision: Re-read the formula box, cover the answers, and explain each exam point aloud. A computing shortcut is ready only when its terminology, unit, layer, scope and conditions are clear.

CHAPTER 2 — COMPUTER HARDWARE, SOFTWARE, MEMORY AND INPUT-OUTPUT DEVICES

1. Introduction

Hardware provides the physical resources on which software operates. Useful exam reasoning follows the memory hierarchy: faster storage is smaller and costlier per bit, while slower storage is larger and persistent. Input and output devices translate between human or physical information and machine data, and interfaces define how devices communicate.

2. Complete Theory

CPU architecture, clock and performance

The CPU datapath contains registers, ALU, internal buses and execution units, while the control path sequences operations. Registers such as the program counter, instruction register, stack pointer and status register have specialized roles.

A clock coordinates state changes; frequency states cycles per second, not instructions per second. An instruction may require multiple cycles, and modern processors overlap or execute work in parallel.

Cache misses, branch behaviour, number of cores, instruction-set design, thermal limits and software all affect performance. A 64-bit word size does not automatically mean every instruction or address uses all 64 bits.

Hinglish Explanation

GHz ko direct program speed mat samjho. CPU ko data cache se mila ya RAM se, instruction kitne cycles leti hai, cores kitne effectively use hue - sab matter karta hai.

Registers CPU ke sabse fast internal storage locations hain.

Memory hierarchy and locality

The hierarchy typically runs registers, cache, main memory and secondary storage. Moving downward increases capacity and persistence but generally increases access time.

Cache works because programs show temporal locality, reusing recently accessed items, and spatial locality, accessing nearby addresses. A cache line moves a block rather than one isolated byte.

A hit is served from the cache; a miss fetches from a lower level. Virtual memory uses secondary storage as backing for pages not currently in RAM, giving each process a large protected address space but not the speed of physical RAM.

Hinglish Explanation

Frequently used data ko CPU ke paas cache mein rakha jata hai. Jaise desk par active files, drawer mein less-used files, store room mein archive.

Virtual memory extra RAM nahi banati; disk-backed paging se capacity illusion deti hai but page fault slow hota hai.

RAM, ROM and flash families

RAM is volatile read-write working memory. SRAM stores bits in flip-flop-like cells, is fast and costly, and is commonly used for cache.

DRAM stores charge in capacitors, needs refresh, is denser and forms main memory. ROM broadly means nonvolatile storage for fixed or infrequently changed content.

PROM is programmed once; EPROM can be erased with ultraviolet light; EEPROM is electrically erasable; flash erases and writes in blocks and is used in firmware and solid-state storage. Naming a technology does not alone specify speed, endurance or interface.

Hinglish Explanation

SRAM fast aur expensive, so cache. DRAM dense aur cheaper, so main RAM, but refresh chahiye.

PROM once, EPROM UV erase, EEPROM electrically erase, flash block-wise electrical erase/write.

Secondary and cloud storage

HDDs store magnetic patterns on rotating platters and use mechanical heads; they offer economical capacity but have seek latency and mechanical vulnerability. SSDs use flash memory with a controller, have no moving parts and provide much lower access latency, but have finite write endurance and require wear management.

Optical media use laser-read pits or marks; magnetic tape offers low-cost sequential archival storage. Pen drives package flash behind USB.

Cloud storage is a service reached over a network, not a new physical storage medium; providers still use data-centre storage and add replication, access control and management.

Hinglish Explanation

Cloud ko hawa mein data mat samjho. Data provider ke physical servers par hi stored hota hai, aap network se access karte ho.

HDD mechanical, SSD solid-state; SSD fast hai but backup ka substitute nahi.

Input devices and recognition technologies

A keyboard generates key events; a mouse or trackball reports relative pointer movement. A scanner digitizes an image.

OCR recognizes printed or handwritten character shapes and converts them into editable text. OMR detects marked positions on forms, while MICR reads magnetically printed characters used in banking.

Barcode and QR readers decode optical patterns; QR can encode data in two dimensions. Touch screens combine display and pointing input.

Biometric systems measure traits such as fingerprints or face patterns and compare templates. Microphones, cameras and sensors convert sound, light or physical quantities into digital data through appropriate transducers and converters.

Hinglish Explanation

OCR letters ko text banata hai, OMR bubbles/marks detect karta hai, MICR cheque ke magnetic characters read karta hai. In teenon ko exam mein swap karna common trap hai.

QR two-dimensional code hai.

Output devices and printing

Monitors create pixels using display technologies. LCD controls backlight transmission through liquid crystals; LED monitor commonly means an LCD with LED backlighting, while OLED pixels emit their own light.

CRT uses an electron beam and phosphor and is bulky. Impact printers physically strike ribbon and can produce multipart forms; dot-matrix is a common example.

Non-impact printers include inkjet, which sprays droplets, and laser, which uses electrostatic imaging and toner. Plotters produce large technical drawings, speakers convert electrical signals to sound, projectors enlarge images, and 3D printers build physical objects layer by layer.

Hinglish Explanation

LED monitor term often LED-backlit LCD ke liye use hota hai; OLED mein pixels self-emissive hote hain. Dot matrix impact printer hai, laser aur inkjet non-impact.

Plotter large engineering drawings ke liye useful.

Ports, wireless interfaces and RAID

USB carries data and power through standardized versions and connector types; connector shape does not uniquely specify speed. HDMI and DisplayPort carry digital audio-video, VGA is analog video, Ethernet provides wired networking and Thunderbolt combines high-speed data with display and other capabilities.

Bluetooth supports short-range personal connections; Wi-Fi provides wireless LAN access. RAID combines drives for performance, redundancy or both.

RAID 0 stripes without redundancy, RAID 1 mirrors, and RAID 5 uses distributed parity with a minimum of three drives. RAID improves availability but does not replace an independent backup.

Hinglish Explanation

USB-C shape dekhkar speed assume mat karo. RAID 0 fast but no redundancy, RAID 1 mirror, RAID 5 parity.

RAID disk failure tolerate kar sakta hai, lekin accidental delete, malware ya disaster ke against separate backup chahiye.

4. Shortcut and Formula Section

Shortcut / Formula Sheet
1. memory hierarchy: registers → cache → RAM → secondary storage
2. cache hit ratio=hits/total accesses
3. average memory access approximately hit time+miss rate x miss penalty
4. 1 byte=8 bits
5. disk capacity decimal GB commonly uses 10^9 bytes
6. binary GiB=2^{30} bytes
7. RAID 0=stripe,no redundancy
8. RAID 1=mirror
9. RAID 5=distributed parity,min 3 drives

5. Formula Derivations and Solved Examples

Suppose cache hit time is 1 ns, miss rate 5% and additional miss penalty 60 ns. Approximate average access time is 1+0.05x60=4 ns. This illustrates why a small miss rate strongly affects performance. For storage units, a marketed 500 GB drive contains about 500×10^9 bytes; an operating system displaying binary GiB reports a numerically smaller value because 1 GiB is 2^{30} bytes.

