Cpr E 281 HW07 SOLUTION

ELECTRICAL AND COMPUTER ENGINEERING
IOWA STATE UNIVERSITY

Arithmetic Circuits and Combinational-Circuit Building Blocks
Assigned Date: Eighth Week
Due Date: First class of 9th week

P1. (6 points) Negate the following binary numbers in 4-bit 2's complement representation:

(Remark: Negate means you find the negative of the number.)

(a) 0001; (b) 1100; (c) 0111

To negate any number in 2's complement, flip all the bits and then add 1.

(a) 1110+1 = 1111

(b) 0011+1 = 0100

(c) 1000+1 = 1001

P2.

Construct the truth table

x_{n-1}	y_{n-1}	c_{n-1}	c_n	s_{n-1} (sign bit)	Overflow
0	0	0	0	0	0
0	0	1	0	1	1
0	1	0	0	1	0
0	1	1	1	0	0
1	0	0	0	1	0
1	0	1	1	0	0
1	1	0	1	0	1
1	1	1	1	1	0

Note that overflow cannot occur when two numbers with opposite signs are added. From the truth table overflow expression is

$$Overflow = \overline{c}_n c_{n-1} + c_n \overline{c}_{n-1} = c_n \oplus c_{n-1}$$

P3. (6 points) Give the 4-bit 2's complement representation for the following decimal numbers:

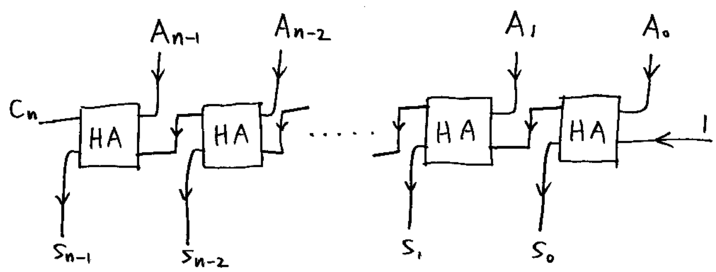
(a) -6; (b) -1; (c) 6

(a) -6 = 1010_2

(b) -1 = 1111_2

(c) 6 = 0110_2

P4.



P5.

A) $27_{10} = 1101.1_2 = 1.1011 \times 2^3$.

In IEEE 754 single-precision floating-point format:

0 10000010 10110000000000000000000

Note that in excess-127 representation, the exponent 3 is represented as 10000010. For the mantissa, the leading one is not stored.

B) 10111111 00101000 00000000 00000000 = 1 01111110 01010000000000000000000

So the exponent is 126 – 127 = -1. So the value is

$-1.0101 \times 2^{-1} = -0.10101_2 = -0.65625_{10}$

P6. For part A it is straight forward where

$$s_i = (x_i \oplus y_i)\overline{c_i} + \overline{(x_i \oplus y_i)}c_i = x_i \oplus y_i \oplus c_i$$

$$c_i = x_i y_i + x_i c_i + y_i c_i$$

For part B

$$s_i = \overline{x_i} y_i \overline{c_i} + x_i \overline{y_i}\,\overline{c_i} + \overline{x_i}\,\overline{y}_i c_i + x_i y_i c_i = (\overline{x_i} y_i + x_i \overline{y_i})\overline{c_i} + (\overline{x_i}\,\overline{y}_i + x_i y_i)c_i$$

$$= (x_i \oplus y_i)\overline{c_i} + \overline{(x_i \oplus y_i)}c_i = x_i \oplus y_i \oplus c_i$$

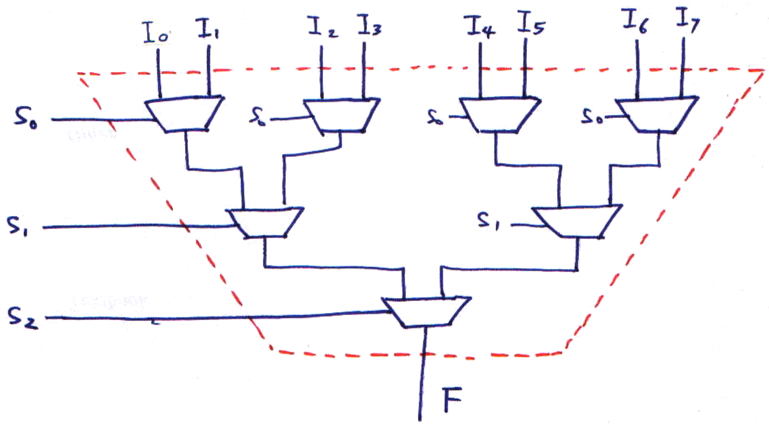
$$c_i = (x_i \oplus y_i)c_i + x_i y_i = (\overline{x_i}\, y_i + x_i \overline{y_i})c_i + x_i y_i = y_i(x_i + c_i) + x_i(y_i + c_i) = x_i y_i + x_i c_i + y_i c_i$$

