

# COE 205 Computer Organization & Assembly Language – Spring 2005

## Assignment 1 Solution

- Q1. (2 pts) Describe the functionality of the Program Counter (PC), the Instruction Register (IR), the Memory Address Register (MAR), and the Memory Data Register (MDR).
- A1. PC: A register that holds the address of the next instruction to be fetched.**  
**IR: Holds the instruction that was fetched.**  
**MAR: Holds the address of the variable to be read or written to memory**  
**MDR: Holds the value of the variable that is read or written to memory**
- Q2. (2 pts) List and briefly describe the tools used by the assembly language programmer.
- A2. Editor: for writing and editing assembly language programs.**  
**Assembler: Is a program that translates programs written in assembly language to object files in machine language.**  
**Linker: Is a program that links together object files in machine language with functions defined in libraries. The output of a linker is an executable file that can be loaded into the memory of the computer and can be executed.**  
**Debugger: Is used to monitor the execution of a program, by executing it either step by step, or by using breakpoints. The content of memory and registers can be examined and modified for testing purposes.**
- Q3. (1 pt for both parts)
- a) Define the term *bus*.
- b) Why are buses used in computers?
- A3. a) Bus: Is a group of wires used to interconnect the different components of a computer.**  
**b) Buses are used to transfer data between the processor and memory, between the processor and the I/O devices, and between the I/O devices and memory.**
- Q4. (2 pts) Represent the following numbers in binary, octal, and hexadecimal.
- a) 2345.5  
b) 149.625
- A4. a)  $2345.5 = (100100101001.1)_2 = (4451.4)_8 = (929.8)_{16}$**   
**b)  $149.625 = (10010101.101)_2 = (225.5)_8 = (95.A)_{16}$**
- Q5. (3 pts) Perform the following arithmetic operations using the designated bases and verify your result by converting the numbers and performing the operation in decimal:
- a)  $(10110110)_2 + (10111)_2$   
b)  $(713)_8 + (167)_8$   
c)  $(C0E)_{16} + (13B)_{16}$

A5. a) Carry      11 11

$$\begin{array}{r} 10110110_2 = 182 \\ + \quad 10111_2 = 23 \\ \hline 11001101_2 = 205 \end{array}$$

b) Carry      111

$$\begin{array}{r} 713_8 = 459 \\ + \quad 167_8 = 119 \\ \hline 1102_8 = 578 \end{array}$$

c) Carry      1

$$\begin{array}{r} C0E_{16} = 3086 \\ + \quad 13B_{16} = 315 \\ \hline D49_{16} = 3401 \end{array}$$

Q6. (3 pts) Express the following numbers in sign-magnitude, 1's complement, and 2's complement notations, using 8-bit representation:

a) - 101

b) - 45

A6. a) - 101 = (11100101)<sub>sign-magnitude</sub> = (10011010)<sub>1's complement</sub> = (10011011)<sub>2's complement</sub>

b) - 45 = (10101101)<sub>sign-magnitude</sub> = (11010010)<sub>1's complement</sub> = (11010011)<sub>2's complement</sub>

Q7. (3 pts) Perform the following operations twice, once for a sign-magnitude notation and once for 2's complement notation, assuming 4-bit representation of numbers. Indicate in your answer when an overflow occurs:

a) 0101 + 1111

b) 1011 - 0111

A7. In sign-magnitude:

a) 0101+1111 = 0101-0111 = -(0111-0101) because 0111 is larger = -0010 = 1010

b) 1011 - 0111 = - 0011 - 0111 = - (0011+0111) = - 1010 = 0010 (Overflow)

In 2's complement:

a) 0101+1111 = 0100 (There is a carry out, BUT NO Overflow)

b) 1011 - 0111 = 1011 + 1001 = 0100 (There is a carry out AND Overflow)

- Q8. (2 pts) Using 8-bit registers, give the following in both binary and decimal:
- The maximum unsigned number that can be stored.
  - The smallest negative number and the largest positive number that can be stored using sign-magnitude notation.
  - The smallest negative number and the largest positive number that can be stored using 2's complement notation.
- A8. a) maximum unsigned =  $(11111111)_2 = 255$**
- b) smallest negative using sign-magnitude =  $(11111111)_2 = -127$**   
**largest positive using sign-magnitude =  $(01111111)_2 = +127$**
- c) smallest negative using 2's complement =  $(10000000)_2 = -128$**   
**largest positive using 2's complement =  $(01111111)_2 = +127$**
- Q9. (2 pts) If you type the string "I Love COE 205" on your keyboard, what byte sequence is sent to the computer using ASCII codes, with the 8<sup>th</sup> bit being an even parity bit?
- A9. I = 49h, Space = 20h, L = 4Ch, o = 6Fh, v = 76h, e = 65h, C = 43h, O = 4Fh, E = 45h, , 2 = 32h, 0 = 30h, 5 = 35h**
- With the 8<sup>th</sup> bit being an even parity bit the byte sequence becomes: C9h, A0h, CCh, 6Fh, F6h, 65h, A0h, C3h, CFh, C5h, A0h, B2h, 30h, 35h.**