Ryerson University
Department of Electrical and Computer Engineering
COE 328 – Digital Systems and Microprocessors

Midterm Test 　　　　　　　　　　　　　　　　**October 27, 2008**

Name: ____________________ **Student Number:** ____________________ **Section:** __________

Time limit: 1 hour 50 min 　　　　　　　　　　Examiners: N. Mekhiel, R. Sedaghat

Notes:

a) Closed book.
b) No calculators.
c) Answer all questions **in the space provided**.
d) Circle your professor's name and hand in these sheets.

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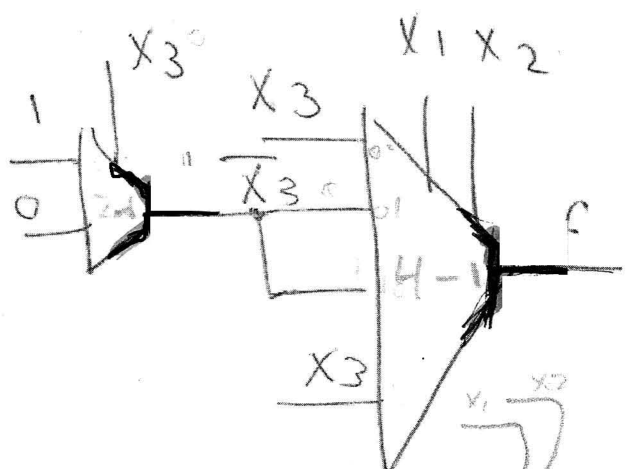
minimum number of

1. Implement function $F = \overline{(x_1 \oplus x_2)}\,\overline{x_3} + (x_1 \oplus x_2)\,x_3$ using ~~4~~ multiplexers. **(?? marks)**
Use 4-to-1 and 2-to-1multiplexer.

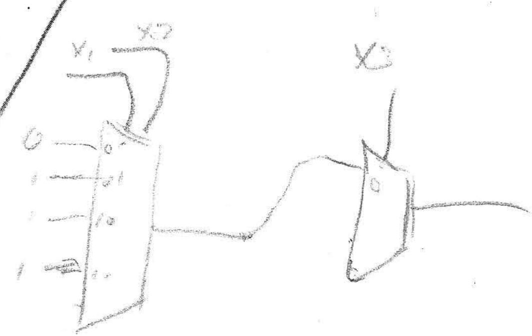
$\overline{F} = \overline{X_1 \oplus X_2 \oplus X_3}$

