EE232 – Digital Electronics College of Engineering Term 2, 2007-08

Midterm

(17)

Name: [redacted] Student No. [redacted]

- *Time: 90 Minutes, Total Marks: 25*
- *Interaction with another student is NOT allowed*
- *Closed book exam. NO additional materials are allowed*
- *Calculators are NOT allowed*

Q1. Write down the 6-bits binary representation for each of the following numbers: (1.5+1.5=3 mark)

(a) $(+16)_{10}$

Sign magnitude: 0

1's complement: 010000 ✓

2's complement: 110000

(b) $(-16)_{10}$

Sign magnitude: 1

1's complement: 110000

2's complement: 010000

(0.5)

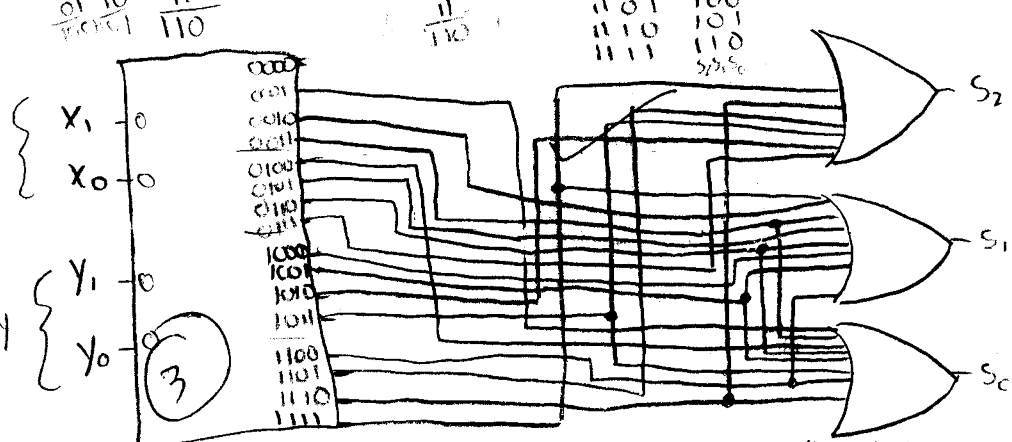
Q2. What is a Tristate gate? Explain its operation. (1 mark)

A tristate gate allows the input to pass to the output if it is enabled. If it is not enabled, the output is High-Z ✓ (1)

Q2. Implement a circuit that adds two binary numbers, X (x_1x_0) and Y (y_1y_0) using one 4x16 decoder. (3 marks)

X_1	X_0	Y_1	Y_0	S_2	S_1	S_0
0	0	0	0	0	0	0
0	0	0	1	0	0	1
0	0	1	0	0	1	0
0	0	1	1	0	1	1
0	1	0	0	0	0	1
0	1	0	1	0	1	0
0	1	1	0	0	1	1
0	1	1	1	1	0	0
1	0	0	0	0	1	0
1	0	0	1	0	1	1
1	0	1	0	1	0	0
1	0	1	1	1	0	1
1	1	0	0	0	1	1
1	1	0	1	1	0	0
1	1	1	0	1	0	1
1	1	1	1	1	1	0

(3)

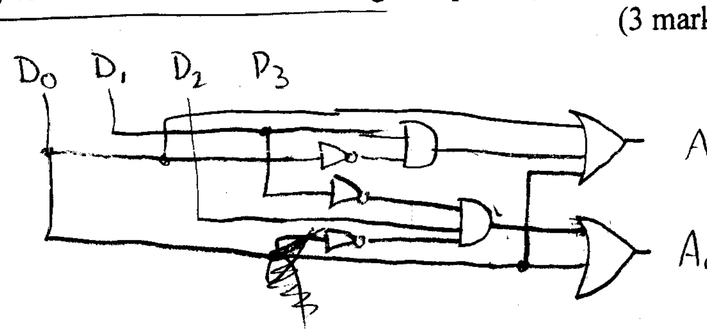


* only link "high" → "low" output from other outputs will provide "low" signal for or

Q3. Design a 4x2 priority encoder (D_3-D_0; D_0 is the LSB and has the highest priority; D_3 has the lowest priority). (3 marks)

D_0	D_1	D_2	D_3	A_1	A_0
0	0	0	1	0	0
0	0	1	X	0	1
0	1	X	X	1	0
1	X	X	X	1	1

(1)

