

# IN1006 Systems Architecture (PRD1 A 2022/23)

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**Started on** Thursday, 8 December 2022, 4:22 PM

**State** Finished

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**Time taken** 10 mins 50 secs

**Grade** 8.90 out of 10.00 (89%)


## Question 1

Correct

Mark 1.00 out of 1.00

Which of the following *best* describes why a memory hierarchy is needed?

Select one:

- ☐ a. Don't know/no answer
- ☐ b. DRAM is cheaper than SRAM per unit of memory.
- ☐ c. Processor speeds have increased faster than SRAM speeds.
- ☐ d. It is useful to be able to exceed physical memory limits.
- ☒ e. Processor speeds have increased faster than memory speeds and there are different technologies of memory with different speeds and costs. 
- ☐ f. SRAM is cheaper than DRAM per unit of memory.

The need for a memory hierarchy is driven by the increasing gap between the speed of the processor and the speed of main memory (though it has other useful applications, e.g. in allowing physical memory) and the different technologies of memory.

The correct answer is: Processor speeds have increased faster than memory speeds and there are different technologies of memory with different speeds and costs.

Question **2**

Incorrect

Mark -0.10 out of 1.00

A 24-bit address generates an address space of \_\_\_\_\_ locations.  
(select a value below to fill in the blank)

Select one:

- ☒ a. 4,294,967,296
- ☐ b. 4096
- ☐ c. 1024
- ☐ d. 16,777,216



Your answer is incorrect.

The number of addressable locations in the system is called an address space. The answer is 2 to the power 24 = 16,777,216.

The correct answer is: 16,777,216

Question **3**

Correct

Mark 1.00 out of 1.00

Which of the following is a pair of non-volatile memories?

Select one:

- ☐ a. EPROM and DRAM
- ☐ b. SRAM and EEPROM
- ☐ c. DRAM and Flash
- ☐ d. DRAM and SRAM
- ☒ e. ROM and Flash



The volatile memories in the question are SRAM, VRAM and DRAM, The only option that does not contain any of them is the answer.

The correct answer is: ROM and Flash

Question **4**

Correct

Mark 1.00 out of 1.00

Which of the following is the best description of the concept of *sequential locality*?

Select one:

- ☐ a. Items in memory tend to get used more than once when accessed.
- ☐ b. Don't know/no answer
- ☐ c. Items get removed from the cache based on the order that they enter.
- ☒ d. Instructions tend to be accessed sequentially.
- ☐ e. Items stored together in memory get used together.
- ☐ f. Items get placed in cache lines in the order that they enter.



Sequential locality refers to the common feature of programs that instructions tend to be accessed sequentially.

The correct answer is: Instructions tend to be accessed sequentially.

Question **5**

Correct

Mark 1.00 out of 1.00

Which of the following statements about the different types of memory that can be found in a computer is correct?

- ☐ a. A computer must always have a full memory hierarchy with L1 cache, L2 cache, RAM and secondary memory.
- ☒ b. A computer can operate without a cache and secondary memory.
- ☐ c. A computer can operate without a ROM.
- ☐ d. A computer can operate without a RAM.
- ☐ e. A computer cannot operate without virtual memory.



Your answer is correct.

The correct answer is:

A computer can operate without a cache and secondary memory.

Question **6**

Correct

Mark 1.00 out of 1.00

Which of the following flip-flops is most often used to construct SRAM?

Select one:

- ☐ a. RS flip-flop
- ☐ b. Don't know/no answer
- ☐ c. SR flip-flop
- ☐ d. Clocked RS flip-flop
- ☒ e. D flip-flop
- ☐ f. J flip-flop



A D flip-flop is the form of flip-flop used in SRAM as one (D) input specifies what is to be written.

The correct answer is: D flip-flop

Question **7**

Correct

Mark 1.00 out of 1.00

Which of the following is the best description of the concept of *temporal locality*?

