EECE.3170: Microprocessor Systems Design I

Fall 2019

Homework 3 Solution

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

Initial state:
EAX: 0x0000B496
EBX: 0x000027A9
ECX: 0x00000003
EDX: 0x00002EA5
CF: 0

Address	Lo			Hi
0x31700	04	00	08	00
0x31704	83	00	01	01
0x31708	05	01	71	31
0x3170C	20	40	60	80
0x31710	02	00	AA	0F

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, 0x000F = 0x0000000F).

```
XOR   AX, BX
```

AX = AX XOR BX = 0xB496 XOR 0x27A9 = 0x933F

```
SHR   AX, 6
```

AX = AX >> 6 (shift in zeroes) = 0x933F >> 6 = 0x024C, CF = 1

```
AND   AH, BYTE PTR [0x31712]
```

AH = AH AND mem(0x31712) = 0x02 AND 0xAA = 0x02

```
ROL   AH, CL
```

AH = AH rotated left by CL = 0x02 rotated left by 3
= 0x10, CF = 0

```
NOT   EDX
```

EDX = ~EDX = ~0x00002EA5 = 0xFFFFD15A

```
SAR   DX, 8
```

DX = DX >> 8 (maintain sign) = 0xD15A >> 8 = 0xFFD1, CF = 0

```
BTR   AL, 7
```

CF = bit 7 of AL = bit 7 of 0x4C = 0
Since bit 7 is already 0, BTR doesn't need to reset bit

```
RCR   AL, 3
```

(AL, CF) = (AL, CF) rotated right by 3
= (0x4C, 0) rotated right by 3
= 0100 1100 0 rotated right by 3 = 0000 1001 1
So, AL = 0000 1001$_2$ = 0x09, CF = 1

```
BTC   AL, 2
```

CF = bit 2 of AL = bit 2 of 0x09 = 0
BTC complements bit 2 → AL = 0x0D

```
BSR   BX, DX
```

DX = 0xFFD1 → ZF = 1

BX = position of first 1 in DX, starting with MSB = 15 = 0x000F