**Chapter 7 - Exercises**

1. List three broad classifications of external, or peripheral, devices.
2. What is the International Reference Alphabet?
3. What are the major functions of an I/O module?
4. List and briefly define three techniques for performing I/O.
5. What is the difference between memory-mapped I/O and isolated I/O?
6. When a device interrupt occurs, how does the processor determine which device issued the interrupt?
7. When a DMA module takes control of a bus, and while it retains control of the bus, what does the processor do?

**Answers to Questions**

1. **List three broad classifications of external, or peripheral, devices.**

* **Human readable**: suitable for communicating with the computer user.
* **Machine readable**: suitable for communicating with equipment.
* **Communication**: suitable for communicating with remote devices.

1. **What is the International Reference Alphabet?**

**The most commonly used text code** is the International Reference Alphabet (IRA), in which each character is represented by a **unique 7-bit binary code**; thus, **128 different character can be represented**.

1. **What are the major functions of an I/O module?**

* **Control and timing**: Coordinates the flow of traffic between internal resources and external devices.
* **Processor communication**: Involves command decoding, data, status reporting, address recognition.
* **Device communication**: Involves commands, status information, and data.
* **Data buffering**: Performs the needed buffering operation to balance device and memory speeds.
* **Error detection**: Detects and reports transmission errors.

1. **List and briefly define three techniques for performing I/O.**

* **Programmed I/O**: data 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.
* **Interrupt-driven I/O**: processor **issues I/O command**, then **goes off to do other things** until the I/O module interrupts the processor to request service when it is ready to exchange data with the processor.
* **Direct Memory Access**: a DMA module **controls the exchange of data** between main memory and I/O module. The processor sends a request for the transfer of a block of data to the DMA module and is interrupted only after the entire block has been transferred.

1. **What is the difference between memory-mapped I/O and isolated I/O?**

With **memory-mapped I/O**, there is **a single address space** for memory locations and I/O devices. The processor treats the **status and data registers** of I/O modules as memory locations and users the same machine instructions to access both memory and I/O devices. With **isolated I/O**, a command specifies whether the address refers to a memory location or an I/O device. The full range of addresses may be available for both.

1. **When a device interrupt occurs, how does the processor determine which device issued the interrupt?**

Four general categories of techniques are in common use: **multiple interrupt lines**, **software poll**, **daisy chain** (hardware poll, vectored), **bus arbitration** (vectored)

1. **When a DMA module takes control of a bus, and while it retains control of the bus, what does the processor do?**

The processor either doesn't need to use the bus at the time, or it is forced to suspend operation temporarily. The processor deals with other things, while the bus operation is left to DMA.