Homework #5 Chapters 3 and 5 (18 points)

1 point each unless noted

Due: Wednesday, October 24th, in class

1. What does RAM stand for? What does ROM stand for? Briefly describe one key difference between the two.

2. Suppose memory has 4096 bytes. How many bits are needed for the memory addresses? (0.5 points)

3. If we have a 8-bit opcode, how many different instructions are possible? (0.5 points)

4. Suppose each machine language instruction in some instruction set has 3 bits for the opcode and 6 bits for each address. Further suppose each instruction has exactly 2 addresses. What is the theoretical maximum memory size needed?

5. List the four subsystems of the von Neumann Architecture and briefly define what each does.

6. If the average access time for RAM is 35 nsec and the average access time for cache memory is 7.5 nsec, what is the overall average access time if our cache hit rate is 70%?

7. List one thing that can be done to increase the cache hit rate.

8. Suppose a, b, c, and d are in memory locations M[100], M[101], M[110], and M[111], respectively. Write an equation that represents the following assembly language instructions:
   
   \[
   \begin{align*}
   &\text{ADD } M[100] \ M[100] \ M[100] \\
   &\text{ADD } M[111] \ M[111] \ M[111] \\
   &\text{ADD } M[110] \ M[100] \ M[111] \\
   &\text{ADD } M[110] \ M[110] \ M[101]
   \end{align*}
   \]


10. Assume that the variables v, w, x, y, and z are stored in memory locations M[000], M[001], M[010], M[011], and M[100], respectively. Using the machine language instructions shown in Section 3.2, translate the following algorithmic operations into their machine language equivalents. You can overwrite a memory location for an intermediate calculation, if that location is no longer needed. See activity 3.2.2 for an example. (2 points)

   a. Set v to the value of \((w + x) + (y + z)\)

   b. Input v from the user, then display v * 3

11. Provide one main difference between CRT, LCD, and Plasma displays. What is one pro and one con for each type of technology?

12. Zybooks mentions four different types of computers. For each one, give a possible use case where that type would be better than the others.
13. Assume that a hard disk has the following characteristics. How many characters can be stored on this disc?
   Number of surfaces = 2 (This is a double-sided disk. A single read/write arm holds both read/write heads.)
   Number of tracks per surface = 400
   Number of sectors per track = 32
   Number of characters per sector = 512

14. Rank the following programming languages from the lowest level to the highest level: Python, Machine language, and Assembly language. (0.5 points)

15. Sort the following memory types from slowest to fastest, then by cost from cheapest to most expensive: Hard Drive, Cache, RAM, and Solid State Drive. What is the relationship between cost and speed?

16. If a computer had 8 transistors in an integrated circuit, how many transistors could it have according to Moore’s law after 10 years? Assume that the number of transistors doubles every 2 years.


18. Consider the following structure of the instruction register. (1.5 points)

<table>
<thead>
<tr>
<th>Op code</th>
<th>Address-1</th>
<th>Address-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 bits</td>
<td>12 bits</td>
<td>12 bits</td>
</tr>
</tbody>
</table>

   a. What is the maximum number of distinct operations that can be recognized and executed by the processor on this machine?

   b. What is the maximum memory size on this machine?

   c. How many bytes are required for each operation?