BSCCS2001: Practice Solutions
Week 8

1. Which of the following does not belong to disk interface standards families?

[MCQ:2points]

- ◯ Serial ATA
- ◯ Small Computer System Interconnect
- √ Storage Area Networks
- ◯ Serial Attached SCSI

Solution: Disk interface standards families

- ATA (AT Attachment) range of standards
- SATA (Serial ATA)
- SCSI (Small Computer System Interconnect) range of standards
- SAS (Serial Attached SCSI)
- Several variants of each standard (different speeds and capabilities)

Please refer to slide No. 39.16

Answer questions 2 and 3 on the basis of the following data.

Consider you have a file named " IITM_BSc " in your hard disk. The file size is 1000 KB.
Seek time of your hard disk read head is 3ms, rotational speed is 30,000 RPM. The disk has 200 sectors/track and sector size is 512 bytes.

2. What is the transfer rate of your hard-disk (in KB/ms)?

[MCQ:2 points]

- √ 50 KB/ms
- ◯ 100 KB/ms
- ◯ 33.33 KB/ms
- ◯ 95 KB/ms

Solution:
Transfer rate is the rate at which data is read from the disk. It can be calculated as follows.
The given rotational speed of the disk = 30,000 RPM.
i.e. disk rotates 30,000 times in 60 sec.
So, time required for making 1 rotation = $60/30,000 = 2$ ms

*Total number of bytes present on one track= number of sectors/track * sector size*
Total number of bytes present on one track= $200 * 512 = 102400$ bytes

Transfer Rate = Bytes on one track / time for making one rotation
Transfer Rate = $102400/2 = 51200$ bytes/ms

Converting into KB/ms = $51200/1024 = 50$ KB/ms.
Hence, option 1 is correct.

3. Considering the fact that the file data is stored in all non-consecutive sectors, how much time will be required to read the whole file after the read request is made?
Note: Consider, Access time + Transfer time

[MCQ:2 points]

- ◯ 10.02 seconds
- √ 8.02 seconds
- ◯ 0.024 second

◯ 0.026 second

Solution:
*Rotational latency= (1/2) * time for making one rotation.*
Therefore, Rotational latency= $(1/2) * 2 = 1$ ms

Transfer time = File size / transfer rate
$= 1000 * 1024/51200 = 20$ ms

Since the file data is stored in random sectors (i.e., non-consecutive), hence each sector would require a new seek.
So each sector would have both seek latency and rotational latency.
Seek time + Rotational latency $= 3 + 1 = 4$ ms.
Number of sectors in which the file is stored,$= 1000 * 1024/512 = 2000$ sectors.
Time required for placing the head on sectors $= 4 * 2000 = 8000$ ms

Time required = Time required for placing the head on sectors (Access time) + transfer time
Therefore, time elapsed $= 8000 + 20 = 8020$ ms or 8.02 seconds.
Hence, option 2 is correct.

4. Consider the following statements, [MCQ:2 points]

   1. DNA data storage is the process of encoding and decoding binary data to and from synthesized strands of DNA.
   2. A DNA synthesizer machine builds synthetic DNA strands matching the sequence of digital code
   3. Both DNA Digital Storage and Quantum Memory can store enormous data which is not possible in file based storage system.
   4. Quantum Memory stores the information in binary states.