6. Practical Applications

- Engineering workstations and CAD.
- Government document scanning and OMR examinations.
- Bank cheque processing through MICR.
- Data-centre storage and backup.
- Displays, printers, sensors and field devices.

7. Short Tricks

- SRAM cache; DRAM main memory.
- OCR text, OMR marks, MICR magnetic characters.
- RAID 0 has no redundancy.
- Cloud storage remains physical at a remote data centre.

8. Concept Diagram

MEMORY HIERARCHY
Fast, small, costly/bit
Registers
v
Cache (SRAM)
v
Main memory (DRAM)
v
SSD / HDD
v
Tape / remote archive
Slow, large, economical/bit

9. Comparison Table

Technology	Volatile?	Typical role
SRAM	yes	CPU cache
DRAM	yes	main memory
EEPROM	no	small reprogrammable firmware/data
Flash	no	SSD, pen drive, firmware
HDD	no	magnetic bulk storage
SSD	no	low-latency solid-state storage

10. Common Mistakes

• Calling virtual memory as fast as RAM.

• Confusing OCR, OMR and MICR.

• Assuming USB-C guarantees one speed.

• Treating RAID as a backup.

• Calling every LED display OLED.

11. Important DSSSB Exam Points

• Hierarchy, volatility, SRAM-DRAM, storage comparisons, recognition devices, printer types and ports are expected areas.

12. Chapter Revision Sheet

Classify hardware by function and persistence. Follow data from input device through interface and memory to processing and output. Compare storage using latency, capacity, durability, cost and access pattern.

13. Practice Questions with Solutions

Attempt each question first. The explanation discusses only the correct answer.

Q1. The fastest storage in the normal hierarchy is

(A) CPU registers
(B) temporal and spatial locality
(C) secondary storage as a backing store for pages
(D) remote storage delivered over a network

Correct Answer: (A)

Registers are located inside the processor datapath.

Q2. Cache memory primarily exploits

(A) cache memory
(B) temporal and spatial locality
(C) programmable once
(D) convert character images into editable text

Correct Answer: (B)

Programs reuse recent and nearby data.

Q3. SRAM is commonly used for

(A) periodic refresh
(B) ultraviolet light
(C) cache memory
(D) detect marked positions on forms

Correct Answer: (C)

It is fast but less dense and more costly.

Q4. DRAM requires

(A) DRAM
(B) in blocks
(C) bank cheque processing
(D) periodic refresh

Correct Answer: (D)

Stored capacitor charge leaks with time.

Q5. Main memory in typical computers is

(A) DRAM
(B) secondary storage as a backing store for pages
(C) magnetically on rotating platters
(D) an impact printer

Correct Answer: (A)

DRAM offers economical high density.

Q6. Virtual memory uses

(A) programmable once
(B) secondary storage as a backing store for pages
(C) has no moving read-write head
(D) toner and electrostatic imaging

Correct Answer: (B)

It extends the process address-space abstraction.

Q7. PROM is normally

(A) ultraviolet light
(B) remote storage delivered over a network
(C) programmable once
(D) self-emissive

Correct Answer: (C)

Its programmed pattern is permanent.

Q8. EPROM is traditionally erased using

(A) in blocks
(B) convert character images into editable text
(C) mirroring
(D) ultraviolet light

Correct Answer: (D)

UV exposure clears its floating-gate charge.

Q9. Flash memory normally erases data

(A) in blocks
(B) magnetically on rotating platters
(C) detect marked positions on forms
(D) striping without redundancy

Correct Answer: (A)

Block erase distinguishes flash organization.

Q10. An HDD stores data

(A) has no moving read-write head
(B) magnetically on rotating platters
(C) bank cheque processing
(D) CPU registers

Correct Answer: (B)

Mechanical heads access magnetic surfaces.

Q11. An SSD differs from an HDD because it

(A) remote storage delivered over a network
(B) an impact printer
(C) has no moving read-write head
(D) temporal and spatial locality

Correct Answer: (C)

Flash and a controller provide solid-state access.

Q12. Cloud storage means

(A) convert character images into editable text
(B) toner and electrostatic imaging
(C) cache memory
(D) remote storage delivered over a network

Correct Answer: (D)

Physical media still exists in provider data centres.

Q13. OCR is used to

(A) convert character images into editable text
(B) detect marked positions on forms
(C) self-emissive
(D) periodic refresh

Correct Answer: (A)

It recognizes glyphs as characters.

Q14. OMR is used to

(A) bank cheque processing
(B) detect marked positions on forms
(C) mirroring
(D) DRAM

Correct Answer: (B)

It reads filled bubbles or marks.

Q15. MICR is strongly associated with

(A) an impact printer
(B) striping without redundancy
(C) bank cheque processing
(D) secondary storage as a backing store for pages

Correct Answer: (C)

Magnetic-ink characters remain reliably machine readable.

Q16. A dot-matrix printer is

(A) toner and electrostatic imaging
(B) CPU registers
(C) programmable once
(D) an impact printer

Correct Answer: (D)

Pins strike an inked ribbon.

Q17. A laser printer uses

(A) toner and electrostatic imaging
(B) self-emissive
(C) temporal and spatial locality
(D) ultraviolet light

Correct Answer: (A)

It is a non-impact page printer.

Q18. OLED pixels are

(A) mirroring
(B) self-emissive
(C) cache memory
(D) in blocks

Correct Answer: (B)

Each active pixel produces its own light.

Q19. RAID 1 uses

(A) striping without redundancy
(B) periodic refresh
(C) mirroring
(D) magnetically on rotating platters

Correct Answer: (C)

Duplicate copies provide redundancy.

Q20. RAID 0 provides

(A) CPU registers
(B) DRAM
(C) has no moving read-write head
(D) striping without redundancy

Correct Answer: (D)

Any member failure can destroy the array data.

Quick Revision: Re-read the formula box, cover the answers, and explain each exam point aloud. A computing shortcut is ready only when its terminology, unit, layer, scope and conditions are clear.

