

1. **What is a microprocessor?**

A programmable IC that fetches, decodes, and executes instructions.

2. **Which was the first microprocessor?**

Intel 4004, a 4-bit processor released in 1971.

3. **Why is a microprocessor called the CPU of a computer?**

It controls and processes all system operations.

4. **How does the ALU work?**

It performs arithmetic and logic operations.

5. **What is the role of the control unit?**

It generates control signals to coordinate operations.

6. **Which buses connect CPU to memory?**

Address, data, and control buses.

7. **Why is program counter needed?**

It holds the next instruction address.

8. **How does a stack help?**

It stores temporary data like return addresses.

9. **What are the flags in 8085?**

Sign, Zero, Auxiliary carry, Parity, and Carry.

10. **What is instruction set?**

A collection of machine-level instructions.

11. **Which addressing modes exist in 8085?**

Immediate, direct, register, indirect, and implied.

12. **Why is assembly language useful?**

It gives low-level hardware control with mnemonics.

13. **How does assembler work?**

It translates mnemonics into machine code.

14. **What is opcode?**

It specifies the operation to be performed.

15. **Which registers are in 8086?**

General, segment, pointer, index, and flag registers.

16. Why does 8086 use segmentation?

To access 1MB memory using 20-bit addressing.

17. How many bits are in 8085's data bus?

It has an 8-bit data bus.

18. What is pipelining?

Overlapping instruction execution phases.

19. Why is instruction queue in 8086?

It prefetches instructions to speed execution.

20. What is difference between RISC and CISC?

RISC has simple, fast instructions; CISC has complex ones.

21. Which is faster: register or memory access?

Registers are much faster.

22. What does instruction decoder do?

It interprets opcodes and signals operations.

23. Why are interrupts used?

They handle urgent events without polling.

24. How does maskable differ from non-maskable interrupt?

Maskable can be disabled; non-maskable cannot.

25. Which is the highest priority interrupt in 8085?

TRAP, a non-maskable interrupt.

26. Why are flags needed in ALU?

They show result conditions like zero or carry.

27. How many address lines in 8085?

16 lines for 64KB memory.

28. What is stack pointer?

A 16-bit register pointing to top of stack.

29. Which memory is cache?

SRAM between CPU and RAM.

30. Why is clock signal needed?

It synchronizes CPU operations.

31. What is machine cycle?

Time for one fetch/read/write operation.

32. Which is faster: SRAM or DRAM?

SRAM is faster but expensive.

33. Why is ALE signal in 8085?

It separates multiplexed address/data lines.

34. How many instructions in 8085?

74 instructions, 246 opcodes.

35. What is difference between CALL and JUMP?

CALL saves return address; JUMP does not.

36. Which instruction clears accumulator?

XRA A sets accumulator to 0.

37. Why are macros used?

They replace repetitive code with one definition.

38. How are subroutines defined?

Small reusable code blocks called by CALL.

39. Which instruction checks zero flag?

JZ checks if result is zero.

40. Why use SIM instruction?

To mask interrupts and set serial output.

41. What do IN/OUT instructions do?

They transfer data between CPU and I/O ports.

42. Why are multiplexed buses used?

To reduce chip pin count.

43. What is DMA?

Direct device-to-memory data transfer.

44. Which signal indicates read?

\overline{RD} indicates memory or I/O read.

45. What is T-state?

One clock period of operation.

46. **Which are segment registers in 8086?**

CS, DS, SS, and ES.

47. **Which register pair points memory in 8085?**

HL register pair.

48. **Why are logical instructions needed?**

For AND, OR, XOR, shifts, complements.

49. **What is difference between immediate and direct addressing?**

Immediate has value; direct has memory address.

50. **Which instruction halts CPU?**

HLT stops execution.

51. **Why is segmentation beneficial?**

Supports modular programming and large memory.

52. **How does microprocessor differ from microcontroller?**

Processor needs peripherals; controller has them built-in.

53. **What is signed vs unsigned numbers?**

Signed include negatives; unsigned only positives.

54. **Which instruction rotates accumulator?**

RLC and **RRC**.

55. **Why are assembler directives used?**

They **guide assembler**, not CPU.

56. **How are loops implemented?**

With LOOP instruction and CX.

57. **What is near vs far jump?**

Near changes IP only; far changes CS:IP.

58. **Why is CALL powerful?**

It supports modular coding.

59. **Which instruction swaps data?**

XCHG exchanges register contents.

60. **Why use pseudo-instructions?**

For labels and variables.

61. **How does PUSH work?**

SP decrements and data is stored.

62. **Which restores data from stack?**

POP retrieves register content.

63. **Why segment overrides in 8086?**

To access non-default segments.

