0907231 Digital Logic — Second Exam — Fall 2015

5 Problems — 70 Minutes — (21)

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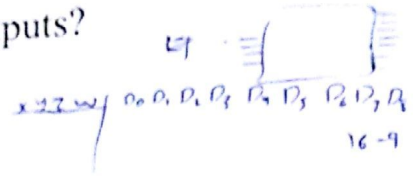
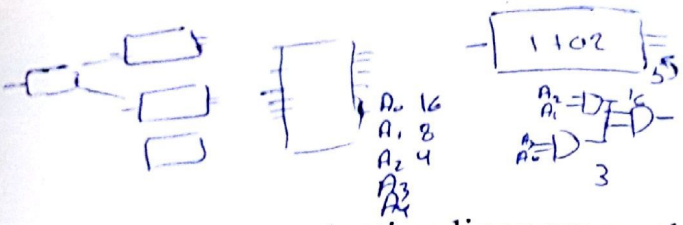
Problem 1. Solve the following short problems. **(10 points)** (7)

a. Given a 4-to-9 line decoder, how many input combinations produce '0' at all outputs?



Answer = 7 ✓

b. Using decoder expansion, how many 2-input AND gates and 1-to-2 line decoders are needed to build a 5-to-32 line decoder?



Number of 2-input AND gates = 48 ✓

Number of 1-to-2 line decoders = 16

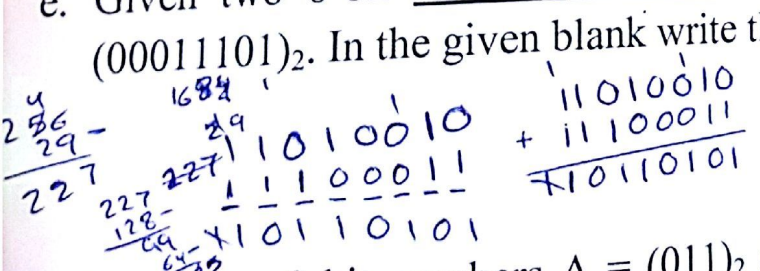
c. How many selection lines are needed for a Quad 18-to-1 Multiplexer?

Answer = 5 ✓

d. Represent the number $(-14)_{10}$ as an 8-bit binary number using ***signed-magnitude*** representation? 1110

Answer = 10001110 ✓

e. Given two 8-bit ***2's complement signed numbers*** A = $(11010010)_2$ and B = $(00011101)_2$. In the given blank write the result of $A - B$?



$A - B$ = 10110101 ✓

f. Given two 3-bit numbers A = $(011)_2$ and B = $(010)_2$. Determine the value of the overflow bit generated by the operation **A+B** if the numbers are treated as ***1) unsigned numbers*** and if they are treated as ***2) 2's complement signed numbers***?

Unsigned Overflow = 0 ✓

Signed Overflow = 1 ✓

g. Given a 6-to-3 high priority encoder with inputs D_5-D_0 and outputs A_2-A_0 and valid bit (V). Write the Boolean equation for A_2 and V bits.

V	D_5	D_4	D_3	D_2	D_1	D_0	A_2	A_1	A_0
1	0	0	0	0	0	0	x	x	x
0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	1	x	0	0	1
0	0	0	0	1	x	x	0	1	0
0	0	0	1	x	x	x	0	1	1
0	0	1	x	x	x	x	1	0	0
0	1	x	x	x	x	x	1	0	1
1	x	x	x	x	x	x	1	1	0
x	x	x	x	x	x	x	1	1	1

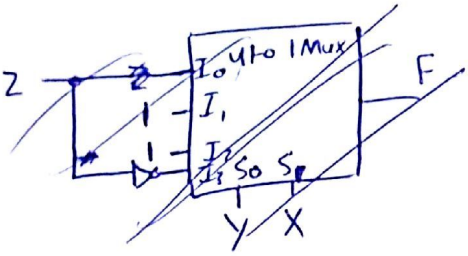
$V = \bar{D}_5 \bar{D}_4 \bar{D}_3 \bar{D}_2 \bar{D}_1 \bar{D}_0$ ✗

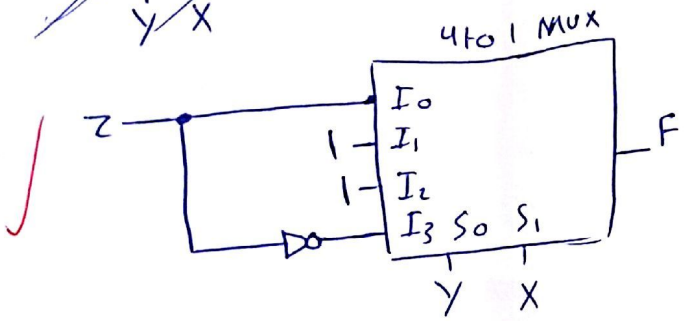
$A_2 = D_2 \bar{D}_3 \bar{D}_4 \bar{D}_5 + D_3 \bar{D}_4 \bar{D}_5$ ✗

