CHAPTER 5

Computer Organization

Review Questions

1. The three subsystems are the CPU, the main memory, and the input/output subsystem.
2. The CPU has an ALU, a control unit, and various kinds of registers.
3. The ALU performs arithmetic and logical operations.
4. The data registers hold data temporarily; instruction registers hold the instructions that have been fetched from main memory; and the program counter is a register that holds the address of the instruction currently being executed.
5. The control unit is responsible for controlling the operation of all of the other subsystems.
6. A byte is always a group of 8 bits, but the size of a word is machine-dependant. A word can be 8, 16, 32, or 64 bits.
7. The function of main memory is to store the data and programs currently being used by the user.
8. The approximation of a megabyte is based on powers of 10 (10^6 or 1,000,000 bytes). The actual size of a megabyte is based on powers of 2 (2^{20} or 1,048,576 bytes).
9. Memory addresses are represented by unsigned integers.
10. RAM is random access memory and can be read from and written to by the user. ROM is read only memory. The contents of ROM are written by the manufacturer and cannot be overwritten by the user.
11. SRAM is static RAM that uses flip-flop gates to hold data. SRAM is fast but expensive. DRAM is dynamic RAM that uses capacitors to hold the data. DRAM needs periodic refreshing to keep from loosing data. It is slow, but cheap.
12. PROM is programmable read only memory and can be programmed by the user using special equipment. EPROM is erasable PROM and can be erased by the user using a special device that uses UV light. EEPROM is electronically erasable PROM that can be reprogrammed while it is still installed in the computer.

13. The purpose of cache memory is to provide the CPU with a holding area for a portion of main memory.
14. High speed memory is used for the registers inside the CPU. Medium speed memory is used for the cache. The slowest memory is used for main memory where all of the data and programs are stored.
15. The keyboard, monitor, and printer are examples of nonstorage I/O devices.
16. Magnetic and optical are the two main classifications of storage devices.
17. A magnetic disk consists of one or more disks with a magnetic coating and one read/write head for each disk surface.
18. The surface of a magnetic disk is divided into circular rings called tracks. Each track is divided into sections called sectors.
19. The rotational speed of the disk, the seek time, and the transfer time are the main factors that determine the performance of a magnetic disk.
20. Magnetic tape consists of a plastic tape with a magnetic coating. The tape drive consists of two reels and a read/write head.
21. The width of a magnetic tape is divided into 9 tracks. The length of the tape may be divided into blocks.
22. The data on a tape is accessed sequentially; that is, to get to a particular block, we must read all of the previous blocks.
23. Five types of optical storage devices are CD, CD-ROM, CD-R, CD-RW, and DVD.
24. A CD-ROM is written to only by the manufacturer. A CD-R and a CD-RW are written to by the user.
25. The advantage of a CD-RW is that it can be overwritten with new data.
26. The pits and lands on a CD-ROM are actual pits and lands in the polycarbonate resin used for the body of the disk. The pits and lands on a CD-R are simulated using a dye within the body of the disk. The pits and lands of a CD-RW are simulated by changing the state of an alloy of silver, indium, antimony, and tellurium to either crystalline (transparent) or amorphous (nontransparent).
27. All three disks use a low-power laser beam to read the disks. They all use the difference in the reflection between a land and pit (real or simulated) to detect data on a disk.
28. Data is erased on a CD-RW with the use of a medium-power laser beam. It changes any spots in the amorphous (nontransparent) state to the crystalline (transparent) state.
29. A DVD uses much smaller pits and lands that allow the disk to hold much more data (4.7 GB to 17 GB) compared to a CD-ROM (650 MB).
30. The data bus is used to transfer data to and from memory. The address bus allows access to particular words in memory. The control bus is used to control the operations of the CPU and memory.
31. The I/O device controllers act as an intermediate between the electronic devices (CPU and memory) and the slower electromechanical devices (i.e., disk drives) to regulate the device's access to buses.

32. A SCSI (small computer system interface) controller is a parallel interface that provides a daisy chain connection between devices and the buses.
33. The FireWire interface is a high speed serial interface that transfers data in packets. It can use a daisy chain or tree configuration.
34. The USB (universal serial bus) controller is a serial controller used to communicate with slower devices. It also supplies power to the devices.
35. Isolated I/O uses a different set of instructions to read/write to memory than to read/write to I/O devices. Memory-mapped I/O uses the same instruction set but different addresses for these operations.
36. The basic steps in a machine cycle are fetch, decode, and execute.
37. In the programmed I/O method, the CPU waits for the I/O device. A lot of CPU time is wasted by checking for the status of an I/O operation. In the interrupt-driven I/O method, the I/O device informs the CPU of its ready status via an interupt. In direct memory access (DMA), the CPU sends its I/O requests to the DMA controller which manages the entire transaction.
38. CISC (complex instruction set computer) has a large set of instructions to execute commands at the machine level. This makes the circuitry of the CPU and the control unit very complicated. RISC (reduced instruction set computer) uses a small set of instructions. Complex operations are accomplished using a larger number of simple commands.

Multiple-Choice Questions

39. d
40. b
41. a
42. d
43. d
44. d
45. c
46. a
47. b
48. a
49. c
50. d
51. b
52. a
53. c
54. b
55. d
56. d
57. a

58. b
59. c
60. b
61. b
62. d
63. c
64. b
65. d
66. c
67. d
68. d
69. c
70. c
71. a
72. c
73. b
74. c
75. b
76. a
77. c

Exercises

78. 64 MB / 4 bytes per word = 16 million = 2^{24}; so 24 bits are needed to access a word.
79. 24 x 80 = 1920 bytes
80. You need 4 bits to determine the instruction ($2^4 = 16$). You need 2 bits to determine a register ($2^2 = 4$). You need 10 bits to determine a word in memory ($2^{10} = 1024$). You therefore need 4 + 2 + 10 or 16 bits for an instruction.
81. Since the smallest word size that can hold an instruction is 16 bits, we must have 16-bit registers.
82. The instruction register must be at least 16 bits.
83. The program counter must be large enough to hold the number of instructions in the largest program used.
84. The data bus must be wide enough to hold 1 word.
85. The address bus must be 10 bits wide.
86. The minimum size of the control bus is 4 bits wide.
87. Since the address space can be shared between controller registers and memory on a computer using isolated I/O, 64 different controllers can be accessed (64 controllers x 16 registers/controller = 1024 register locations).

88. Since the address space must be shared between I/O addressing and memory addressing, there can be 6 4-register controllers ($6 \times 4 = 24$, $24 + 1000$ words $= 1024$ or 2^{10}).