   Choose the correct option below

   ◯ Statements 2,3 & 4 are correct

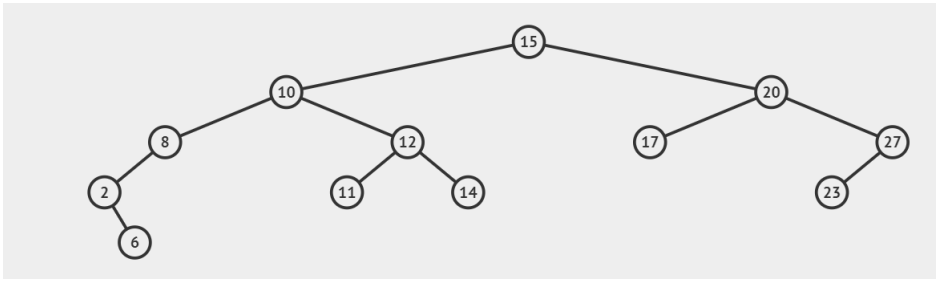
   ◯ Statements 1,3 & 4 are correct

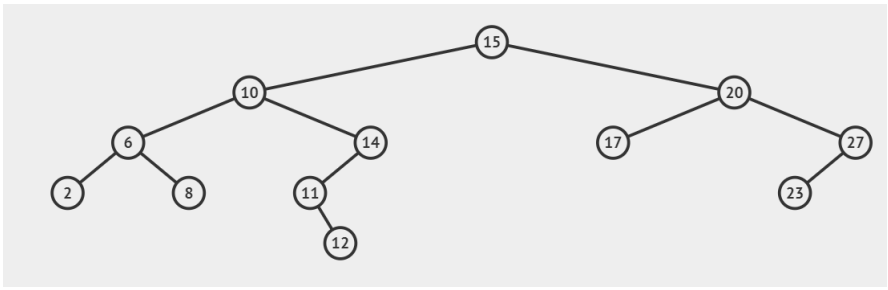
   √ Statements 1,2 & 3 are correct

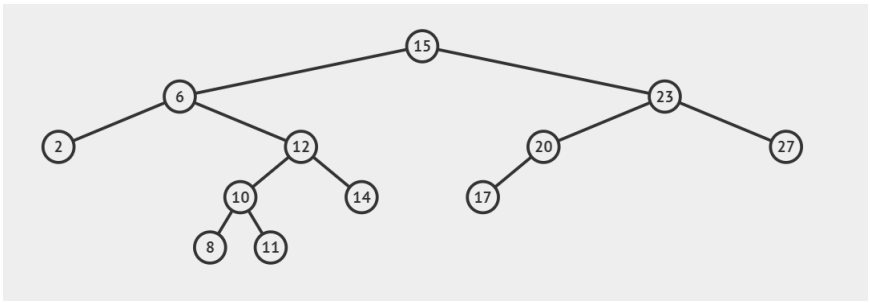
   ◯ All the statements are correct

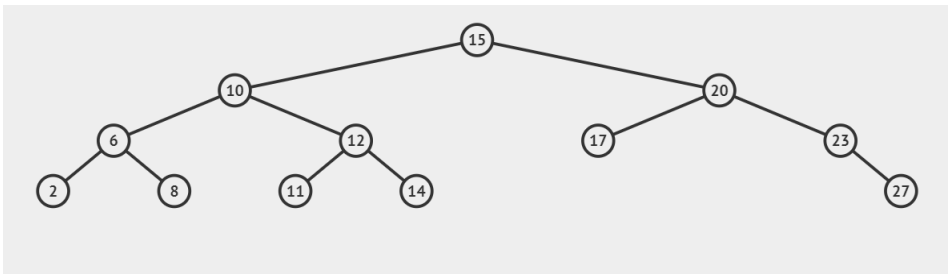
Solution: Please refer to slide no 39.31 and 39.32

5. Choose the correct Binary Search Tree (BST) for the following sequence:
   15,10,20,6,12,17,23,2,8,11,14,27 [MCQ:2 points]

◯ 

◯ 

◯ 

√ 

Solution:
Option 1: It represents the BST for sequence
15,10,20,8,12,27,23,2,6,11,14,17

Option 2: It represents the BST for sequence
15,10,6,20,27,2,23,17,8,14,11,12

Option 3: It represents the BST for sequence
15,23,6,20,12,2,10,17,8,14,11,27

option 4: Is a correct answer.

6. Which of the following is an example of a volatile storage medium?

[MCQ:2 points]

◯ Flash memory
√ Main memory
◯ Hard disk
◯ Magnetic tape

Solution:
All the options except main memory are examples of non-volatile storage. Main memory or RAM is a volatile storage medium. Hence, option 2 is correct.

7. Heap file organization is used for storing records of a relation **R**. The cardinality of **R** is 8192. A given selection operation (SELECT query) is such that it fetches only one specific record from **R**. What is the maximum number of search steps/compare operations required to run this SELECT statement?

[MCQ:2 points]

- ◯ 1
- √ 8192
- ◯ 13
- ◯ 8193

Solution:
In heap file organization records can be stored in any available free space and no ordering is done in this file organization. Hence a selection operation has to go through all the possible records to find the required record. In worst case the required record can be the last one and so 8192 search steps/comparisons will be required. Hence option 2 is correct.

8. Which of the following statements is/are correct about physical storage media?

[MSQ: 2points]

- ◯ Cache are the non-volatile and most costly form of storage.
- √ Flash memory are widely used in embedded devices such as digital cameras, phones, and USB keys.
- √ In magnetic-disk, data must be moved from the disk to main memory for access, and written back for storage.
- ◯ Reads and writes are faster in optical disk storage than magnetic disk.

Solution: Please refer to lecture no 8.4

9. Which of the following statements is/ are correct about a Buffer Manager?

[MSQ: 2 points]

√ If the block is already in the buffer, the buffer manager returns the address of the block in the main memory.

◯ If the block is in the buffer, the buffer manager allocates space in the buffer for the block.

◯ In Buffer manager, the subsystem responsible for allocating buffer space in secondary memory.

√ If the block is not in the buffer, the buffer manager reads the block from the disk to the buffer, and returns the address of the block in main memory to the requester.

