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CMIS 310

HOMEWORK #3 – Week #3

This homework is worth 10% of your course grade.

Read each problem carefully. Failure to follow the instructions for a problem will result in a zero score for that problem.

Submit the completed Homework via Assignment in LEO.

1. How many bits are required to address a 4M X 16 main memory if

a) Main memory is byte addressable? 23 bits  
 $16 \text{ bits} = 2 \text{ bytes} \therefore 2 \times 4 \times 2^{20} = 2^1 \times 2^2 \times 2^{20} = 2^{23}$

b) Main memory is word addressable? 22 bits  
 $4 \times 2^{20} = 2^2 \times 2^{20} = 2^{22}$

2. Suppose that a 16M X 16 main memory is built using 512K X 8 RAM chips and memory is word addressable.

a) How many RAM chips are necessary? 64  
 $16 \text{ bit} / 8 \text{ bit} = 2$  columns  $16 \text{ M} / 512 \text{ K} = 32$  rows  $2 \times 32 = 64$

b) How many RAM chips are needed for each memory word? 2

c) How many address bits are needed for each RAM chip? 19 bits  
 $512 \text{ K} = 512 \times 2^{10} = 2^9 \times 2^{10} = 2^{19}$

d) How many address bits are needed for all memory? 24 bits  
 $16 \text{ M} = 16 \times 2^{20} = 2^4 \times 2^{20} = 2^{24}$

3. A digital computer has a memory unit with 24 bits per word. The instruction set consists of 150 different operations. All instructions have an operation code part (opcode), and an address part (allowing for only one address). Each instruction is stored in one word of memory.

a) How many bits are needed for the opcode? 8 bits

b) How many bits are left for the address part of the instruction? 16 bits  
 $24 - 8 = 16$

c) What is the maximum allowable size for memory? 65536

$2^{16} = 65536$

$2^7 = 128 \leftarrow 150$   
 $2^8 = 256$

4. Write the following MARIE assembly language equivalent of the following machine language instructions

a) <sup>2</sup>0010 <sup>0</sup>0000 <sup>0</sup>0000 <sup>7</sup>0111 STORE 007

b) <sup>B</sup>1001 <sup>0</sup>0000 <sup>0</sup>0000 <sup>B</sup>1011 JUMP 00B

c) <sup>3</sup>0011 <sup>0</sup>0000 <sup>0</sup>0000 <sup>9</sup>1001 ADD 009

5. What is the difference between hardwired control and microprogrammed control?

A hardwired control unit is a physical implementation of logic gates to perform specific functions based on pre-determined instructions. This type of unit is faster, but more expensive. Modifications to the instruction set also require modifications to the physical circuitry.

A microprogrammed control unit relies on microinstructions in the control memory to produce control signals. This requires frequent lookup requests to the control memory, slowing the program. The cons of speed loss in these units is offset by their flexibility and price. Since complex instructions can be broken down to a series of simpler microinstructions, it's much easier to implement these instructions in a microprogrammed control unit than a hardwired one.