Problem 2: Let $F(x, y, z)$ be given by the below truth table. 5.5 **(6 points)**

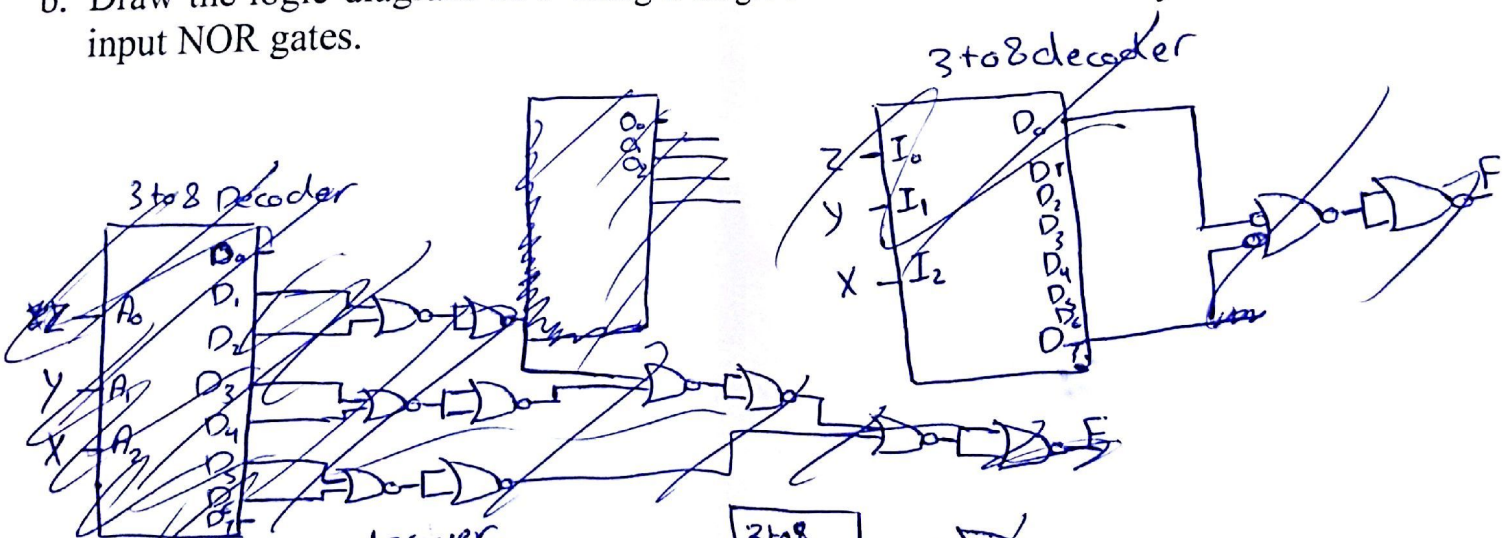
X	Y	Z	F	
0	0	0	0	Z
0	0	1	1	
0	1	0	1	1
0	1	1	1	
1	0	0	1	1
1	0	1	1	
1	1	0	1	$\bar{Z}$
1	1	1	0	

a. Draw the logic diagram of F using a single 4-to-1 Multiplexer and any number of inverter gates.