Select one:

- ☐ a. Don't know/no answer
- ☐ b. Items get written to memory locations in the order that the processor accesses the memory locations.
- ☐ c. Items stored together in memory get used together.
- ☐ d. Items get placed in cache positions in the order that they enter.
- ☐ e. Items get removed from the cache based on the order that they enter.
- ☒ f. Items in memory tend to get used more than once when accessed.



Temporal locality refers to the common feature of programs that items in memory tend to get used more than once when accessed.

The correct answer is: Items in memory tend to get used more than once when accessed.

## Question 8

Correct

Mark 1.00 out of 1.00

Suppose we have a byte-addressable computer which has a memory of 4,294,967,296 addresses, a cache with 16 blocks where each block contains 16 bytes. Determine the size of the tag field in the memory addresses used by this computer.

Select one:

- ☒ a. 24
- ☐ b. 32
- ☐ c. 3
- ☐ d. Don't know/no answer
- ☐ e. 5
- ☐ f. 16



As the computer has a memory with 4,294,967,296 bytes, it will need 32 bits to identify the addresses of all of them ( $4,294,967,296 = 2^{32}$ ). Thus, the total size of the tag, block and offset fields is 32.

As the cache has 16 blocks, it can be indexed with 4 bits ( $16 = 2^4$ ), so the size of the block field is 4 bits.

As each block has 16 bytes, we need 4 bits for the offset field to access each byte in the block ( $16=2^4$ ) bytes .

Finally, the tag field is:  $32 - 4 - 4 = 24$ .

The correct answer is: 24

## Question 9

Correct

Mark 1.00 out of 1.00

Which of the following is the most accurate statement relating to the term *virtual memory*?

Select one:

- ☒ a. Allows secondary storage (e.g. hard disk) to play the role of main memory. ✔ The basic idea of VM is that the disk is used to support extra virtual pages of main memory
- ☐ b. Allows the DRAM capacity to be increased.
- ☐ c. Allows programmers to write sloppy code.
- ☐ d. Allows secondary storage (e.g. hard disk) to play the role of the cache.
- ☐ e. Don't know/no answer
- ☐ f. Allows the cache hit rate to be increased.

Virtual memory allows secondary storage (e.g. hard disk) to play the role of main memory.

The correct answer is: Allows secondary storage (e.g. hard disk) to play the role of main memory.

Question **10**

Correct

Mark 1.00 out of 1.00

Assume a computer having a main memory of  $2^{32}$  bytes and a direct mapped cache of 1024 blocks each of which containing 32 bytes. To which cache block the main memory address  $000063FA_{16}$  map?

Select one:

- ☐ a. Don't know/no answer
- ☐ b. Block 1024
- ☐ c. Block 573
- ☒ d. Block 799
- ☐ e. Block 1
- ☐ f. Block 64



As the computer has a memory with  $2^{32}$  bytes, it will need 32 bits to identify the addresses of all of them. Thus, the total size of the tag, block and offset (TBO) fields is 32.

As the cache has 1024 blocks, it can be indexed with 10 bits ( $1024 = 2^{10}$ ), so the size of the block (B) field is 10 bits.

As each block has 32 bytes, so it can be indexed with 5 bits ( $32 = 2^5$ ) or, equivalently, the offset (O) field must be 5 bits long.

Thus, the tag (T) field is:  $TBO - B - O = 32 - 10 - 5 = 17$ .

Consequently the memory address format will be

**TAG (32<sup>nd</sup> to 16<sup>th</sup>) BLOCK (15<sup>th</sup> to 6<sup>th</sup> bit) OFFSET (5<sup>th</sup> to 1<sup>st</sup> bit)**

The hexadecimal address  $000063FA_{16}$  corresponds to the binary address:

**0000 0000 0000 0000 0110 0011 1111 1010**

So the block part in this address consists of the bold bits below:

0000 0000 0000 0000 **0110 0011 1111** 1010

And if we convert  $110\ 0011\ 111_{bin}$  to decimal, we get  $799_{dec}$ . So the given address will map to block 799 in cache.

The correct answer is: Block 799

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