Virginia Tech - ECE 5484 - Summer 2020

Homework 3

Before starting this homework assignment, please be sure that you have completed all of the following activities.

- View the relevant online lectures and read associated sections in the textbook before or while you work on this homework assignment.
- Review the course syllabus. Note the grading policies, including policies for submitting assignments.
- Review the course schedule. Note the due dates for course assignments, including this one.
- Review the Graduate Honor System at https://graduateschool.vt.edu/academics/expectations/graduate-honor-system.html. Review the Graduate Honor System Constitution, especially Articles I (Sections 1, 2, and 3), V, VI, VII, VIII, and IX.

Please note the following.

- Solutions must be clear and presented in the order assigned. Solutions must show work needed, as appropriate, to derive your answers. Written answers should be concise, but sufficiently complete to answer the question. Neat hand drawings, where needed, are acceptable. Your final solution for each problem must be easily identified.
- At the top of the first page, include: your name (as recorded by the university); your email address; and the assignment name ("ECE 5484, Homework 3"). Do *not* include your Virginia Tech ID number or your social security number.
- Homework must be submitted as a PDF (.pdf) file with the file name *lastname_firstname_*HW3.pdf, where *lastname* is your last or family name and *firstname* is your first or given name. Submit a single file.
- Submit your assignment using the Assignments area of the class website. You must submit your assignment by 11:55 p.m. on the due date.

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

    a. Main memory is byte-addressable?

    b. Main memory is word-addressable? (For part b, assume a 16-bit word.)

2. You want to use 256 x 8 RAM chips to provide a memory capacity of 4096 bytes.

    a. How many chips will you need?

    b. How many bits will each address contain?

    c. How many address lines must go to each chip?

    d. How many address lines must be decoded for the chip select inputs? In other words, specify the size of the decoder.

3. A digital computer has a memory unit with 40 bits per word. The instruction set consists of 165 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?

    d. What is the largest unsigned binary number that can be accommodated in one word of memory?

4. Section 4.10 of the text provides an example of the execution of a simple MARIE program. For this problem, you are to complete a similar example for a different program. In particular, for the MARIE program given below, you are to complete the equivalent of Figure 4.14, but for the program below. You do not need to show how the "Halt" instruction is executed. Specify values in PC, IR, MAR, MBR, and AC in hexadecimal. A template for your answer is provided as a Microsoft Word file that is included with this assignment on Canvas. You are to incorporate your answer for this problem into your submission for the homework assignment so that you submit only one PDF file for the entire assignment.

The program is as follows. Note that this table is the equivalent of Table 4.3 in the textbook, only for a different program.

Hex Address	Instruction	Binary Contents of Memory Address	Hex Contents of Memory
100	Load 105	0001 0001 0000 0101	1105
101	Subt 104	0100 0001 0000 0100	4104
102	Store 104	0010 0001 0000 0100	2104
103	Halt	0111 0000 0000 0000	7000
104	00A3	0000 0000 1010 0011	00A3
105	00F3	0000 0000 1111 0011	00F3

5. **Scavenger Hunt:** Two pioneers of early computers and computer organization were Howard H. Aiken and John von Neumann. Answer the questions below regarding Aiken and von Neumann. *Cite sources used for your answers.*

    a. Is Aiken or is von Neumann associated with the so-called Princeton architecture?

    b. Is Aiken or is von Neumann associated with the so-called Harvard architecture?

    c. In your own words, what is the key feature of a Princeton architecture computer compared to the Harvard architecture?

    d. Does the MARIE architecture owe more to Aiken or von Neumann? In your own words, briefly justify your answer.