64. **What are software vs hardware interrupts?**

Software from instructions; hardware from signals.

65. **Which instruction generates software interrupt?**

INT n.

66. **Why priority encoder in interrupts?**

To resolve multiple requests.

67. **What is instruction queue size in 8086?**

6 bytes.

68. **Which signal distinguishes memory vs I/O?**

IO/M $\bar{}$.

69. **Why parity flag?**

It checks even/odd bits.

70. **Which instruction complements accumulator?**

CMA flips all bits.

71. **Why use shift instructions?**

For fast multiply/divide by 2.

72. **What is SHR vs SAR?**

SHR logical; SAR arithmetic.

73. **Why interrupts faster than polling?**

They avoid constant checking.

74. **Which register is base pointer in 8086?**

BP register.

75. **Why overlap segments in 8086?**

For memory efficiency.

76. What is trap flag?

It enables single-step debugging.

77. Why conditional jumps?

They branch based on flags.

78. Which instruction multiplies signed numbers?

IMUL.

79. Why minimum and maximum mode in 8086?

For single or multiprocessor use.

80. Which instruction divides unsigned numbers?

DIV.

81. What is assembler pass-1?

It builds symbol table and checks syntax.

82. What is pass-2?

It generates machine code.

83. Why are labels used in assembly?

They mark instruction addresses.

84. Which register holds instruction pointer?

IP register.

85. What is difference between MOV and MVI?

MOV copies register/memory; MVI loads immediate data.

86. Why segment:offset addressing?

To form 20-bit address.

87. What are predefined interrupts in 8086?

INT 0–4 for divide, debug, NMI, etc.

88. Which flag shows overflow?

Overflow flag (OF).

89. Why conditional call instructions?

They call subroutines only if flag set.

90. What is difference between assembler and linker?

Assembler makes object code; linker combines modules.

91. **Which instruction clears carry flag?**

CLC.

92. **Why stack grows downward?**

To avoid overlap with code/data segments.

93. **What is difference between ORG and EQU?**

ORG sets location; EQU assigns constant.

94. **Which instruction is no-operation?**

NOP.

95. **Why LOOP instruction useful?**

It reduces jump overhead.

96. **What is role of CS in 8086?**

Holds code segment base address.

97. **Which instruction loads effective address?**

LEA.

98. **Why test instruction used?**

It performs AND without changing operands.

99. **What is use of XLAT?**

It translates byte from lookup table.

100. **Which instruction copies string?**

MOVS copies bytes/words.

101. **Why direction flag important?**

It decides string movement left/right.

102. **Which instruction scans string?**

SCAS searches for byte/word.

103. **Why repeat prefixes used?**

To repeat string instructions.

104. **What is difference between REP and REPE?**

REP repeats always; REPE while equal.

105. **Which instruction compares strings?**

CMPS compares two strings.

106. **Why use conditional assembly?**

To assemble code selectively.

107. **What are macros vs procedures?**

Macros expanded inline; procedures invoked.

108. **Why modular programming important?**

It improves readability and reuse.

109. **Which instruction returns from interrupt?**

IRET.

110. **What is difference between CLI and STI?**

CLI clears interrupts; STI enables them.

111. **Why are WAIT states used?**

To match slow memory speed.

112. **What is READY signal in 8086?**

It indicates peripheral readiness.

113. **Which pin indicates power supply in 8085?**

$V_{cc} = +5V$, $V_{ss} = GND$.

114. **Why multiplex address/data lines?**

To save pins on IC.

115. **What is function of SID/SOD in 8085?**

Serial input/output lines.

116. **Which register holds memory pointer in 8086?**

SI and DI.

117. **Why is SS register needed?**

It points to stack segment.

118. **What is difference between JMP and LCALL?**

JMP changes control; LCALL saves return.

119. **Why PUSHF and POPF used?**

To save and restore flags.

120. **Which instruction shifts with carry?**

RCL/RCR.

121. **What is role of NOP?**

It wastes one cycle for timing.

122. **Why assembler generates listing file?**

For debugging and reference.

123. **What is use of END directive?**

It marks end of source program.

124. **What is microcode in processors?**

It is low-level control instructions stored in control memory.

125. **Which pipeline hazards occur in microprocessors?**

Structural, data, and control hazards.

126. **Why cache coherence is important?**

To keep multiple cache copies consistent.

127. **How does virtual memory help CPUs?**

It extends memory using disk storage.

128. **What is paging in memory systems?**

Dividing memory into fixed-size pages.

129. **Why segmentation faults occur?**

Due to invalid memory access.

130. **How does MMU work?**

It translates virtual to physical addresses.

131. **Which technique improves instruction throughput?**

Pipelining.