Solution:

- If the block is already in the buffer, the buffer manager returns the address of the block in the main memory.
- If the block is not in the buffer, the buffer manager
  - Allocates space in the buffer for the block.
  - Reads the block from the disk to the buffer, and returns the address of the block in the main memory to the requester.
- In Buffer manager, the subsystem responsible for allocating buffer space in **main** memory.

10. Which of the following statements is/ are correct? [MSQ:2points]

- √ Disk controller is the interface between the computer system and the disk drive hardware.
- ◯ NOR flash storage is much cheaper than NAND flash storage.
- √ USB flash drives are removable and rewritable storage devices.
- ◯ All of the above

Solution:

- Disk controller is the interface between the computer system and the disk drive hardware.
- NAND flash storage is much cheaper than NOR flash storage.
- USB flash drives are removable and rewritable storage devices.

Please refer to Lecture no 8.4

11. Which of the following statements is/are correct? [MSQ:2 points]

- ◯ A Secure Digital (SD) card is a type of removable memory card which is used to read large quantities of data only.
- √ SSDs do not include any moving parts unlike HDD.
- ◯ The speed of SSD is lesser than that of HDD as it reads/writes data at lower input/output per second.
- √ Cloud storage supports file sharing dynamically as it can be shared anywhere with network access.

Solution:

- A Secure Digital (SD) card is a type of removable memory card used to **read and write** large quantities of data.
- SSDs do not include any moving parts unlike HDD.
- The speed of SSD is **much larger than** that of HDD as it reads/writes data at **higher** input-output per second.
- Cloud storage supports file sharing dynamically as it can be shared anywhere with network access.

Answer questions 12 and 13 based on the given data.

Consider a disk with 10 platters, 64 tracks/surface, 256 sectors/track, 512 bytes/sector. 4 bytes/sector is reserved for storing file system information (formatting data).

12. How much free space is available for use (in MB, upto two decimal places)?

[NAT:2 points]

Answer: 158.75

Solution:
Total number of surfaces $= 2 * 10 = 20$
Total number of sectors $= 20 * 64 * 256 = 327680$ sectors.
Total space reserved for file system data= 4 * no. of sectors = 1310720 bytes.
Converting to MB $= 1310720/2^{20} = 1.25$ MB
Total disk space $= 20 * 64 * 256 * 512 = 167772160$ bytes.
Converting to MB $= 167772160/2^{20} = 160$ MB
Disk space left for the user $= 160 - 1.25 = 158.75$ MB.
Answer is 158.75.

In a 32 GB pen drive, the file's system information, called format overhead, is stored and hence not all of the 32 GB is available for use.

13. How many bits are required for addressing all the sectors ? [NAT:2 points]

Answer: 19

Solution:
No. of sectors = 327680
No. of bits required to address all of them $= \lceil \log_2 327680 \rceil = 19$ bits.
Answer is 19.

14. Consider a string of pending block references in the given order: $3, 4, 1, 4, 2, 3, 1, 4, 2, 3$. The system has a buffer with 3 slots. Assume that initially the buffer is empty. If LRU buffer replacement policy is used, then how many misses will occur while referencing all the requested blocks ? [NAT:2 points]

Answer: 9

Solution:
Will be explained in practice live session.
This is an example of block reference order, where LRU worsens the working and increases the misses. As mentioned in the slides.

15. Choose the correct arrangement of the given growth functions in increasing order.

[MCQ:2points]

- √ $\log\log N < N\log N < N^2 < 2^N < N^N$
- ◯ $\log\log N < N\log N < N^2 < N^N < 2^N$
- ◯ $N\log N < \log\log N < N^2 < N^N < 2^N$
- ◯ $N\log N < \log\log N < 2^N < N^2 < N^N$

Solution: Refer slide 36.18, 36.19 for the concept and similar example.

16. What will be the worst-case asymptotic running time of the following code?
Hint: $O(n!) = O(n^n)$ follows from 'Stirling's approximation'.

[MSQ:2points]

```
int sum = 0;
for(int i = 1 ; i <= n ; i++){
    for(int j = 1 ; j <= i ; j=j*2){
        sum = sum + i + j;
    }
}
```

- √ O($n \log n$)
- √ O($\log(n!)$)
- ◯ O($n! \log n$)
- ◯ O(n^n)

Solution: The outer loop runs n times and for each iteration of the outer loop the inner loop runs $\log(i)$ times. Therefore, the total number of iterations are
$\Sigma \log(i)$ and i $\in$ {1,2,3...n}.
$= \log(1) + \log(2) + ... + \log(n)$
$= \log(1.2.3....n)$
$= \log(n!) \approx \log(n^n)$.....using Stirling's approximation
$= n \log n$