EECE.3170: Microprocessor Systems Design I

Spring 2016

Homework 3 Solution

Assume the initial state of an x86 processor's registers, memory, and carry flag are:

EAX: 00003170h
EBX: 9876DCBAh
ECX: 00001995h
EDX: AC921E14h
ESI: 00008440h
CF: 0

Address	Lo			Hi
8440h	FF	03	99	87
8444h	08	09	F6	BB
8448h	78	15	00	00

*What is the result of each of the instructions listed below? Assume that the instructions execute in sequence—in other words, the result of each instruction may depend on the results of earlier instructions. Correctly evaluating each instruction will earn you **10 points**.*

Note that you may assume any constant values shown using less than 32 bits are zero-extended to 32 bits if necessary (for example, 000Fh = 0000000Fh).

ADD AX, BX

Solution: AX = AX + BX = 3170h + DCBAh = **0E2Ah**, **CF = 1**

ADC EAX, ECX

Solution: EAX = EAX + ECX + CF = 00000E2Ah + 00001995h + 1 = **000027C0h**, **CF = 0**

INC WORD PTR [ESI]

Solution: Add 1 to word at address ESI = 00008440h

→ Word @ 8440h = 03FFh + 1 = **0400h** (byte @ 8440h = 00h, byte @ 8441h = 04h)

MUL BYTE PTR [ESI+4]

Solution: AX = AL * unsigned byte @ (ESI+4)

→ Address = ESI + 4 = 8440h + 4 = 8444h; byte @ 8444h = 08h

→ AX = C0h * 08h = 192 * 8 = 1536 = **0600h**

SUB AX, [ESI+8]

Solution: AX = AX – word @ ESI+8

→ Address = ESI + 8 = 8440h + 8 = 8448h; word @ 8448h = 1578h

→ AX = 0600 – 1578h = **F088h**, **CF = 1** (since borrow out of MSB required)

DEC AH

Solution: AH = AH – 1 = F0 – 1 = **EFh**

IMUL AH

Solution: AX = AL * AH (signed multiplication) = 88h * EFh = -120 * -17 = 2040 = **07F8h**

IDIV DL

Solution: AL = AX / DL (signed division) = 07F8h / 14h = 2040 / 20 = 102 = **66h**
AH = AX % DL (remainder) = 2040 % 20 = **00h**

DIV DH

Solution: AL = AX / DH (unsigned division) = 0066h / 1Eh = 102 / 30 = **03h**
AH = AX % DH (remainder) = 102 % 30 = 12 = **0Ch**

NEG AH

Solution: AH = -AH = -0Ch = -($0000\ 1100_2$) = ($1111\ 0011_2$ + 1 = $1111\ 0100_2$ = **F4h**