

USAF ACADEMY

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ECE 281 GRADED REVIEW #1 SPRING 2016

Name: _____

Section: _____

Academic Security This examination is not released from academic security until **1630 on 16 February 2016**. Until this time, you may not discuss the examination contents or the course material with anyone other than your instructor.

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Authorized Resources Calculator

- Instructions**
- **Show all work for full credit**
 - Box or circle your final answer.
 - For all numerical answers, use engineering notation and include units.
 - Completely label all your diagrams, drawings, graphs, etc. for full credit.
 - You have **53 minutes** to complete this exam.
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Problem	Value	Earned
1	20	
2	20	
3	18	
4	16	
5	6	
6	20	
Total	100	

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ECE 281 – GR #1

Problem 1

Number Conversions

- a. Using 2s complement representation, the range of numbers you can represent with eight bits is:

$$-2^{N-1} \text{ to } 2^{N-1} - 1 \quad -128 \text{ to } 127$$

- b. Convert 111101_2 to hexadecimal. Show your work.

3 1 0

a. 75

b. 3D

c. E1

d. 61

e. none of these

- c. Convert 101_{10} to octal. Show your work.

101
12 5
1 4
0 1

a. 131

b. 145

c. 65

d. 61

e. none of these

- d. Convert 1010110_2 to decimal. Show your work.

$$2^6 + 2^4 + 2^2 + 2^1 = 64 + 16 + 4 + 2$$

a. 108

b. 29

c. 56

d. 86

e. none of these

- e. Convert 27_{16} to binary. Show your work.

27
13 1
6 1
3 0
1 1
0 1

a. 011011

b. 101010

c. 100110

d. 010111

e. none of these

- f. Convert -25_{10} to 6-bit 2s complement binary. Show your work.

a. 100111

b. 111001

c. 011001

d. 010101

e. none of these

- g. Convert -25_{10} to 6-bit signed magnitude. Show your work.

a. 110101

b. 011001

c. 111101

d. 100111

e. none of these

$$25 \rightarrow 011001$$

$$-25 \rightarrow 111001$$

Problem 2 (20 points)*Boolean Equations and Algebra*a. Which expression is the most simplified form of $X + Y(Z + \bar{X} + \bar{Z})$?

a. 0

b. 1

c. $X + Y$ d. $X + YZ$ e. $X + YZ + Y\bar{X}\bar{Z}$

$$\begin{aligned}
 &Z + \bar{X}\bar{Z} = Z + \bar{X} \\
 &X + Y(Z + \bar{X}\bar{Z}) \\
 &X + Y(Z + \bar{X}) \\
 &X + YZ + Y\bar{X} \\
 &X + YZ + Y
 \end{aligned}$$

b. Given that: $F(A, B, C) = \bar{A}BC + \bar{B}\bar{C} + BC$, what does $F(1, 1, 0)$ equal?

$$\bar{1}10 + \bar{1}\bar{0} + 10 = 0 + 0 + 0$$

i. 0

ii. 1

iii. C

iv. \bar{C}

v. none of these

c. Answer the following questions for this truth table.

X	Y	Z	L
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

$$\begin{array}{cccc}
 0 & 0 & 0 & 1 \\
 0 & 0 & 1 & 1 \\
 1 & 1 & 0 & 1 \\
 1 & 0 & 1 & 0
 \end{array}$$

$$POS = (x+y+z)(x+y\bar{z})(\bar{x}+y+\bar{z})(\bar{x}+\bar{y}+z)$$

i. Write the Boolean equation for this truth table in SOP form.

$$L = \bar{x}\bar{y}\bar{z} + \bar{x}y\bar{z} + x\bar{y}\bar{z} + x\bar{y}z \rightarrow \bar{x}y(\bar{z}+z) + x\bar{y}\bar{z} + x\bar{y}z$$

ii. Write the SOP in simplified form.

$$L = \bar{x}y + y\bar{z} + x\bar{y}\bar{z}$$

$$\begin{aligned}
 &y(\bar{x}+x\bar{z}) + x\bar{y}\bar{z} \\
 &y(\bar{x}+z) + x\bar{y}\bar{z} \\
 &y\bar{x} + yz + x\bar{y}\bar{z}
 \end{aligned}$$

d. Darth Vader will enjoy his picnic on sunny days that have no ants. He will also enjoy his picnic any day he sees a humming bird, as well as days where there are ladybugs but no ants. Write a Boolean equation for his enjoyment (E) in terms of sun (S), ants (A), hummingbirds (H), and ladybugs (L).

$$E = S\bar{A} + H + L\bar{A}$$

Problem 3

*K Maps & Combinational Logic
Implementation*

a. Simplify the following equation using a Karnaugh map:

A	B	C	D	Y
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	1
0	1	1	1	0
1	0	0	0	1
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	X
1	1	1	0	1
1	1	1	1	1

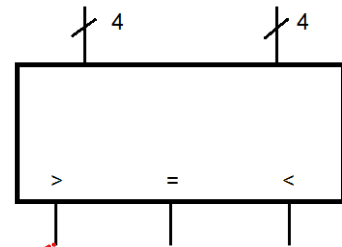
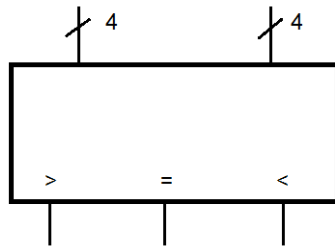
AB \ CD		CD			
		00	01	11	10
00	01	0	0	0	1
01	11	1	0	0	1
11	10	1	0	1	1
10	00	1	X	1	1

Simplified Boolean Equation: $Y = \underline{C\bar{D} + B\bar{D} + A\bar{D} + AC}$

Problem 4

Circuit Design

- a. Given two four-bit magnitude comparators, add some combinational logic gates and create an eight-bit magnitude comparator. Ensure the inputs (and associated bits) are clearly labeled. The outputs are shown on the left side of the page. (**Hint: How would a person compare two numbers?**)



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See design problem email

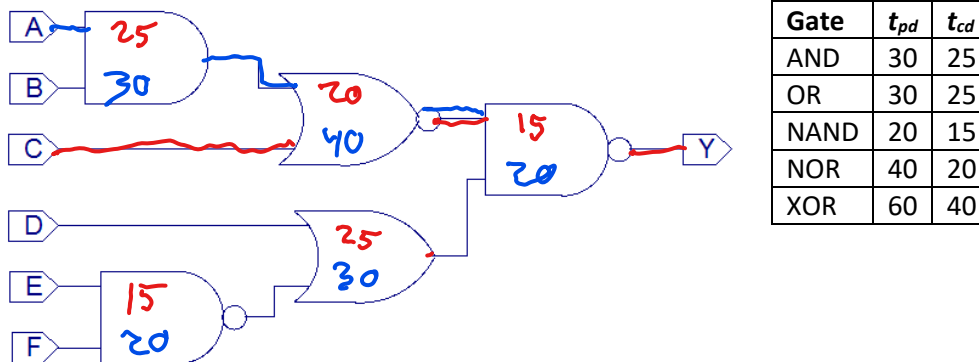
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Problem 5

Timing Analysis

Use the information in the below schematic and associated table to answer the next two questions.



- a. Draw the short path in the above schematic.
- b. Given the chart of gate delays in ps, calculate the length of the critical path. Show your work.

$$t_{crit path} = 30 + 40 + 20 = 90 \text{ ps}$$