CHAPTER 3 — OPERATING SYSTEMS

1. Introduction

An operating system is the resource manager and abstraction layer between applications, users and hardware. It schedules processors, manages memory and files, controls devices and enforces protection. Exam questions often test distinctions: program versus process, authentication versus authorization, paging versus segmentation, and buffering versus caching.

2. Complete Theory

Purpose, types and services

The OS provides convenient abstractions such as processes, files and virtual memory while allocating CPU time, memory, devices and storage. Batch systems process queued jobs with little interaction.

Multiprogramming keeps several jobs in memory so the CPU can work while another waits. Multitasking and time sharing rapidly switch among tasks or users.

Real-time systems emphasize bounded response; hard real-time deadlines must not be missed. Distributed systems coordinate networked resources, network OSs provide shared services, and mobile or embedded OSs are optimized for their platforms.

A cloud environment still relies on operating systems beneath orchestration layers.

Hinglish Explanation

OS ko office manager samjho: CPU time, memory, files aur devices allocate karta hai. Real-time ka matlab sirf fast nahi; response deadline predictable hona chahiye.

Multiprogramming utilization improve karti, time sharing interactive response deta hai.

Kernel, shell, system calls and booting

The kernel executes privileged operations and manages core resources. A shell or GUI accepts user commands; applications request kernel services through system calls.

Device drivers translate generic OS requests into device-specific operations. Utilities perform supporting tasks.

On power-up, firmware performs initialization and selects a boot device. BIOS is the traditional firmware interface; UEFI is its modern successor with richer services.

A boot loader loads the OS kernel, which initializes memory, drivers and services before login. Cold boot starts from power-off; restart is a warm boot in common exam terminology.

Hinglish Explanation

Computer ON karte hi OS directly magic se start nahi hota. Firmware hardware initialize karta, boot device choose karta, boot loader kernel load karta, then kernel drivers/services start karta.

Shell kernel nahi hai; user interface layer hai.

Programs, processes, threads and states

A program is passive executable code; a process is a running instance with address space, resources and execution context. The process control block stores identifiers, state, program counter, registers, scheduling and resource information.

Typical states are new, ready, running, waiting or blocked, and terminated. A scheduler selects a ready process; a context switch saves one context and restores another.

Threads are execution sequences within a process and normally share its code, data and open resources while retaining separate stacks and registers. Sharing makes threads economical but requires synchronization.

Hinglish Explanation

Same program ko do baar open karoge to generally two processes ban sakte hain. Process ke andar multiple threads common data share karte hain.

Ready process CPU ka wait karta hai; blocked process event ya I/O ka wait karta hai.

CPU scheduling and deadlock

FCFS runs in arrival order and may cause a convoy effect. SJF selects the shortest predicted CPU burst and minimizes average waiting time for a known set, but long jobs can starve.

Priority scheduling may also starve low-priority work; aging gradually raises waiting priority. Round Robin gives each ready process a time quantum and supports interactivity; too large a quantum approaches FCFS, while too small creates excessive context-switch overhead.

Deadlock requires mutual exclusion, hold and wait, no preemption and circular wait simultaneously. Prevention breaks at least one condition; avoidance and detection are different strategies.

Hinglish Explanation

Round Robin ko rotating queue samjho: har process ko quantum milta hai. Quantum huge hua to FCFS jaisa, tiny hua to switching overhead.

Deadlock tab possible hai jab four Coffman conditions ek saath present hon.

Memory management, paging and segmentation

Paging divides virtual memory into fixed-size pages and physical memory into equal frames. A page table maps pages to frames, eliminating external fragmentation but allowing internal fragmentation.

Segmentation divides a program into variable-size logical units such as code, data and stack; it matches programmer view but can suffer external fragmentation. Virtual memory loads only needed pages.

A reference to an absent page causes a page fault; the OS obtains a frame, reads the page and updates mappings. Excessive paging is thrashing.

Swapping moves process memory between RAM and secondary storage. Cache is a performance copy, not the same abstraction as virtual memory.

Hinglish Explanation

Paging fixed-size blocks use karti hai; segmentation logical variable-size parts. Page fault error nahi - requested page RAM mein absent hai, OS disk se laata hai.

Bahut zyada faults se system thrash karta hai.

Files, devices and I/O techniques

A file is a named persistent collection of data; directories organize names into a hierarchy. File systems track allocation, metadata, permissions and free space.

FAT is simple and widely compatible; NTFS supports richer permissions, journaling and large-volume features. An interrupt alerts the CPU that an event needs service.

DMA transfers blocks between a device and memory with limited CPU intervention. Buffering absorbs producer-consumer speed differences, caching keeps reusable copies, and spooling queues complete jobs for a shared device such as a printer.

Compression reduces representation size; backup creates recoverable copies.

Hinglish Explanation

Buffer temporary flow difference handle karta hai, cache future reuse ke liye copy rakhta hai, spool printer jaise shared device ki jobs queue karta hai. DMA bulk transfer CPU ko har byte copy karne se bachata hai.

Security, malware, Windows and Linux basics

Authentication verifies identity; authorization decides permitted actions. Encryption protects data confidentiality using keys, while hashing commonly supports integrity checks and password verification.

A firewall filters network traffic; antivirus detects or blocks malicious software but cannot guarantee complete safety. A virus attaches to a host, a worm self-propagates across systems, a Trojan disguises malicious behaviour, and ransomware encrypts or blocks data for extortion.

Updates, least privilege, multifactor authentication and tested offline backups form layered defence. Windows and Linux both provide GUI and CLI; Linux commonly uses a single rooted directory tree and is distributed under open-source licenses, while Windows conventions and administration differ.

Hinglish Explanation

Password se identity prove karna authentication; file edit kar sakte ho ya nahi authorization. Antivirus alone enough nahi.

Patches, least privilege, MFA aur offline tested backup combine karke defence-in-depth banta hai.

4. Shortcut and Formula Section

Shortcut / Formula Sheet
1. turnaround time=completion-arrival
2. waiting time=turnaround-CPU burst
3. response time=first run-arrival
4. RR behaviour: large quantum → FCFS
5. page number=floor(logical address/page size)
6. offset=logical address mod page size
7. physical address=frame number x frame size+offset
8. deadlock requires mutual exclusion+hold and wait+no preemption+circular wait
9. backup rule example=3 copies,2 media,1 off-site/offline

5. Formula Derivations and Solved Examples

Scheduling example: P1 arrives at 0 with burst 5 and P2 arrives at 1 with burst 3. Under FCFS, P1 completes at 5 and P2 at 8. Waiting times are 0 and 4, so average waiting is 2 time units. For paging with page size 1024 bytes, logical address 2500 has page number floor(2500/1024)=2 and offset 452. The page table supplies the physical frame.