3 input XOR truth table

X1	X2	X3	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1



$\overline{x}\,\overline{y} + xy = \overline{x \oplus y}$



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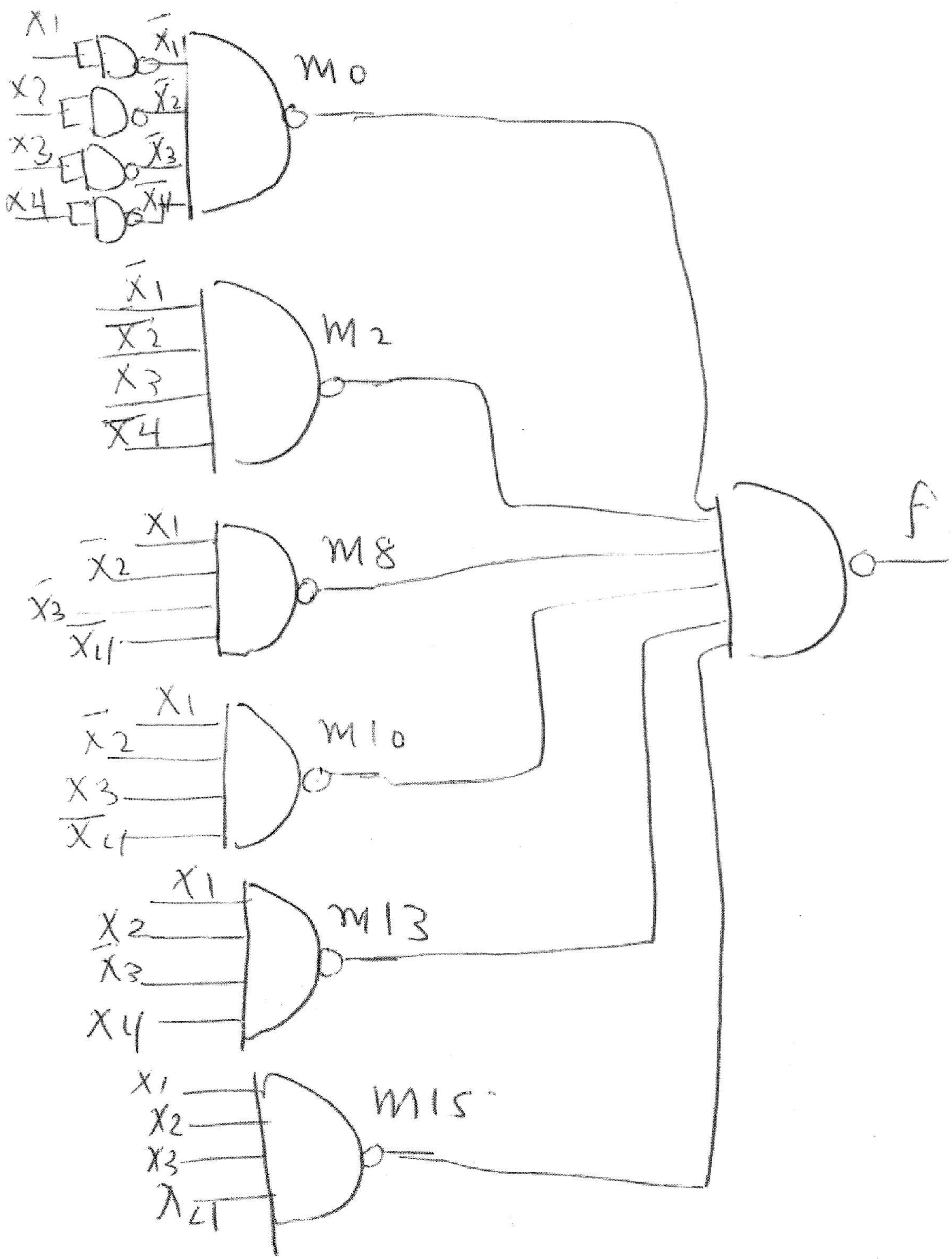
2. **(?? marks)**

a) Implement the following logic function using NAND gates only (Do not simplify)

$F(x_1,x_2,x_3,x_4) = \sum m(0,2,8,10,13,15)$



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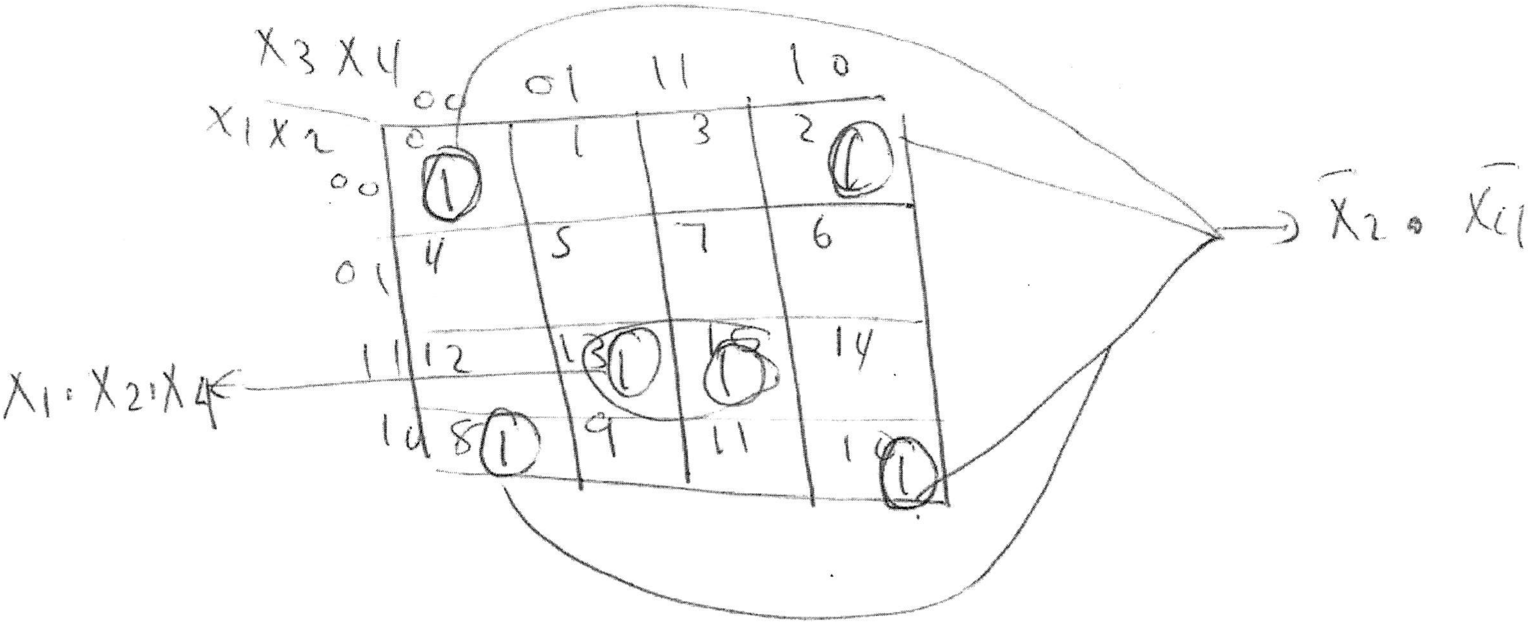
b) Simplify the above function