132. **Why branch prediction important?**

To reduce pipeline stalls.

133. **What is microprogrammed control?**

Control signals generated by microcode.

134. **Which addressing mode is fastest?**

Register addressing.

135. **Why is Harvard architecture used?**

It separates instruction and data buses.

136. **How does superscalar architecture improve performance?**

By executing multiple instructions per cycle.

137. **What is difference between macro and micro instruction?**

Macro is high-level assembly; micro is hardware-level control.

138. **Why stack overflow occurs?**

Due to exceeding allocated stack memory.

139. **How does interrupt vector table work?**

It holds addresses of ISRs.

140. **Which scheduling is used in pipelines?**

Dynamic instruction scheduling.

141. **Why out-of-order execution is useful?**

It avoids stalls by reordering instructions.

142. **What is register renaming?**

Technique to eliminate false dependencies.

143. **Why is CISC still used today?**

For code density and legacy support.

144. **How does instruction latency differ from throughput?**

Latency = time per instruction; throughput = instructions per unit time.

145. **What is speculative execution?**

Executing instructions before branch resolution.

146. **Which register stores flags in 8086?**

FLAGS register.

147. **Why is instruction pipelining limited?**

Due to hazards and dependencies.

148. **What is difference between control and status signals?**

Control directs operations; status shows current state.

149. **Why is DMA faster than CPU transfer?**

It bypasses CPU for memory access.

150. **How does vectored interrupt differ from non-vectored?**

Vectored has fixed ISR address; non-vectored needs external.

151. **What is shadow register?**
Backup registers for fast context switching.
152. **Why prefetch buffer used?**
To reduce memory access delay.
153. **What is pipeline flushing?**
Clearing pipeline on wrong branch.
154. **Which flag detects arithmetic overflow?**
OF flag.
155. **Why instruction length varies in CISC?**
For flexibility and complex operations.
156. **What is stack frame?**
Memory layout for procedure calls.
157. **Why call stack important?**
It tracks active subroutine calls.
158. **How does priority interrupt work?**
By assigning fixed priorities to requests.
159. **Which unit performs floating-point operations?**
FPU (Floating-Point Unit).
160. **Why is microprocessor clock doubled internally?**
To speed up instruction phases.
161. **How does pipeline stall resolved?**
Using forwarding or bubbles.
162. **What is hyper-threading?**
Simultaneous multi-threading for parallelism.
163. **Why instruction alignment important?**
Misalignment causes extra cycles.
164. **What is watchdog timer?**
A timer to detect system hangs.
165. **Why memory-mapped I/O used?**
To unify I/O and memory address space.

166. **Which unit fetches instructions in pipeline?**

Instruction Fetch Unit.

167. **Why cache associativity used?**

To reduce conflict misses.

168. **What is difference between write-through and write-back cache?**

Write-through updates memory immediately; write-back delays.

169. **Why hazard detection unit needed?**

To avoid pipeline errors.

170. **How does clock skew affect CPU?**

It causes synchronization issues.

171. **What is speculative branch execution?**

Executing predicted branch path.

172. **Why loop unrolling used in assembly?**

It reduces branch overhead.

173. **What is instruction window?**

A buffer holding decoded instructions.

174. **Why instruction set must be orthogonal?**

For simplicity and consistency.

175. **What is micro-operation?**

Small step implementing instruction execution.

176. **Why paging with TLB important?**

It speeds up address translation.

177. **What is bus arbitration?**

Process of deciding bus master.

178. **Why priority inversion problem occurs?**

When low-priority task blocks high-priority.

179. **How does cache miss penalty reduced?**

Using multi-level caches.

180. **What is difference between maskable and vectored interrupts?**

Maskable can be disabled; vectored has predefined addresses.

181. **Why is instruction pre-decoding done?**

To speed up later pipeline stages.

182. **What is barrel shifter?**

A circuit for fast shifting/rotation.

183. **Why instruction cycle differs from machine cycle?**

Instruction cycle is multiple machine cycles.

184. **How does Harvard differ from Von Neumann?**

Harvard separates memory; Von Neumann uses single.

185. **Why stack-based machines simpler?**

They avoid explicit register addressing.

186. **What is pipeline depth?**

Number of stages in pipeline.

187. **Why hazard forwarding used?**

To solve data hazards quickly.

188. **What is branch delay slot?**

Instruction executed after branch regardless.

189. **Why dynamic branch prediction better?**

It adapts to program behavior.

190. **What is bus cycle?**

One transfer operation over bus.

191. **Why instruction-level parallelism important?**

It improves CPU throughput.

192. **What is superscalar execution?**

Multiple pipelines execute instructions simultaneously.