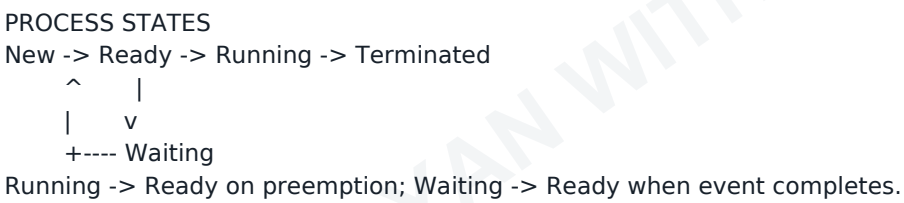
6. Practical Applications

- Desktop and mobile platforms.
- Real-time industrial and safety systems.
- Servers and cloud virtual machines.
- File, print and device management.
- Security, backup and user administration.

7. Short Tricks

- Ready waits for CPU; blocked waits for event.
- Large RR quantum tends to FCFS.
- Paging fixed; segmentation logical variable size.
- Spooling is common for printers.

8. Concept Diagram



9. Comparison Table

Concept	Unit/structure	Typical issue
Paging	fixed pages and frames	internal fragmentation
Segmentation	variable logical segments	external fragmentation
Buffering	temporary flow smoothing	speed mismatch
Caching	reusable copy	stale copy/coherence
Spooling	queued device jobs	shared-device scheduling

10. Common Mistakes

- Calling a program and process identical.
- Confusing ready with blocked.
- Assuming real-time only means fast.
- Confusing page fault with system crash.
- Treating authentication as authorization.

11. Important DSSSB Exam Points

- Boot sequence, process states, scheduling, deadlock conditions, paging, I/O terms and malware differences are high-yield.

12. Chapter Revision Sheet

View the OS as a resource manager. For every scenario identify the resource, process state, scheduling policy, address translation, I/O method and protection decision.

13. Practice Questions with Solutions

Attempt each question first. The explanation discusses only the correct answer.

Q1. The core privileged part of an OS is the

(A) kernel
(B) an application interface to kernel services
(C) ready state
(D) time quantum

Correct Answer: (A)
It manages protected hardware and resource operations.

Q2. A system call provides

(A) UEFI
(B) an application interface to kernel services
(C) blocked or waiting
(D) starvation

Correct Answer: (B)
User programs request OS operations through system calls.

Q3. The modern firmware successor to traditional BIOS is

(A) loads the operating-system kernel
(B) PCB
(C) UEFI
(D) four

Correct Answer: (C)
UEFI provides the contemporary boot firmware interface.

Q4. A boot loader primarily

(A) passive code
(B) code and data address space
(C) fixed-size pages and frames
(D) loads the operating-system kernel

Correct Answer: (D)
It transfers control from firmware to the OS.

Q5. A program is

(A) passive code
(B) ready state
(C) the convoy effect
(D) variable-size logical units

Correct Answer: (A)
A process is an executing instance of that code.

Q6. A process waiting for CPU is in the

(A) blocked or waiting
(B) ready state
(C) average waiting time
(D) a referenced page is not in physical memory

Correct Answer: (B)

It has resources except the processor.

Q7. A process waiting for I/O is normally

(A) PCB
(B) time quantum
(C) blocked or waiting
(D) transfer blocks with limited CPU intervention

Correct Answer: (C)

It cannot run until the event completes.

Q8. Process context is recorded in the

(A) code and data address space
(B) starvation
(C) printer job queues
(D) PCB

Correct Answer: (D)

The process control block stores state and scheduling information.

Q9. Threads in one process usually share

(A) code and data address space
(B) the convoy effect
(C) four
(D) who the user is

Correct Answer: (A)

Each thread still has its own stack and registers.

Q10. FCFS may suffer from

(A) average waiting time
(B) the convoy effect
(C) fixed-size pages and frames
(D) kernel

Correct Answer: (B)

Short jobs can wait behind a long CPU-bound job.

Q11. SJF with known bursts minimizes

(A) time quantum
(B) variable-size logical units
(C) average waiting time
(D) an application interface to kernel services

Correct Answer: (C)

Serving shorter jobs first gives the optimal average for the set.

Q12. Round Robin is controlled by a

(A) starvation
(B) a referenced page is not in physical memory
(C) UEFI
(D) time quantum

Correct Answer: (D)

The quantum limits each turn on the CPU.

Q13. Aging helps prevent

(A) starvation
(B) four
(C) transfer blocks with limited CPU intervention
(D) loads the operating-system kernel

Correct Answer: (A)

Waiting tasks gradually receive higher priority.

Q14. Deadlock requires how many Coffman conditions?

(A) fixed-size pages and frames
(B) four
(C) printer job queues
(D) passive code

Correct Answer: (B)

All four necessary conditions must hold simultaneously.

Q15. Paging uses

(A) variable-size logical units
(B) who the user is
(C) fixed-size pages and frames
(D) ready state

Correct Answer: (C)

Equal sizes simplify physical allocation.

Q16. Segmentation uses

(A) a referenced page is not in physical memory
(B) kernel
(C) blocked or waiting
(D) variable-size logical units

Correct Answer: (D)

Segments correspond to code, data or other logical parts.

Q17. A page fault occurs when

(A) a referenced page is not in physical memory
(B) transfer blocks with limited CPU intervention
(C) an application interface to kernel services
(D) PCB

Correct Answer: (A)

The OS must fetch the page from backing storage.

Q18. DMA is used to

(A) printer job queues
(B) transfer blocks with limited CPU intervention
(C) UEFI
(D) code and data address space

Correct Answer: (B)

A controller handles most of the data movement.

Q19. Spooling is commonly associated with

(A) who the user is
(B) loads the operating-system kernel
(C) printer job queues
(D) the convoy effect

Correct Answer: (C)

Jobs wait on storage for a shared sequential device.

Q20. Authentication determines

(A) kernel
(B) passive code
(C) average waiting time
(D) who the user is

Correct Answer: (D)

Authorization subsequently determines allowed actions.

Quick Revision: Re-read the formula box, cover the answers, and explain each exam point aloud. A computing shortcut is ready only when its terminology, unit, layer, scope and conditions are clear.

CHAPTER 4 — COMPUTER NETWORKING

1. Introduction

A network connects devices so data and resources can be exchanged under agreed protocols. Correct answers often depend on scope and layer: a switch forwards frames using MAC addresses, a router forwards packets using IP addresses, and DNS translates names rather than assigning addresses. This chapter moves from topology and media to layered models, addressing, services and security.