$$F = X_1 \cdot X_2 \cdot X_4 + \overline{X_2} \cdot \overline{X_4}$$

c) Find the complement of the optimized function using DeMorgan theorem

$$\overline{F} = \overline{(X_1 \cdot X_2 \cdot X_4 + \overline{X_2} \cdot \overline{X_4})}$$

$$= (\overline{X_1} + \overline{X_2} + \overline{X_4}) \cdot (X_2 + X_4)$$

$$= \overline{X_1} \cdot X_2 + \overline{X_1} \cdot X_4 + \overline{X_2} \cdot X_4 + \overline{X_4} \cdot X_2$$

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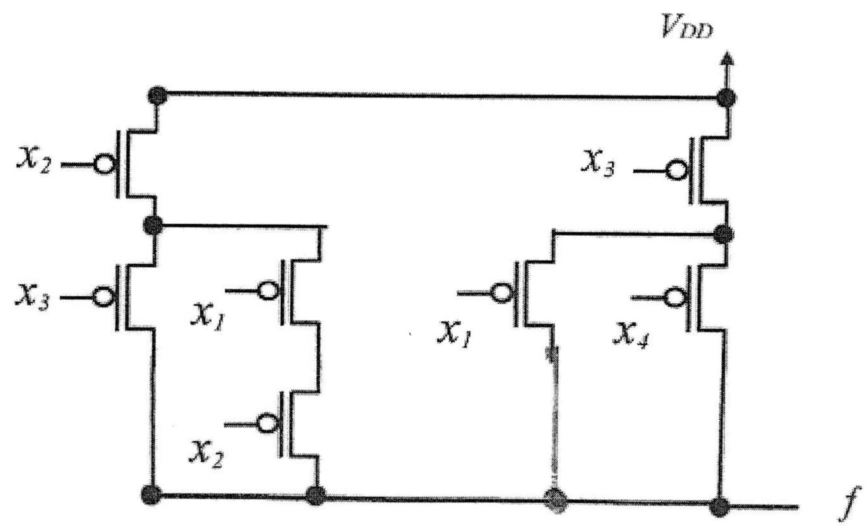
3.

a) Find the logic equation for the function *f* implemented in CMOS. Its PMOS circuit is shown below.

(?? marks)

~~$F(x) = (\bar{x}_3 + \bar{x}_1 \bar{x}_2)\bar{x}_2 + \bar{x}_3(\bar{x}_1 \bar{x}_2)$~~



$$F = \bar{x}_2 \cdot (\bar{x}_3 + \bar{x}_1 \cdot \bar{x}_2) + \bar{x}_3 \cdot (\bar{x}_1 + \bar{x}_4)$$