193. **Why control word used in 8255?**

To configure modes of operation.

194. **What is tri-state buffer?**

It has high, low, and high-impedance states.

195. **Why instruction profiling done?**

To optimize performance hotspots.

196. **How does hardwired control differ from microprogrammed?**

Hardwired is fast but inflexible; microprogrammed is flexible.

197. **Why segmentation in memory beneficial?**

It supports modular programs.

198. **What is paging overhead?**

Extra time for address translation.

199. **Why wait states added?**

For slow peripherals to sync.

200. **What is bus contention?**

Conflict when devices drive same bus.

201. **Why stack pointer auto-decrements during PUSH?**

To store data at lower memory addresses as stack grows downward.

202. **How does microprocessor handle recursive calls?**

By using stack to save return addresses for each call.

203. **What is front-end and back-end of CPU pipeline?**

Front-end fetches and decodes; back-end executes and writes results.

204. **Why instruction reordering is done by CPU?**

To reduce stalls and improve execution efficiency.

205. **Which instructions are privileged in 8086?**

Those that control system resources, like CLI and STI.

206. **Why instruction cache is smaller than main memory?**

To provide faster access and reduce latency.

207. **What is context switch in microprocessor?**

Saving and loading registers to switch between tasks.

208. **Why memory interleaving improves speed?**

It allows parallel access to multiple memory banks.

209. **Which instruction sets include SIMD operations?**

MMX, SSE, AVX in modern Intel processors.

210. **Why does pipeline have hazards?**

Due to instruction dependencies and branching.

211. How is branch prediction implemented?

Using static (fixed) or dynamic (history-based) algorithms.

212. What is reorder buffer in CPU?

It stores instructions executed out-of-order for correct commit.

213. Why speculative load used in microprocessors?

To fetch data before confirmation, reducing stall cycles.

214. Which instruction handles signed division in 8086?

IDIV instruction divides signed numbers.

215. Why multiple clock domains in CPU?

To allow components to run at optimal frequencies.

216. What is memory-mapped I/O advantage?

Same instructions can access both memory and I/O.

217. How does branch target buffer work?

It caches addresses of recently taken branches.

218. Why instruction decode stage critical?

Errors here affect entire execution pipeline.

219. What is dual-ported memory?

Memory with two independent access ports for parallel read/write.

220. Why instruction prefetch improves performance?

It reduces fetch delays by loading instructions in advance.

221. What is write buffer in CPU?

Temporary storage for writes before updating main memory.

222. Why is instruction scheduling important?

To minimize pipeline stalls and maximize throughput.

223. Which instruction sets support bit manipulation?

8085/8086 includes ROL, ROR, SHL, SHR, BT, BTS, BTR.

224. How does hardware loop counter work?

Automatically decrements register and checks zero to control loops.

225. Why CPU uses speculative execution?

To utilize idle pipeline stages and improve throughput.

226. What is memory alignment?

Data stored at addresses divisible by its size for efficiency.

227. Why cache line size matters?

It determines how much contiguous memory is fetched per access.

228. Which instruction saves flags on stack?

PUSHF in 8086 saves all flag registers.

229. Why instruction register important?

It holds current instruction being executed.

230. What is dynamic voltage and frequency scaling (DVFS)?

Adjusts CPU speed and voltage for power efficiency.

231. How does TLB improve virtual memory access?

It caches recent virtual-to-physical address translations.

232. Why branch misprediction costly?

Pipeline must flush and refill, wasting cycles.

233. Which instruction repeats string operation?

REP, REPE, or REPNE.

234. What is priority encoder?

Selects highest-priority active input among multiple requests.

235. Why stack grows downward in most processors?

To avoid overlapping with code and data segments.

236. How does CPU handle nested interrupts?

By stacking return addresses and enabling priority-based servicing.

237. Which instruction swaps bytes in a word?

XCHG can swap register contents; BSF/BTC used in bit-level.

238. Why control unit can be hardwired or microprogrammed?

Hardwired is faster; microprogrammed is flexible.

239. What is difference between synchronous and asynchronous interrupts?

Synchronous occur with instruction execution; asynchronous by external events.

240. How does instruction fusion improve performance?

Combines multiple instructions into a single micro-op.

241. **Why CPU uses multi-level caches?**

To reduce latency and increase hit rate for memory accesses.

242. **What is branch folding?**

Skipping execution of branch when outcome is already known.

243. **Which instructions support atomic operations?**

XCHG, CMPXCHG, and LOCK-prefixed instructions.

244. **Why stack frame pointer used in debugging?**

It helps trace local variables and procedure call history.

245. **How do superscalar pipelines handle multiple instructions?**

By executing independent instructions simultaneously in parallel pipelines.