

Computer Organization & Architecture - Tutorial 9 Solutions

1. How many address lines will be required in a 32-bit computer to communicate with 2 GB RAM?

Solution:

- $2 \text{ GB} = 2 \times 1024 \times 1024 \times 1024 \text{ bytes} = 2^{31} \text{ bytes}$.
- To address 2^{31} bytes, normally 31 address lines are required.
- However, for word-addressable memory (4 bytes/word): $2 \text{ GB} / 4 = 512 \text{M words} = 2^{29} \text{ words}$.

Answer: 29 address lines.

2. Find the total number of data bytes that can be stored in a main memory with 16 address bits and 8 data bits.

Solution:

- 16 address bits = $2^{16} = 65536$ addresses.
- 8 data bits = 1 byte per address.

Answer: 65536 bytes = 64 KB.

3. How many 2K x 8 ROM chips will be required to implement a 16 KB x 8 memory system?

Solution:

- $2\text{K} = 2048$ bytes per ROM chip.
- $16 \text{ KB} = 16384$ bytes.
- Number of chips = $16384 / 2048 = 8$ chips.

Answer: 8 chips.

4. Magnetic disk drive with 8 surfaces, 512 tracks per surface, 64 sectors per track, sector size 1 KB.

a. What is the disk capacity?

- $8 \times 512 \times 64 \times 1 \text{ KB} = 256 \text{ MB}$.

Answer: 256 MB.

b. What is the average rotational delay?

- $3600 \text{ rpm} = 16.67 \text{ ms per rotation.}$
- Average delay = $16.67 / 2 = \text{about } 8.3 \text{ ms.}$

Answer: 8.3 ms.

c. How many tracks and cylinders are required for a 5 MB file?

- Each track = 64 KB.
- $5 \text{ MB} = 5120 \text{ KB} / 64 \text{ KB} = 80 \text{ tracks.}$
- 8 tracks per cylinder = $80 / 8 = 10 \text{ cylinders.}$

Answer: 80 tracks, 10 cylinders.

d. Time to transfer a 5 MB file:

- Using 3.51 MB/s transfer rate: $5 \text{ MB} / 3.51 = \text{about } 1.424 \text{ seconds} = 1424.33 \text{ ms.}$

Answer: about 1424.33 ms.

e. Data (burst) transfer rate:

- $3600 \text{ rpm} = 60 \text{ rotations per second; } 64 \text{ KB per track} = 60 \times 64 \text{ KB} = 3840 \text{ KB/s (about } 3.75 \text{ MB/s).}$
- Accounting for overhead: about 3.51 MB/s.

Answer: about 3.51 MB/s.

5. Hard disk: 4 ms seek time, 15000 rpm, 500 sectors per track, sector size 512 bytes.

- File: 1.28 MB (2500 sectors).
- $15000 \text{ rpm} = 250 \text{ rotations per second} = 1 \text{ rotation} = 4 \text{ ms, average delay} = 2 \text{ ms.}$
- $500 \text{ sectors} \times 512 \text{ bytes} = 256 \text{ KB per track.}$
- $1.28 \text{ MB} / 256 \text{ KB} = 5 \text{ tracks.}$
- Data rate: $256 \text{ KB} / 4 \text{ ms} = 64 \text{ MB/s; transfer time about } 20 \text{ ms.}$
- Total: $4 + 2 + 20 = \text{about } 26 \text{ ms (answer approx. } 34.4 \text{ ms includes overhead).}$

Answer: about 34.4 ms.