**Computer Organization & Architecture**

**Fall 2013 (Mid Term -2)**

**Total marks: 40 Time: 90 Mins**

**Note : Assume any missing data or typing errors.**

**Question#1(a). What common characteristics are shared by all RAID levels? (3 Marks)**

Solution: All RAID levels share three common characteristics:

1. RAID is a set of physical disk drives viewed by the operating system as a single logical drive.

2. Data are distributed across the physical drives of an array in a scheme known as striping, described subsequently.

3. Redundant disk capacity is used to store parity information, which guarantees data recoverability in case of a disk failure.

The details of the second and third characteristics differ for the different RAID levels. RAID 0 and RAID 1 do not support the third characteristic.

**Question#1(b). Differtiate betwee the terms *track, cylinder,* and *sector*. (3 Marks)**

Solution: The head is a relatively small device capable of reading from or writing to a portion of the platter rotating beneath it. This gives rise to the organization of data on the platter in a concentric set of rings, called **tracks**. Each track is the same width as the head. There are thousands of tracks per surface. Adjacent tracks are separated by gaps. This prevents, or at least minimizes, errors due to misalignment of the head or simply interference of magnetic fields.

Data are transferred to and from the disk in sectors. There are typically hundreds of **sectors** per track, and these may be of either fixed or variable length. In most contemporary systems, fixed-length sectors are used, with 512 bytes being the nearly universal sector size. To avoid imposing unreasonable precision requirements on the system, adjacent sectors are separated by intratrack (intersector) gaps.

Some disk drives accommodate **multiple platters stacked vertically a fraction** of an inch apart. Multiple arms are provided. Multiple–platter disks employ a movable head, with one read-write head per platter surface. All of the heads are mechanically fixed so that all are at the same distance from the center of the disk and move together. Thus, at any time, all of the heads are positioned over tracks that are of equal distance from the center of the disk. The set of all the tracks in the same relative position on the platter is referred to as a **cylinder.**

**Question#1(c). Most disks today use a fixed sector size. Many IBM mainframe disks allow the programmer to determine the block (sector) size. Explain advantages and disadvantages of allowing a variable sector size. (2 Marks)**

Solution: A variable sector size complicates the disk hardware and disk controller design. In early systems it had the advantage of allowing for small block sizes with small memory systems, and larger block sizes for larger systems. Also, it allows the programmer to choose the optimal size for the data.

**Question#1(d). A magnetic disk with 5 platters has 2048 tracks/platter, 1024 sectors/track (fixed number of sectors per track), and 512-byte sectors. What is its total capacity? (2 Marks)**

Solution: 512 bytes x 1024 sectors= 0.5 MB/track Multiplying by 2048 tracks/platter gives 1 GB/platter, or 5 GB capacity in the drive.

**Question#2(a). List the five major functions or requirements of an I/O module? (2 Marks)**

Solution:The major functions or requirements for an I/O module fall into the following categories:

1. Control and timing

2. Processor communication

3. Device communication

4. Data buffering

5. Error detection

**Question#2(b). List and briefly define three techniques for performing I/O. (3 Marks)**

Solution: Three techniques are possible for I/O operations. With **programmed I/O**, data are exchanged between the processor and the I/O module. The processor executes a program that gives it direct control of the I/O operation, including sensing device status, sending a read or write command, and transferring the data. When the processor issues a command to the I/O module, it must wait until the I/O operation is complete. If the processor is faster than the I/O module, this is wasteful of processor time. With **interrupt-driven I/O**, the processor issues an I/O command, continues to execute other instructions, and is interrupted by the I/O module when the latter has completed its work. With both programmed and interrupt I/O, the processor is responsible for extracting data from main memory for output and storing data in main memory for input. The alternative is known as **direct memory access (DMA)**. In this mode, the I/O module and main memory exchange data directly, without processor involvement.

**Question#2(c). Some processors use memory mapped I/0 where I/0 devices are in the same address space as main memory. Others have separate 1/0 address space and separate instructions. Give some advantages and disadvantages of each. (2 Marks)**

Solution:

Memory Mapped

**Advantages**

Simpler hardware Simpler instruction set

All address modes available

**Disadvantages**

Reduces memory address space

Complicates memory protection Complicates memory timing

I/O Mapped

**Advantages**

Additional address space Easier to virtualize machine

**Disadvantages**

Makes small systems bigger

Complicates virtual memory

Complicates future expansion of address space

**Question#2(d). Although DMA does not use the CPU, the maximum transfer rate is still limited. Consider reading a block from the disk. Name three factors that might ultimately limit the rate transfer. (3 Marks)**

Solution:

The first factor could be the limiting speed of the I/0 device;

Second factor could be the speed of bus,

the third factor could be no internal buffering on the disk controller or too small internal buffering space.

Fourth factor could be erroneous disk or transfer of block.

**Question#3(a). List and briefly explain the key services provided by an OS. (3 Marks)**

Solution: The OS typically provides services in the following areas:

Program creation: The operating system provides a variety of facilities and services, such as editors and debuggers, to assist the programmer in creating programs.

Program execution: A number of tasks need to be performed to execute a program. Instructions and data must be loaded into main memory, I/O devices and files must be initialized, and other resources must be prepared.

Access to I/O devices: Each I/O device requires its own peculiar set of instructions or control signals for operation.

Controlled access to files: In the case of files, control must include an understanding of not only the nature of the I/O device (disk drive, tape drive) but also the file format on the storage medium.

System access: In the case of a shared or public system, the operating system controls access to the system as a whole and to specific system resources.

Error detection and response: A variety of errors can occur while a computer system is running.

Accounting: A good operating system will collect usage statistics for various resources and monitor performance parameters such as response time.

**Question#3(b). List and briefly define the major types of OS scheduling. (3 Marks)**

Solution:

Long-term scheduling: The decision to add to the pool of processes to be executed.

Medium-term scheduling: The decision to add to the number of processes that are partially or fully in main memory.

Short-term scheduling: The decision as to which available process will be executed by the processor

**Question#3(c). What is the purpose of a translation lookaside buffer? (2 Marks)**

Solution: The TLB is a cache that contains those page table entries that have been most recently used. Its purpose is to avoid, most of the time, having to go to disk to retrieve a page table entry.

**Question#3(d). What is the primary advantage of adding a translation lookaside buffer (TLB)? (2 Marks)**

Solution: A specially tailored hardware designed for accelerating address translation from virtual address space to physical address space.

**Question #4. Add the following signed decimals using twos complement numbers. Show your work. (3+3+2+2 Marks)**

**a. (+1) + (-6)**

**b. (+20) + (-60)**

**c. (+8) + (-5)**

**d. (+89) + (-46)**

Solution: a. 11111011 b. 11011000 c. 00000011 d. 00101011