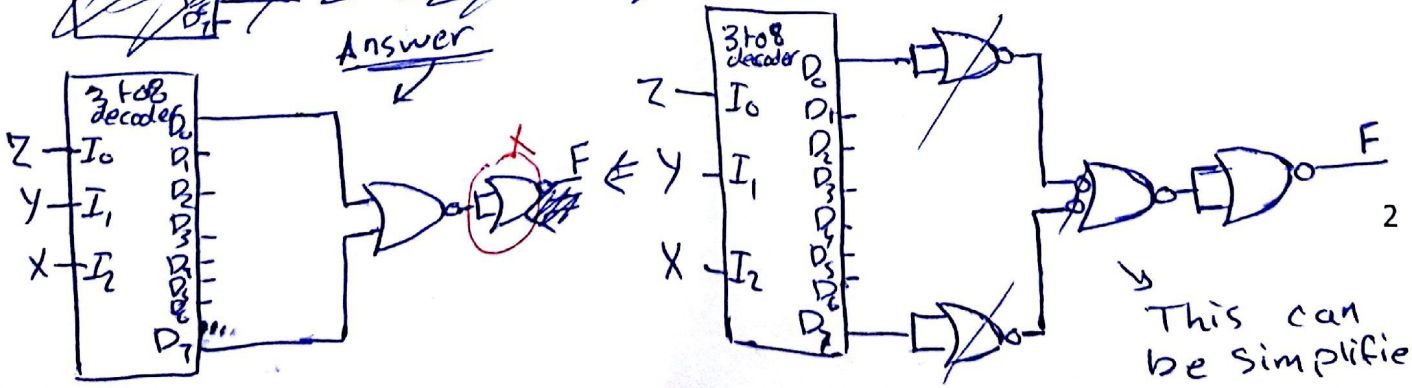




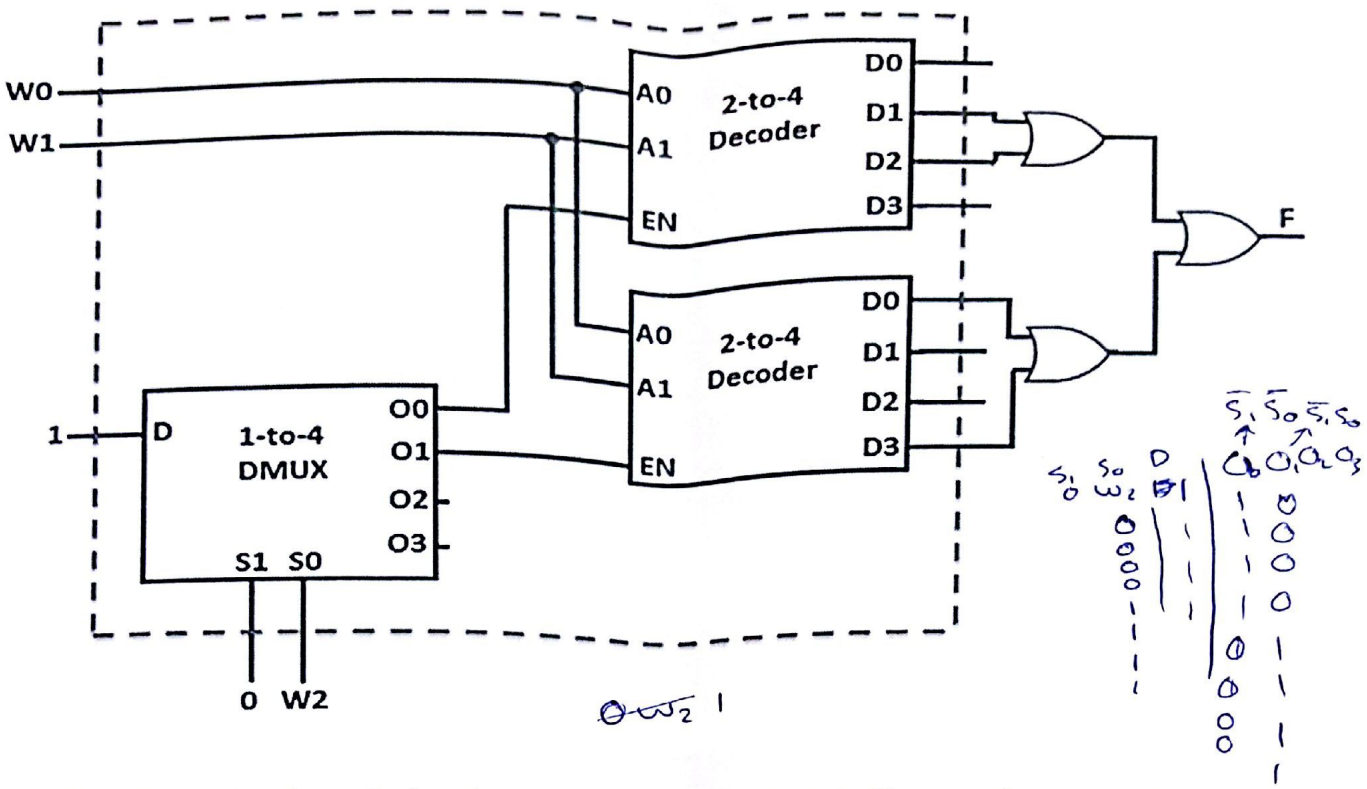
b. Draw the logic diagram of F using a single 3-to-8 Decoder and any number of 2-input NOR gates.



Answer



Problem 3: Consider the following combinational circuit to answer the below questions. **(5points)**



a. What does the dotted circuit represent as one block? Choose the correct answer.

i. 1-to-8 Demultiplexer

ii. 8-to-1 Multiplexer

iii. 3-to-8 Decoder

iv. 5-to-3 Encoder

b. Fill the truth table for the Boolean function F.