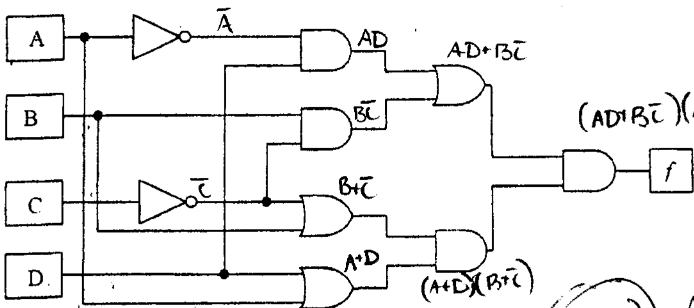


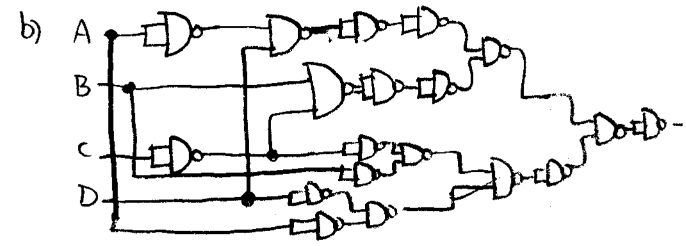
Q4. Draw the truth table for the following function: $f = \bar{a}b + \bar{a}\bar{b}c$. Implement the function using two 2x1 MUX. (2+2=4 marks)

a	b	c	f
0	0	0	0

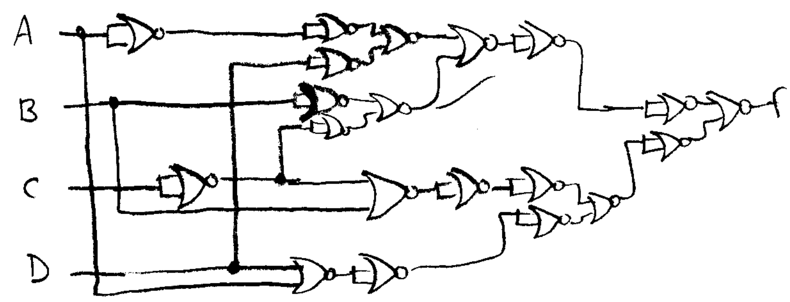
a b c

Q5. Consider the following circuit. (a) Determine the circuit's function, $f(A,B,C,D)$; (b) Implement the circuit using only 2-input NAND gates; (c) Implement the circuit using only 2-input NOR gates; (d) Between (a) and (b), which implementation is more efficient (in terms of number of gates)? (1+2+2+1=6 marks)





a) $f = (AD+B\bar{C})(A+D)(B+\bar{C})$



d) NAND implementation is more efficient.

5

Q6. Simplify the following K-maps and write down the simplified Boolean expressions. (1+1=2 marks)

(a)

AB \ CD	00	01	11	10
00	0	1	1	0
01	0	1	1	1
11	1	1	1	1
10	1	0	0	0

$AB + A\bar{C}\bar{D} + \bar{A}D + BC$
$= A(B+\bar{C}\bar{D}) + \bar{A}D + BC$

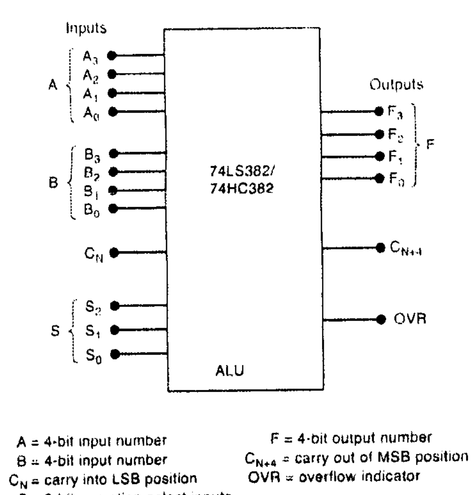
1.5

(b)

AB \ CD	00	01	11	10
00	0	1	1	1
01	0	1	0	1
11	1	1	1	1
10	1	1	1	0

$A\bar{C} + \bar{C}D + AD + AB + \bar{A}C\bar{D} + \bar{A}\bar{B}C$
$= A(\bar{C}+D+B) + \bar{C}D + \bar{A}(C\bar{D}+\bar{B}C)$

Q 7. Consider the following 74LS382 IC. Using minimum number of this IC, design a circuit that produces a HIGH output (1-bit) only when A ($A_3A_2A_1A_0$) = B ($B_3B_2B_1B_0$). No external gates can be used. (3 marks)



A = 4-bit input number
B = 4-bit input number
C_N = carry into LSB position
S = 3-bit operation select inputs

F = 4-bit output number
C_{N+4} = carry out of MSB position
OVR = overflow indicator

(a)

Function Table

S_2	S_1	S_0	Operation	Comments
0	0	0	CLEAR	$F_3F_2F_1F_0$ = 0000
0	0	1	B minus A	Needs C_N = 1
0	1	0	A minus B	
0	1	1	A plus B	Needs C_N = 0
1	0	0	$A \oplus B$	Exclusive-OR
1	0	1	A + B	OR
1	1	0	AB	AND
1	1	1	PRESET	$F_3F_2F_1F_0$ = 1111

Notes: S inputs select operation.
OVR = 1 for signed-number overflow.

(b)

method: A−B (subtract)
if =0, result is high

0100 + 1111 = 10011
0001 + 1111 = 0000 ← MSB is output

if non-zero binary number is added to 1111, MSB=0