2. Complete Theory

Network scope, purpose and ownership

A PAN covers a person's short-range devices; a LAN covers a limited site under local administration; a MAN spans a city-scale area; and a WAN connects distant regions through carrier or shared infrastructure. The Internet is the global interconnection of networks.

An intranet uses Internet technologies within an organization, while an extranet grants controlled access to selected outsiders. A VPN creates a protected logical tunnel over another network; it does not necessarily provide anonymity or eliminate endpoint risks.

Networks enable sharing, communication, centralized services and redundancy, but introduce management, security and dependency costs.

Hinglish Explanation

PAN phone-earbuds jaisa, LAN office/building, MAN city scale, WAN distant locations. Intranet organization ke andar, extranet selected outside partners ke liye.

VPN encrypted tunnel de sakta hai, but infected endpoint ko clean nahi karta.

Topologies and physical-logical distinction

In a bus, devices share a backbone; it is simple but backbone failure disrupts service. A star connects every node to a central device, easing isolation but making that device important.

A ring forms a closed path; a mesh offers multiple links and high redundancy at greater cost. Tree is hierarchical and hybrid combines forms.

Physical topology describes cabling or radio arrangement, while logical topology describes how frames or access flow. Modern switched Ethernet is physically star-shaped even though historical Ethernet discussions may use bus concepts.

Hinglish Explanation

Topology diagram dekhkar central switch ho to star. Mesh reliable but links rapidly increase.

Physical shape aur logical data flow same hona compulsory nahi. Exam mein advantage ke saath failure point bhi identify karo.

Network devices and forwarding

A repeater regenerates signals. A hub repeats incoming bits to all ports and does not learn addresses.

A bridge connects LAN segments and filters frames; a switch is a multiport bridge that learns source MAC addresses and forwards frames selectively. A router examines network-layer addresses and selects paths between IP networks.

A gateway is a broad term for a device or service translating between dissimilar systems; default gateway commonly means the local router. A modem modulates or converts signals

for an access technology.

An access point bridges wireless stations to a LAN. A firewall applies traffic-control policy.

Hinglish Explanation

Hub sabko copy bhejta hai, switch MAC table se correct port choose karta hai, router IP networks ke beech path choose karta hai. Repeater signal regenerate karta hai.

Device ko layer aur address se yaad karo.

Transmission media

Twisted-pair copper reduces electromagnetic interference through twisting and is common in Ethernet. Coaxial cable has a central conductor and shield.

Optical fiber carries light, provides high bandwidth, long distance and immunity to electromagnetic interference, but requires optical interfaces and careful handling. Wireless uses radio and supports mobility while sharing spectrum and facing interference.

Infrared is short-range and commonly line-of-sight; microwave links can be terrestrial line-of-sight or satellite based. Medium choice depends on bandwidth, distance, environment, cost, security and installation.

Hinglish Explanation

Construction site ke noisy electrical environment mein fiber EMI immune ho sakta hai. Twisted pair economical LAN choice, wireless mobility deta hai.

Fastest bolkar blindly answer nahi; distance, cost aur environment bhi dekho.

OSI and TCP/IP layered models

The OSI model has Physical, Data Link, Network, Transport, Session, Presentation and Application layers. Physical transmits bits; Data Link frames and local delivery; Network packets and routing; Transport end-to-end delivery; Session manages dialogs; Presentation handles representation, compression or encryption concepts; Application supports user-facing network services.

TCP/IP commonly groups functions into Link, Internet, Transport and Application layers. Encapsulation adds headers as data descends; the receiver removes them.

Layering supports modular design, but actual protocols do not always map perfectly to textbook boundaries.

Hinglish Explanation

Mnemonic: Please Do Not Throw Sausage Pizza Away - Physical to Application. Sender par data ke saath headers add hote hain; receiver reverse order mein remove karta hai.

OSI reference model hai, TCP/IP practical protocol suite/model.

Addresses, naming and configuration

A MAC address identifies a network interface for local-link delivery; an IP address provides logical addressing across networks. IPv4 uses 32 bits and IPv6 uses 128 bits.

A subnet prefix separates network and host portions. Private IPv4 ranges are not directly routed on the public Internet and often use NAT.

DNS maps domain names to records such as IP addresses. DHCP automatically supplies configuration including address, mask, gateway and DNS server.

A URL identifies a resource and includes a scheme and location. Public IP, private IP and MAC address serve different scopes and must not be interchanged.

Hinglish Explanation

Switch local MAC dekhta hai, router IP dekhta hai. DNS name resolve karta hai; DHCP address configuration deta hai.

IPv4 32-bit, IPv6 128-bit. URL sirf domain nahi - scheme, host aur optional path bhi include kar sakta hai.

Protocols, Internet services and security

HTTP transfers web resources; HTTPS is HTTP protected by TLS. FTP transfers files but traditional FTP is not encrypted.

SMTP submits and relays email; POP3 commonly downloads messages, while IMAP synchronizes server-side mailboxes. Cloud computing provides shared configurable resources as services, and IoT connects sensing or control devices.

Phishing manipulates users into revealing data, spoofing forges identity information, and malware exploits endpoints. TLS authenticates servers with certificates and protects data in transit.

A digital signature supports origin authentication and integrity, not secrecy by itself. Cyber hygiene includes updates, strong unique credentials, MFA, backups and cautious link handling.

Hinglish Explanation

HTTPS ka S sirf website genuine hone ki unlimited guarantee nahi; TLS connection protect aur certificate identity bind karta hai. SMTP sending, POP3 download-oriented, IMAP server synchronization.

Digital signature data hide nahi karti; integrity/authenticity support karti hai.

4. Shortcut and Formula Section

Shortcut / Formula Sheet
1. IPv4 length=32 bits
2. IPv6 length=128 bits
3. IPv4 address count=2^{32}
4. IPv6 address count=2^{128}
5. subnet addresses=$2^{\text{host bits}}$
6. usable IPv4 hosts in conventional subnet approximately $2^{\text{host bits}}-2$
7. transmission time=data size/bit rate
8. propagation time=distance/propagation speed
9. total simple delay approximately transmission+propagation+processing+queueing

5. Formula Derivations and Solved Examples

Example: a /26 IPv4 subnet leaves 6 host bits, so it contains $2^6=64$ addresses and conventionally 62 usable host addresses. A 1 Mbit frame on a 10 Mbit/s link takes 0.1 s to transmit. This transmission time is distinct from propagation delay, which depends on distance and signal speed. Layer identification example: a switch selects a LAN port using MAC information, while a router selects a network path using an IP prefix.