W2	W1	W0	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

5

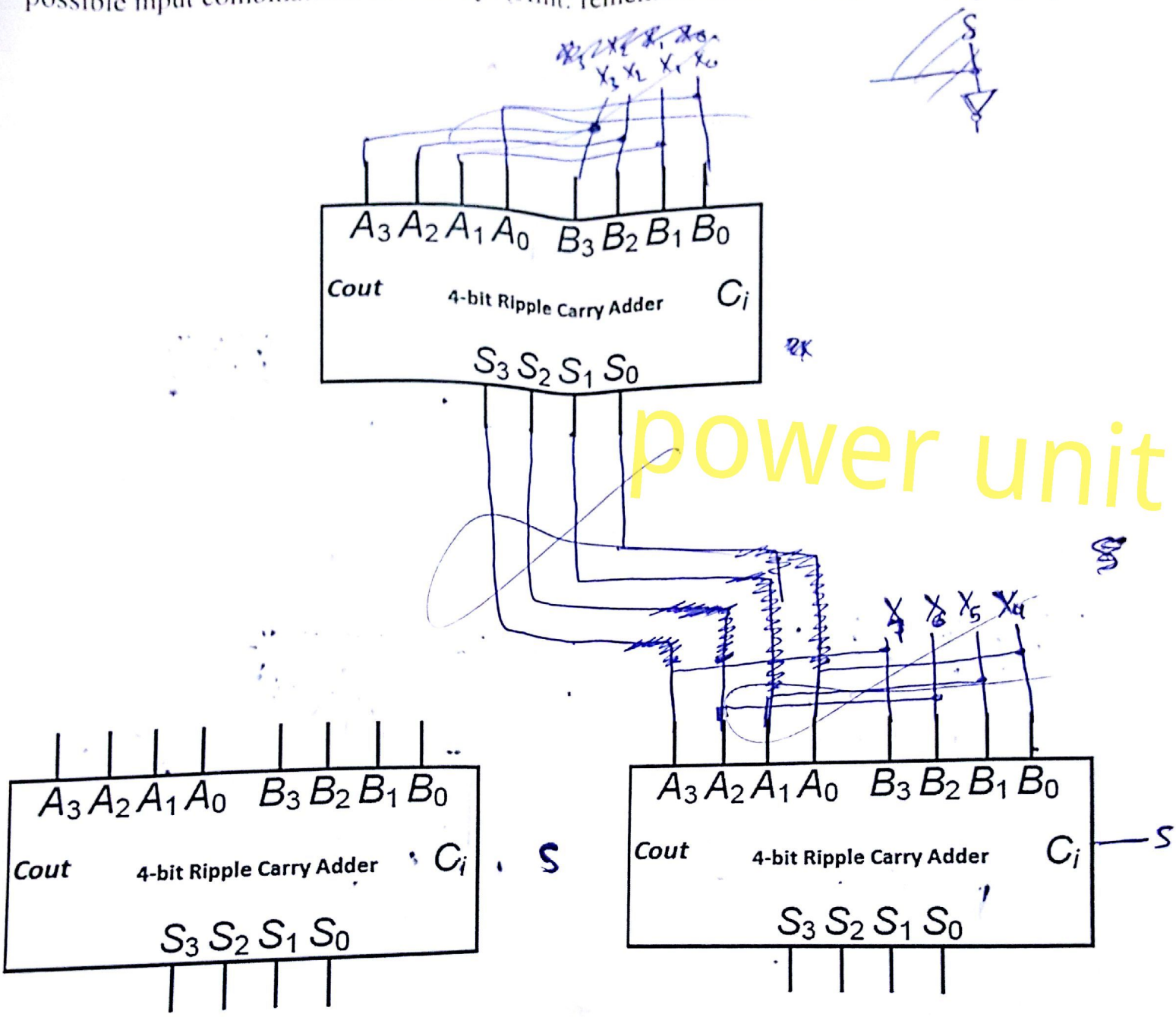
Problem 4: Write the truth table for a combinational circuit that takes a 4-bit BCD number (in the range 1-8) as an input and outputs 1 only if the BCD number has more 0s than 1s. ***Do NOT show input combinations that have don't care outputs***. **(4 points)**

BCD

B_3	B_2	B_1	B_0	#	F
0	0	0	1		1
0	0	1	0		1
0	0	1	1		0 x
0	1	0	0		1
0	1	0	1		0 x
0	1	1	0		0 x
0	1	1	1		0
1	0	0	0		1

2.5

Problem 5: Assume x and y are 4-bit *2's complement signed numbers*. Using *only* the following three 4-bit ripple carry adders and any gates you need, design a circuit that outputs an 8-bit signed number z. The circuit has a control bit S, when S=0 the output $z=y+2x$, when S=1 the output $z=y-2x$. Your circuit should produce correct results for all possible input combinations of x and y. (Hint: remember that $2x=x+x$) **(5 points)**



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