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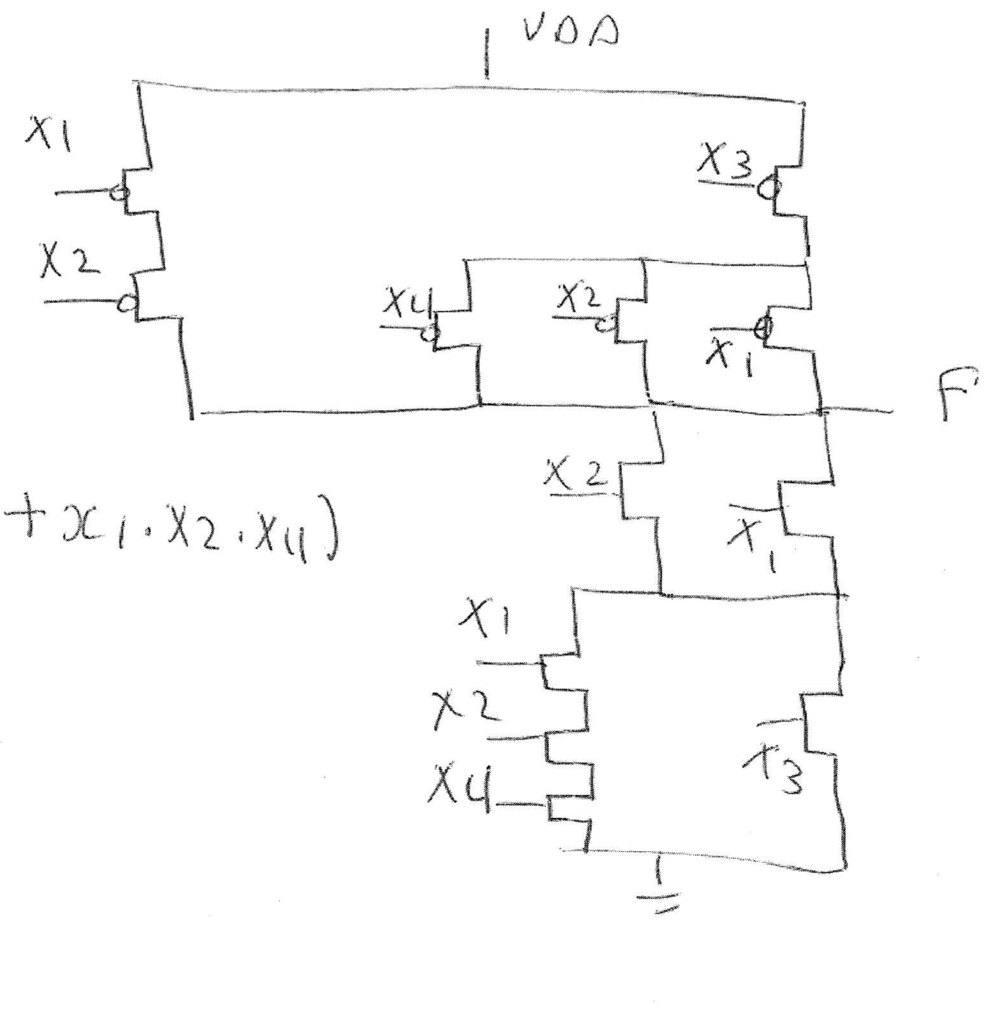
b) Simplify the above function

$$F = \bar{x}_2 . \bar{x}_3 + \bar{x}_1 . \bar{x}_2 + \bar{x}_3 . \bar{x}_1 + \bar{x}_3 . \bar{x}_4$$

$$= \bar{x}_3 (\bar{x}_2 + \bar{x}_1 + \bar{x}_4) + \bar{x}_1 . \bar{x}_2$$

c) Implement the optimized function using CMOS



$$\bar{F} = (X_1 + X_2) . (X_3 + x_1 . X_2 . X_4)$$

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4. Given the binary 8 bit number 11011001, find the following:

a) The decimal value if the 8 bit number is an unsigned-number

~~(1+8+16+64+~~ +128) = 25+64+128 = 217

b) The decimal value if the 8 bit number is signed-magnitude

−(1+8+16+64) = −89

c) The decimal value if the 8 bit number is 2's complement

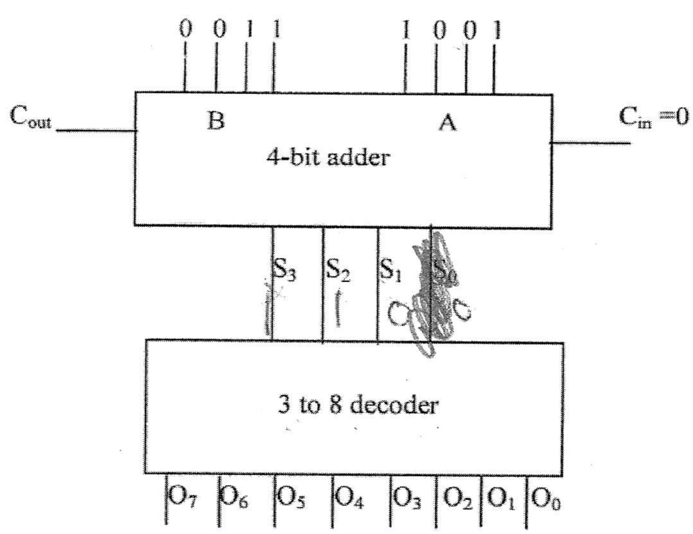
−(0100111) = −(1+2+4+32) = −39

d) Convert the 8 bit number to a hexadecimal-number

D9

Dec	9	10	11	12	13	14	15	16
Hex	9	A	B	C	D	E	F	10

5. Find the values of the outputs ($O_7 \dots O_0$) for the circuit given below assuming A=1001 and B=0011



0 1 0 0 0 0 0 0

S = 1001 + 0011 = 1100

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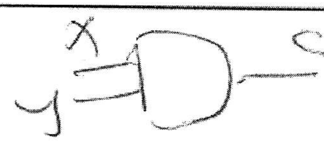
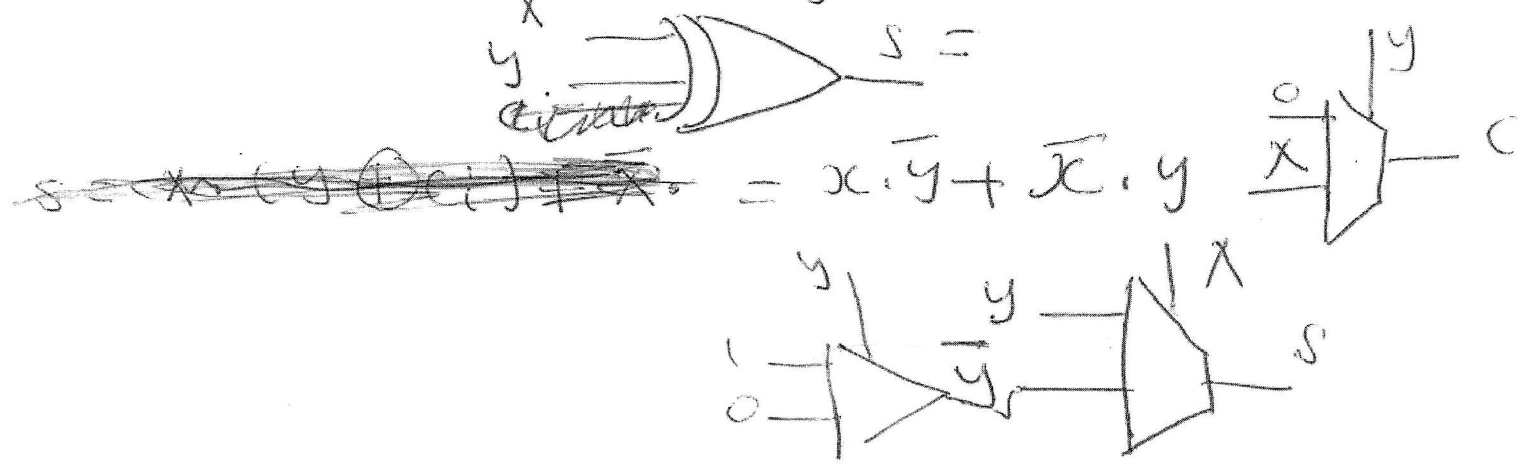
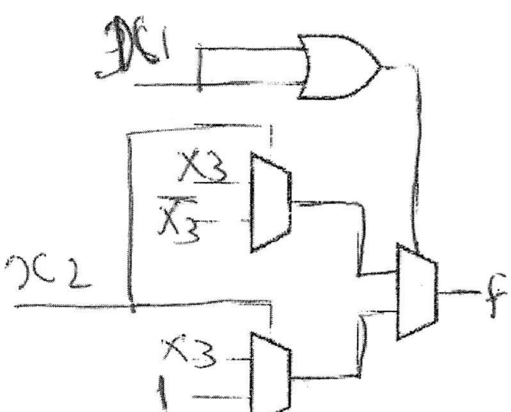
6. Construct a one-bit adder using a 2-to-1 multiplexer **(?? marks)**





7. Show how the function $f = x_2 \overline{x_3} + x_1 x_3 + \overline{x_2} x_3$ can be realized using the following circuit. Derive and write all values for the circuit inputs.

(?? marks)



$f = \bar{x}_1 \cdot \bar{x}_2 (x_3) + \bar{x}_1 \cdot x_2 (\bar{x}_3)$

$+ x_1 \cdot \bar{x}_2 (x_3) + x_1 \cdot x_2 (\bar{x}_3 + x_3)$