6. Practical Applications

- Office and campus LANs.
- Remote access through VPN.
- Cloud, IoT and smart infrastructure.
- Email, web and file services.
- Distributed engineering and GIS systems.

7. Short Tricks

- Hub broadcasts bits; switch learns MAC; router uses IP.
- DNS resolves names; DHCP configures hosts.
- SMTP sends; POP3/IMAP retrieve.
- IPv4 32 bits; IPv6 128 bits.

8. Concept Diagram

```
OSI MODEL
7 Application   - user network services
6 Presentation  - representation
5 Session       - dialog control
4 Transport     - end-to-end delivery
3 Network       - IP routing
2 Data Link     - frames and MAC
1 Physical      - bits and signals
```

9. Comparison Table

Device	Main information	Primary job
Hub	bits only	repeat to all ports
Switch	MAC address	forward LAN frames
Router	IP address	route between networks
Access point	wireless and MAC	bridge Wi-Fi to LAN
Firewall	policy and headers/state	permit or block traffic

10. Common Mistakes

- Saying DNS assigns IP configuration.
- Saying a switch normally routes IP packets.
- Confusing Internet with WWW.
- Calling HTTPS immune to all attacks.
- Using IPv4 classes where prefix notation is required.

11. Important DSSSB Exam Points

• Network types, topologies, devices, media, OSI layers, IP/DNS/DHCP and Internet protocols dominate exam questions.

12. Chapter Revision Sheet

For every network question identify scope, topology, medium, device, layer, address and protocol. Separate local frame delivery from routed packet delivery and naming from configuration.

13. Practice Questions with Solutions

Attempt each question first. The explanation discusses only the correct answer.

Q1. A network covering a building or campus is normally a

(A) LAN
(B) a protected logical tunnel over another network
(C) MAC addresses
(D) adding layer information as data moves downward

Correct Answer: (A)

A LAN covers a limited locally administered area.

Q2. A VPN primarily creates

(A) a central device
(B) a protected logical tunnel over another network
(C) IP addresses
(D) 32 bits

Correct Answer: (B)

It securely carries traffic over shared infrastructure.

Q3. A star topology connects nodes to

(A) mesh
(B) regenerate a weakened signal
(C) a central device
(D) 128 bits

Correct Answer: (C)

Every endpoint has a separate link to the centre.

Q4. The most redundant basic topology is

(A) all ports
(B) optical fiber
(C) maps domain names to records such as IP addresses
(D) mesh

Correct Answer: (D)

Multiple paths can remain after link failures.

Q5. A hub forwards incoming bits to

(A) all ports
(B) MAC addresses
(C) Network layer
(D) supplies automatic host configuration

Correct Answer: (A)

It does not learn destination addresses.

Q6. A switch normally forwards using

(A) IP addresses
(B) MAC addresses
(C) end-to-end process delivery
(D) TLS

Correct Answer: (B)

It learns and filters data-link frames.

Q7. A router normally forwards using

(A) regenerate a weakened signal
(B) adding layer information as data moves downward
(C) IP addresses
(D) sending and relaying email

Correct Answer: (C)

It chooses paths between logical networks.

Q8. A repeater is used to

(A) optical fiber
(B) 32 bits
(C) synchronize server-side mailboxes
(D) regenerate a weakened signal

Correct Answer: (D)

It operates on signal-level information.

Q9. The medium immune to electromagnetic interference is

(A) optical fiber
(B) Network layer
(C) 128 bits
(D) integrity and origin authentication

Correct Answer: (A)

Information travels as light in dielectric material.

Q10. The OSI layer responsible for routing is

(A) end-to-end process delivery
(B) Network layer
(C) maps domain names to records such as IP addresses
(D) LAN

Correct Answer: (B)

Layer 3 handles logical addressing and paths.

Q11. The OSI transport layer provides

(A) adding layer information as data moves downward
(B) supplies automatic host configuration
(C) end-to-end process delivery
(D) a protected logical tunnel over another network

Correct Answer: (C)

Transport protocols serve communicating applications.

Q12. Encapsulation means

(A) 32 bits
(B) TLS
(C) a central device
(D) adding layer information as data moves downward

Correct Answer: (D)

Each relevant layer adds control information.

Q13. IPv4 addresses contain

(A) 32 bits
(B) 128 bits
(C) sending and relaying email
(D) mesh

Correct Answer: (A)

IPv4 uses four octets.

Q14. IPv6 addresses contain

(A) maps domain names to records such as IP addresses
(B) 128 bits
(C) synchronize server-side mailboxes
(D) all ports

Correct Answer: (B)

IPv6 greatly expands the address space.

Q15. DNS primarily

(A) supplies automatic host configuration
(B) integrity and origin authentication
(C) maps domain names to records such as IP addresses
(D) MAC addresses

Correct Answer: (C)

It is the distributed naming system.

Q16. DHCP primarily

(A) TLS
(B) LAN
(C) IP addresses
(D) supplies automatic host configuration

Correct Answer: (D)

It can provide address, prefix, gateway and DNS settings.

Q17. HTTPS is HTTP protected by

(A) TLS
(B) sending and relaying email
(C) a protected logical tunnel over another network
(D) regenerate a weakened signal

Correct Answer: (A)

TLS provides authentication and encryption in transit.

Q18. SMTP is used primarily for

(A) synchronize server-side mailboxes
(B) sending and relaying email
(C) a central device
(D) optical fiber

Correct Answer: (B)

Mail clients and servers submit or relay with SMTP.

Q19. IMAP is designed to

(A) integrity and origin authentication
(B) mesh
(C) synchronize server-side mailboxes
(D) Network layer

Correct Answer: (C)

Messages and folders remain managed on the server.

Q20. A digital signature primarily supports

(A) LAN
(B) all ports
(C) end-to-end process delivery
(D) integrity and origin authentication

Correct Answer: (D)

Verification detects alteration and binds the signer.

Quick Revision: Re-read the formula box, cover the answers, and explain each exam point aloud. A computing shortcut is ready only when its terminology, unit, layer, scope and conditions are clear.

CHAPTER 5 — DATABASE MANAGEMENT SYSTEMS (DBMS)

1. Introduction

A DBMS provides controlled, shared and reliable access to structured data. It replaces isolated files with schemas, constraints, query processing, transactions, security and recovery. The chapter develops models, relational terminology, keys, ER design, normalization, SQL and ACID transactions using practical government and engineering examples.

2. Complete Theory

Data, information, databases and DBMS purpose

Data are recorded facts; information is data interpreted in context. A database is an organized collection of related data, while a DBMS is the software used to define, store, query, protect and recover it.

