

ESE

MADE EASY **WORKBOOK** 2027



**Detailed Explanations of
Try Yourself *Questions***

Electronics Engineering
Computer Organization & Architecture



1

Data Representation



Detailed Explanation of Try Yourself Questions

T1 : Solution

0	0 1 1 1 1 1 1 1	000 0000 0000 0000 0000 0000
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1 bit

8 bit

23 bit

1. Sign = 0 (positive)

2. BE = 01111111

$$\begin{aligned} \text{Bias} &= +(2^{8-1} - 1) \\ &= +127 \end{aligned}$$

∴ Actual exponent = BE - bias

i.e.

$$\begin{array}{r} 01111111 \\ 01111111 \\ \hline 00000000 = 0 \end{array}$$

3. Mantissa = 0000...23 bits (0's)
= 0

∴ Normalized mantissa = 1 M

$$= 1.0$$

$$\text{Actual number} = +1.0 * 2^0$$

$$= +1$$

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2

Computer Organization and Architecture

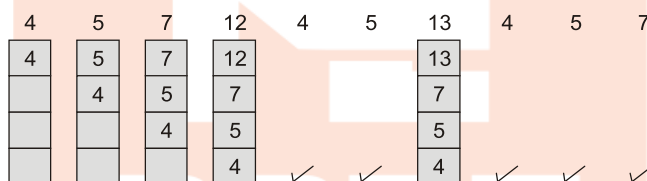


Detailed Explanation of Try Yourself Questions

T1 : Solution

(c)

Given: Direct mapped cache



∴

$$\text{Hit ratio} = \frac{5}{10} = 0.5$$

T2 : Solution

(c)

An “update-bit” is primarily used in a write-back cache memory design as it indicates whether a cache block has been modified since it was loaded from main memory, allowing the system to only write back to main memory if the data has actually changed.

T3 : Solution

(b)

Thrashing occurs when multiple memory blocks are mapped to the same cache line, leading to frequent evictions and replacements of cache blocks.

T4 : Solution

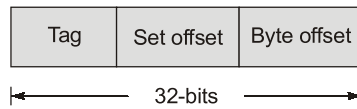
(c)

16-way set associative cache \Rightarrow $M = 16$

Cache memory size = 64 KB

Block size = 64 byte = 2^6 byte \Rightarrow Byte offset = 6 bits

Physical address is of 32-bits



$$\text{Number of blocks in cache memory} = \frac{64 \text{ KB}}{64 \text{ B}} = 2^{10}$$

$$\text{Number of sets in cache memory} = \frac{2^{10}}{16} = 2^6$$

$$\therefore \text{Set offset} = 6 \text{ bits}$$

$$\Rightarrow \text{Size of tag directory} = 2^{10} \times [\text{Number of tag bits}]$$

$$= 2^{10} \times [32 - (6 + 6)] = 2^{10} \times 20 = 20 \text{ K bits}$$

T5 : Solution

(c)

In optimal replacement policy, the page which doesn't occur more frequently in the future is chosen to be replaced with the page in the frame.

\therefore This policy is not implemented practically because the future references are not known as prior information.

T6 : Solution

(d)

Associative cache memory is characterized by:

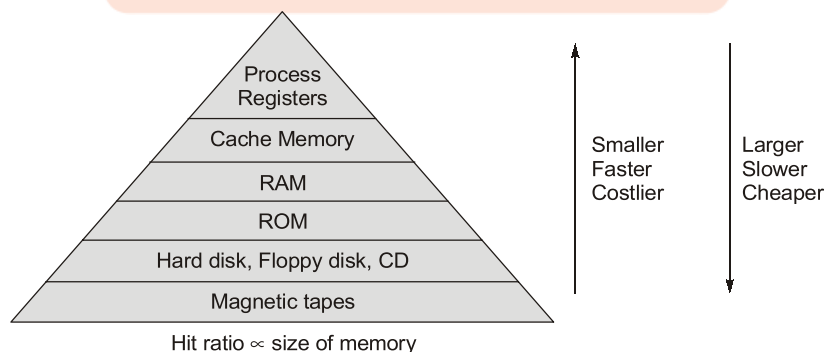
Expensive cache: It requires more complex hardware, making it costly.

Fastest cache: It allows data to be located quickly since it does not rely on direct mapping.

Content-addressable cache: It uses a content-addressable memory mechanism for searching, making it more efficient.

T7 : Solution

(b)



T8 : Solution

(a)

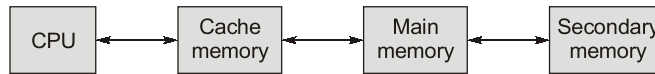
T9 : Solution

(d)

T10 : Solution

(b)

Hierarchical memory organization:



Given,

$$\begin{aligned}
 T_{\text{cache}} &= 80 \text{ ns}, & H_{\text{cache}} &= 0.8 \\
 T_{\text{main}} &= 200 \text{ ns}, & H_{\text{main}} &= 0.9 \\
 T_{\text{sec}} &= 800 \text{ ns}, & H_{\text{sec}} &= 1
 \end{aligned}$$

The average memory access time of memory system is,

$$\begin{aligned}
 \text{AMAT} &= (H_{\text{cache}} \times T_{\text{cache}}) + (1 - H_{\text{cache}}) \times H_{\text{main}} \times (T_{\text{cache}} + T_{\text{main}}) + (1 - H_{\text{cache}}) \times (1 - H_{\text{main}}) \times (T_{\text{cache}} + T_{\text{main}} + T_{\text{sec}}) \\
 &= (0.8 \times 80 \times 10^{-9}) + (1 - 0.8) \times 0.9 \times (80 + 200) \times 10^{-9} + (1 - 0.8) \times (1 - 0.9) \times (80 + 200 + 800) \times 10^{-9} \\
 &= (64 + 50.4 + 21.6) \times 10^{-9} = 136 \text{ ns}
 \end{aligned}$$

T11 : Solution

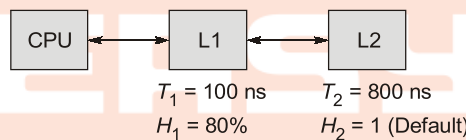
(c)

T12 : Solution

(c)

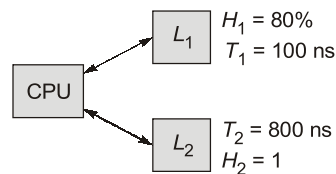
2-level memory hierarchy design:

Hierarchical access:



$$\begin{aligned}
 \text{Average memory access time} &= H_1 T_1 + (1 - H_1) (T_1 + T_2) \\
 &= (0.8 \times 100 \times 10^{-9}) + (0.2) (900 \times 10^{-9}) \\
 &= 260 \text{ ns}
 \end{aligned}$$

Simultaneous access:



$$\begin{aligned}
 \text{AMAT} &= H_1 T_1 + (1 - H_1) T_2 \\
 &= (0.8 \times 100) + (0.2 \times 800) = 240 \text{ ns}
 \end{aligned}$$

Note: By default, use simultaneous access formula.

T13 : Solution

(a)

$$\text{Number of chips} = \frac{\text{Required memory size}}{\text{Available memory size}} = \frac{256 \times 2^{10} \times 8}{32 \times 2^{10} \times 1} = 64$$

T14 : Solution

(c)

$$\text{Number of chips} = \frac{\text{Required memory size}}{\text{Available memory size}} = \frac{2 \times 2^{20} \times 32}{512 \times 2^{10} \times 8} = \frac{64 \times 2^{10}}{4096} = 16$$

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