

1. How many bits are required to address a $4\text{M} \times 16$ main memory if
 - a) Main memory is byte addressable? _____
 - b) Main memory is word addressable? _____

2. Suppose that a $16\text{M} \times 16$ main memory is built using $512\text{K} \times 8$ RAM chips and memory is word addressable.
 - a) How many RAM chips are necessary? _____
 - b) How many RAM chips are needed for each memory word? _____
 - c) How many address bits are needed for each RAM chip? _____
 - d) How many address bits are needed for all memory? _____

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? _____
 - b) How many bits are left for the address part of the instruction? _____
 - c) What is the maximum allowable size for memory? _____

4. Write the following MARIE assembly language equivalent of the following machine language instructions
 - a) 0010 0000 0000 0111
 - b) 1001 0000 0000 1011
 - c) 0011 0000 0000 1001

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