File-based systems often duplicate data, create inconsistent copies, couple programs to formats and provide weak concurrent control. A DBMS offers controlled redundancy, integrity constraints, data independence, authorization, backup, recovery and shared access.

Costs include software, administration, complexity and resource overhead. Applications include banking, reservations, hospitals, government records, ERP, MIS, GIS and project management.

Hinglish Explanation

Excel files alag departments mein duplicate hon to address update ek file mein aur dusri mein old reh sakta hai. DBMS central rules, keys, transactions aur controlled access se inconsistency reduce karta hai.

Database data hai; DBMS usko manage karne wala software.

Database models and three-schema architecture

The hierarchical model organizes records as a tree and naturally represents one-to-many paths. The network model allows graph-like multiple-parent links.

The relational model represents data in tables and uses values and keys to express relationships. Object-oriented databases persist objects, while NoSQL is an umbrella for non-relational families such as document, key-value, column-family and graph stores.

The three-schema architecture separates external user views, the conceptual global logical schema and the internal physical representation. Logical and physical data independence reduce the effect of schema or storage changes on higher levels.

Hinglish Explanation

External level user ko required view, conceptual level complete logical design, internal level disk par storage method. Separation ka fayda: storage change se user forms/queries ideally break na hon.

NoSQL ek single model nahi, multiple families ka umbrella hai.

ER modelling

An entity is a distinguishable object; an entity type groups similar objects. Attributes describe entities and may be simple, composite, single-valued, multivalued or derived.

A relationship associates entity types. Cardinality states maximum participation, such as one-to-one, one-to-many or many-to-many; participation states whether involvement is mandatory or optional.

A weak entity lacks a complete key of its own and depends on an owner through an identifying relationship. ER diagrams use rectangles for entities, diamonds for relationships in classical notation, ovals for attributes, underlining for key attributes and double symbols for weak entities or total participation as defined by the chosen notation.

Hinglish Explanation

Student, Project ya Employee entities ho sakte hain; name/ID attributes. Department employs Employee relationship.

Cardinality maximum count batati hai, participation mandatory ya optional. Weak entity owner ke bina uniquely exist nahi kar sakti.

Relational structure and keys

A relation is a table, a tuple is a row, an attribute is a column and a domain is the allowed set of values. A superkey uniquely identifies tuples but may contain unnecessary attributes.

A candidate key is a minimal superkey; one candidate is chosen as primary key and the others become alternate keys. A composite key uses multiple attributes.

A foreign key references a candidate or primary key in another or the same relation and enforces referential integrity. Primary-key values are unique and not null.

Foreign-key values may repeat and may be null if the relationship is optional and constraints allow it.

Hinglish Explanation

Har unique column candidate key nahi; candidate key minimal bhi hona chahiye. Primary chosen candidate hai.

Foreign key dusre table se relation banati hai, repeat ho sakti hai. Primary key aur foreign key ko identical rules mat do.

Normalization and anomalies

Normalization decomposes relations to reduce undesirable redundancy while preserving information. First normal form requires atomic values and no repeating groups.

Second normal form is 1NF plus no partial dependency of a non-key attribute on part of a composite candidate key. Third normal form is 2NF plus no transitive dependency of a non-key attribute on a key through another non-key attribute.

BCNF requires every determinant in a nontrivial functional dependency to be a superkey and is stronger than 3NF. Poor design causes insertion, update and deletion anomalies.

Decomposition should be lossless, and dependency preservation is desirable.

Hinglish Explanation

Suppose table mein StudentID, CourseID, StudentName, CourseName, Marks hain. Composite key StudentID+CourseID, but StudentName sirf StudentID par dependent - partial dependency, so 2NF violation.

DepartmentName through DepartmentID aaye to transitive dependency 3NF issue.

SQL categories and core commands

DDL defines structure: CREATE, ALTER and DROP. DML manipulates data: SELECT, INSERT, UPDATE and DELETE in common exam classification.

DCL controls privileges with GRANT and REVOKE. TCL controls transactions with COMMIT, ROLLBACK and SAVEPOINT.

SELECT chooses columns and rows; WHERE filters before grouping, GROUP BY forms groups, HAVING filters groups and ORDER BY sorts output. DELETE removes rows and can use WHERE; DROP removes the database object definition.

SQL is declarative: the user states the required result, while the DBMS optimizer chooses an execution plan.

Hinglish Explanation

DELETE rows remove karta hai, DROP table object hi remove kar sakta hai. WHERE individual rows before grouping, HAVING groups after GROUP BY.

UPDATE without WHERE all rows change kar sakta hai - practical dangerous mistake.

Transactions, ACID and concurrency

A transaction is a logical unit of work. Atomicity means all-or-nothing; consistency preserves declared rules from one valid state to another; isolation makes concurrent transactions behave according to the supported isolation level; durability preserves committed results after failures.

COMMIT makes work permanent and ROLLBACK undoes uncommitted work. Locks and multiversion methods control concurrency.

Problems include lost updates, dirty reads and nonrepeatable reads. A database deadlock occurs when transactions wait cyclically for resources; detection and victim rollback can resolve it.

Logs, checkpoints and backups support recovery.

Hinglish Explanation

Bank transfer mein debit hua but credit fail hua to atomicity rollback karayegi. COMMIT ke baad durability result ko failure ke baad recoverable rakhti hai.

Isolation concurrent users ko unsafe interference se bachati hai. ACID letters exact meaning se yaad karo.

Integrity, security, backup and applications

Domain constraints restrict allowed values; key constraints enforce uniqueness; entity integrity protects primary keys; referential integrity protects foreign-key references. Authentication identifies users and authorization grants least-privilege access through roles or privileges.

Views can expose selected rows or columns. Encryption protects stored or transmitted data, while auditing records actions.

Backup is a copy for restoration; logs and recovery procedures reconstruct a consistent state. Full, incremental and differential strategies trade backup time, storage and restore complexity.

Sensitive government, banking and infrastructure databases require tested recovery plans, not merely a successful backup job.

Hinglish Explanation

Backup file hona enough nahi; restore test hona chahiye. Role-based least privilege do, sabko admin access nahi.

Constraints bad data ko entry point par reject kar sakte hain, aur audit trail batata hai kisne kya change kiya.

