Solutions - Quiz 1

(September 30th @ 5:30 pm)

Problem 1 (30 pts)

- Complete the following table. We are representing positive integer numbers.

Decimal	BCD (bits)	Binary	Hexadecimal
79	0111 1001	01001111	4F
14	0001 0100	00001110	0E
78	0111 1000	01001110	4E

- Perform the following operations of 8-bit unsigned integers. Determine whether there is an overflow (in the addition) and whether we need to borrow from a higher byte (in the subtraction). `91 = $5B, 194 = $C2`.
  - `91 + 194`

```
                 c8=1 c7=1 c6=0 c5=0 c4=0 c3=0 c2=1 c1=0 c0=0
  91 = 0x5B =      0    1    0    1    1    0    1    1   +
 194 = 0xC2 =      1    1    0    0    0    0    1    0
 ------------------------------------------------------------
Overflow! ->      1    0    0    0    1    1    1    0    1
```

  - `91 - 194`

```
Borrow out! ->   b8=1 b7=0 b6=0 b5=0 b4=0 b3=0 b2=0 b1=0 b0=0
  91 = 0x5B =      0    1    0    1    1    0    1    1   -
 194 = 0xC2 =      1    1    0    0    0    0    1    0
 ------------------------------------------------------------
                   1    0    0    1    1    0    0    1
```

- Perform the following operation using the 2's complement representation with 8 bits. Determine whether the operation results in an overflow. `-13=$F3` in 2's complement representation with 8 bits.
  - `-91 -13`

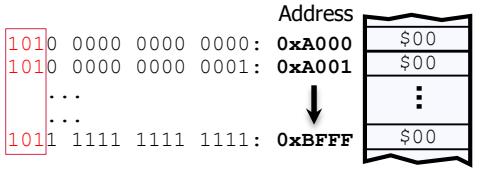
$c_8 \oplus c_7 = 0$ No Overflow

```
                 c8=1 c7=1 c6=1 c5=0 c4=0 c3=1 c2=1 c1=1 c0=1
-91 = 0xA5 =     1    0    1    0    0    1    0    1   +
-13 = 0xF3 =     1    1    1    1    0    0    1    1
 ------------------------------------------------------------
-104 = 0x98 =    1    0    0    1    1    0    0    0
```

Problem 2 (20 pts)

- A microprocessor has a 16-bit address line, where each address contains 8 bits. An SRAM device is connected to the microprocessor. The microprocessor has assigned the addresses `0xA000` to `0xBFFF` to this SRAM. What is the size (in KB, or MB) of this SRAM? What is the minimum number of bits required to represent the addresses on this SRAM?

✓ The range `0xA000 to 0xBFFF` is akin to all possible cases with 13 bits. Thus, the SRAM size is 2^{13} bytes = 8 KB. We only need 13 bits for this SRAM.



Problem 3 (50 pts)

Given the following set of instructions, complete the following:

- Register values (in hexadecimal format) as the instructions are executed.
- The state of the memory contents (in hexadecimal format) after the last instruction has been executed.
- The addressing mode of each instruction. Be specific, if for example the addressing mode is indexed, indicate which one in particular. Note that the `movw` instruction uses two addressing modes.

Addressing Mode		D	X	Y
		$207F	$20C0	$10A0
Indexed - Post-Decrement	`sty 2,X-`	$207F	$20BE	$10A0
Extended, Indexed - Pre-Increment	`movw $20C0,1,+Y`	$207F	$20BE	$10A1
Inherent	`clrb`	$2000	$20BE	$10A1
Immediate	`adda #$40`	$6000	$20BE	$10A1
Indexed Indirect - 16-bit Offset	`staa [0,Y]`