Then A and B expressions are the same. You can also do this exercise with the help of truth tables.

P6.

a. A 2^nx1 multiplexer would take **2^n-1** 2x1 multiplexers.

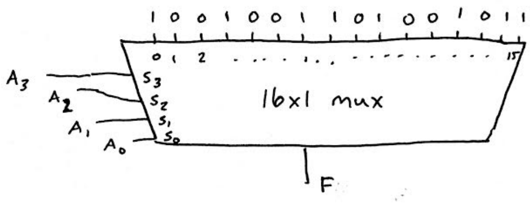
b.



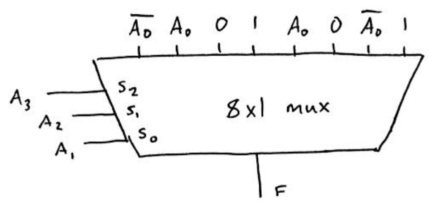
P8. (a)

A3	A2	A1	A0	F (a) (b)	(c)
0	0	0	0	1	A0’
0	0	0	1	0	
0	0	1	0	0	A0
0	0	1	1	1	
0	1	0	0	0	0
0	1	0	1	0	
0	1	1	0	1	1
0	1	1	1	1	
1	0	0	0	0	A0
1	0	0	1	1	
1	0	1	0	0	0
1	0	1	1	0	
1	1	0	0	1	A0’
1	1	0	1	0	
1	1	1	0	1	1
1	1	1	1	1	

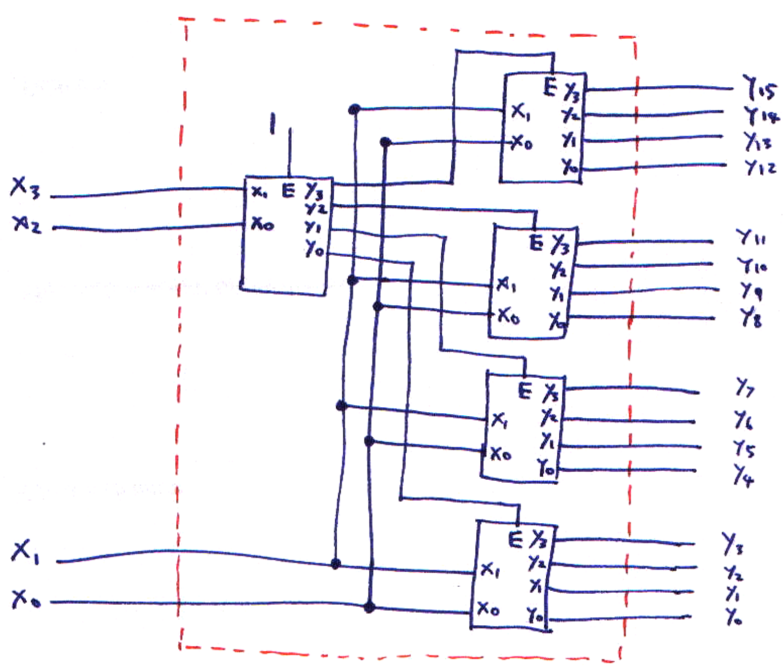
(B)


16x1 mux
A3
A2
A1
A0
S3
S2
S1
S0
F

(C)


8x1 mux
A3
A2
A1
S2
S1
S0
F

P9.


X3
X2
X1
X0
Y15
Y14
Y13
Y12
Y11
Y10
Y9
Y8
Y7
Y6
Y5
Y4
Y3
Y2
Y1
Y0