4. Shortcut and Formula Section

Shortcut / Formula Sheet
1. superkey=unique attribute set
2. candidate key=minimal superkey
3. primary key=chosen candidate key
4. 1NF=atomic values
5. 2NF=1NF+no partial dependency on composite key
6. 3NF=2NF+no transitive non-key dependency
7. BCNF=every determinant is a superkey
8. SQL logical order: FROM → WHERE → GROUP BY → HAVING → SELECT → ORDER BY
9. ACID=Atomicity,Consistency,Isolation,Durability

5. Formula Derivations and Solved Examples

Normalization example: ENROLL(StudentID,CourseID,StudentName,CourseName,Marks) has composite key (StudentID,CourseID). StudentName depends only on StudentID and CourseName only on CourseID, creating partial dependencies. Decompose to STUDENT(StudentID,StudentName), COURSE(CourseID,CourseName) and ENROLL(StudentID,CourseID,Marks). SQL example: SELECT Department, COUNT(*) FROM Employee WHERE Active=1 GROUP BY Department HAVING COUNT(*)>5 ORDER BY Department;

6. Practical Applications

- Banking, railway and hospital records.
- Government citizen services.
- ERP, payroll and inventory.
- Construction projects, contracts and assets.
- GIS, MIS and engineering data.

7. Short Tricks

- Candidate key is minimal superkey.
- Primary key cannot be null.
- WHERE before grouping; HAVING after grouping.
- COMMIT keeps; ROLLBACK reverses uncommitted work.

8. Concept Diagram

THREE-SCHEMA DBMS
External views (users/applications)
v
Conceptual schema (global logical design)
v
Internal schema (files, indexes, pages)
v
Physical storage

9. Comparison Table

Term	Meaning	Key property
Primary key	chosen candidate key	unique and not null
Foreign key	reference to another key	may repeat
1NF	atomic values	no repeating groups
2NF	remove partial dependency	relevant to composite keys
3NF	remove transitive non-key dependency	non-key depends on key
BCNF	determinants are superkeys	stronger condition

10. Common Mistakes

• Calling every superkey a candidate key.

• Assuming foreign keys must be unique.

• Confusing DELETE with DROP.

• Using WHERE to filter groups instead of HAVING.

• Treating backup completion as verified recovery.

11. Important DSSSB Exam Points

• Keys, ER cardinality, normalization dependencies, SQL command classes, WHERE/HAVING and ACID are major exam areas.

12. Chapter Revision Sheet

Begin with entities and business rules, choose minimal keys, express relationships, normalize dependencies, enforce constraints, query declaratively and protect multi-step work with transactions.

13. Practice Questions with Solutions

Attempt each question first. The explanation discusses only the correct answer.

Q1. A database is

(A) an organized collection of related data
(B) tables
(C) the maximum relationship count
(D) atomic attribute values

Correct Answer: (A)

A DBMS is the software that manages it.

Q2. The relational model represents data mainly as

(A) the global logical database structure
(B) tables
(C) an owner entity for identification
(D) partial dependency on part of a composite key

Correct Answer: (B)

Relations are displayed as rows and columns.

Q3. The conceptual schema describes

(A) a user or application view
(B) a row in a relation
(C) the global logical database structure
(D) transitive dependency of non-key attributes

Correct Answer: (C)

It sits between external views and internal storage.

Q4. An external schema represents

(A) a distinguishable real-world object or concept
(B) a minimal superkey
(C) DDL
(D) a user or application view

Correct Answer: (D)

Different users can see different subsets.

Q5. An entity is

(A) a distinguishable real-world object or concept
(B) the maximum relationship count
(C) the selected candidate key
(D) DML

Correct Answer: (A)

Its attributes record properties.

Q6. Cardinality describes

(A) an owner entity for identification
(B) the maximum relationship count
(C) enforce a reference between relations
(D) DCL

Correct Answer: (B)

Examples include one-to-many and many-to-many.

Q7. A weak entity depends on

(A) a row in a relation
(B) atomic attribute values
(C) an owner entity for identification
(D) TCL

Correct Answer: (C)

It lacks a complete independent key.

Q8. A tuple is

(A) a minimal superkey
(B) partial dependency on part of a composite key
(C) all operations occur or none occur
(D) a row in a relation

Correct Answer: (D)

Each tuple represents one relational record.

Q9. A candidate key is

(A) a minimal superkey
(B) the selected candidate key
(C) transitive dependency of non-key attributes
(D) committed results survive failure

Correct Answer: (A)

No attribute can be removed while retaining uniqueness.

Q10. A primary key is

(A) enforce a reference between relations
(B) the selected candidate key
(C) DDL
(D) an organized collection of related data

Correct Answer: (B)

It is chosen to identify tuples.

Q11. A foreign key is used to

(A) atomic attribute values
(B) DML
(C) enforce a reference between relations
(D) tables

Correct Answer: (C)

It points to a candidate or primary key.

Q12. First normal form requires

(A) partial dependency on part of a composite key
(B) DCL
(C) the global logical database structure
(D) atomic attribute values

Correct Answer: (D)

Repeating groups and nested values are removed.

Q13. Second normal form removes

(A) partial dependency on part of a composite key
(B) transitive dependency of non-key attributes
(C) TCL
(D) a user or application view

Correct Answer: (A)

Non-key attributes must depend on the whole key.

Q14. Third normal form removes

(A) DDL
(B) transitive dependency of non-key attributes
(C) all operations occur or none occur
(D) a distinguishable real-world object or concept

Correct Answer: (B)

Non-key facts should not depend through another non-key fact.

Q15. CREATE is commonly classified as

(A) DML
(B) committed results survive failure
(C) DDL
(D) the maximum relationship count

Correct Answer: (C)

It defines a database object.

Q16. INSERT is commonly classified as

(A) DCL
(B) an organized collection of related data
(C) an owner entity for identification
(D) DML

Correct Answer: (D)

It adds rows to a relation.

Q17. GRANT is classified as

(A) DCL
(B) TCL
(C) tables
(D) a row in a relation

Correct Answer: (A)

It assigns privileges.

Q18. COMMIT is classified as

(A) all operations occur or none occur
(B) TCL
(C) the global logical database structure
(D) a minimal superkey

Correct Answer: (B)

It ends a successful transaction durably.

Q19. Atomicity means

(A) committed results survive failure
(B) a user or application view
(C) all operations occur or none occur
(D) the selected candidate key

Correct Answer: (C)

Partial transaction effects are rolled back.

Q20. Durability means

(A) an organized collection of related data
(B) a distinguishable real-world object or concept
(C) enforce a reference between relations
(D) committed results survive failure

Correct Answer: (D)

Recovery mechanisms preserve committed work.

Quick Revision: Re-read the formula box, cover the answers, and explain each exam point aloud. A computing shortcut is ready only when its terminology, unit, layer, scope and conditions are clear.