TUTORIAL #7	Semiconductor Memories, HDD and SSD.	(SC1006/Cx1106)

1. What is the difference between system and storage memory? Elaborate your answer with an example of a person working on his Laptop Computer, using a Power Point application from the Microsoft Office suite to draft his presentation slides.

2. What memory type (SRAM, DRAM, NOR Flash, NAND Flash etc) would you use to implement the cache in Processor Cx1006-200M16 in the case study notes? Explain your choice.

3. Name two main types of Flash memory available in the market. What are the differences between them? Which application/product areas are they used in?

4. Reference the two HDDs listed in the case study notes (HDD001 and HDD002)

   a. What is the **capacity** of each drive?

   b. For HDD001,
      i. What is its **access time**?
      ii. What is the time needed to transfer a 4Kbyte file stored in random non-consecutive sectors on different tracks? Assume that every sector is on a different track.
      iii. After defragmenting HDD001, what would be the time needed to transfer a 280Kbyte file?

   c. If you are building a Network Access Storage for your home to act as a backup storage for your home's computers, which HDD would you choose? Justify your choice. MTTF in the HDD parameters refer to Mean-Time-To-Failure. It's a statistical approximation of how long a product could last before failing. Note that MTTF=1M hours doesn't mean the product's mean time to failure is 1M hours, but the larger MTTF value does indicate that the product is more reliable (statistically).

   d. Would you use a SSD instead for Q4(c) above? Since SSD is more robust than HDD and robustness is very important for backup storage.

5. What would be the memory choices for the system and storage memory for the use case scenario below? Justify your memory choice selection in terms of functionality, performance and cost.
   a. Entry level Microsoft Windows desktop computer for general office use but needs huge data storage capacity to store videos relating to the company product.

6. The main active storage of Data Centers are HDD. But HDD is prone to crashing due to the mechanical nature of its design. How does these centers mitigate this issue?

Flash has larger page size so can only be erased at KB level. This is not suitable for certain use case such as storing of user configuration parameters, which is typically done at order of bytes level. An EEPROM, , which has a smaller page size is more suitable for such use case as it result in less page erases. Also, EEPROM has a larger erase cycle endurance, could tolerate more erasures before failing

(Not necessary to be covered during tutorial)

7. Why does the Processor Cx1006-200M16 has two different types of non-volatile memory (Flash and EEPROM) on-chip? (Hint: Compare the Block/Page Size of the two memories).

memory where CPU execute code during runtime

Q1. System memory is the place code is run directly from but it may not be large enough to contain all the data and information you have. System memory consists of NOR Flash memory, DRAM and SRAM.
Storage memory is the entire collection of data and programs. Storage memory is non volatile as it needs to preserve the program and data after the computer powers down. Storage memory consist of HDD, SSD and Storage ICs.
most of the time, storage memory do not support code execution

Q2. SRAM should be used as a cache in the processor. A cache is a small and fast memory that stores frequently accessed data and instructions used by CPU. SRAM are volatile memory and are faster than DRAM.
DRAM too slow and transfer too complex for cache. Flash not suitable due to its finite erase cycles and slower speed

Q3. The two types of flash memory are NOR flash and NAND flash.
NOR flash acts like a NOR gate and supports execute in place. This allows for random reading of memory data. using only address information. It can be used as system memory or general storage memory.less compact

NAND flash acts like a NAND gate and does not support execute in place. The data is accessed one page at a time with the NAND chips using a single bus to carry address and data. It has lower cost per bit than NOR, is used as Main storage memory, USB Flash drives and SSDs.
more compact due to cell layout

Command used to open a particular page followed by individual bytes read/write

Q4. HDD001 capacity: 512 x 128 x 1024 x 4 =268435456B = 256MB
HDD002 capacity: 512 x 256 x 1024 cylinders/~~4platters~~ x 8heads = ~~256MB~~ 1GB

Access time = seek time+ rotational delay = 5ms + 0.5/(5000/60)s = 0.011s.

512 bytes/sector. 4Kb = 4096b. Transfer time = Number of bytes/(RPS * DT * DS) = 4096 / (5000/60 * 128 * 512) = 0.00075s. number of sectors accessed = 4096/512 = 8
Total time = access time + transfer time = 0.00075s + 0.011s x 8 = 0.08875s.

4 tracks to store 24KB
280KB = 286720B. → 4x23=92ms (24x1024)
Transfer time = 286720/(5000/60 * 128 * 512) = ~~0.0525s~~ 4.5ms
Total time = 0.011+~~0.0525~~ = ~~0.0635s~~ 15.5ms
4.5ms
92+15.5 = 107.5ms

SSD still has a higher cost per bit than HDD. Not ideal for application that requires huge storage, especially for consumer home use.

I would use HDD002 as it has a higher rotational speed meaning that it is faster in data transfer and it also has a higher MTTF of 1000000 hours. Also, the track to track seek time is shorter and there are more sectors per track. This is also considering that ~~both~~ HDDs have the ~~same~~ capacity of 256MB.
002 more than

finite read/write cycles of SSDs compared to HDD almost infinite read/write cycles.

I would use a SSD for backup storage as it has no moving parts, is lighter and occupy less space while having a higher transfer rate. As it is only for personal use, the extra cost is bearable.

SSD cannot replace HDD in backup storage area, including data centres, servers due to cost.

Q5. Use HDDs and DRAM. DRAM has larger capacity, faster access times and lower cost, while being volatile.These are all needed for storing videos. HDDs are non volatile and can store large amounts of data which videos need, and are cheaper than SSDs.

Q6 They create a housing structure for shock absorption and centres are built near natural cooling elements for reliable cooling.

Redundancy. User data is stored in multiple servers at multiple sites. If one breaks down, the other would take over. Within a server, some other error correction/ recovery techniques may be used to mitigate localised error. Data is also backup to tapes. This serves as the last line of defence.

Q7. EEPROM has a very small page size of 64B while the flash memory has page sizes in KBs. Both page sizes have their benefits where smaller page sizes, reduces the amount of wasted space and improves overall memory utilisation while a larger page size means fewer pages are needed to store a given amount of data.