

Student ID: \_\_\_\_\_

# CS 151 Quiz 5

Name : \_\_\_\_\_ , \_\_\_\_\_  
(Last Name) (First Name)

Student ID : \_\_\_\_\_

Signature : \_\_\_\_\_

## **Instructions:**

1. Please verify that your paper contains **5 pages** including this cover.
2. Write down your Student-Id on the top of each page of this quiz.
3. This exam is **closed book**. No notes or other materials are permitted.
4. Total credits of this quiz are **40 points**.
5. To receive credit you must show your work clearly.
6. **No re-grades will be entertained if you use a pencil.**
7. Calculators are **NOT** allowed.

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**Q1: Logic Optimization** **[20 points]**

Design a circuit that accepts a 4-bit BCD (Binary Coded Decimal) digit and outputs 1 if the number is an odd number less than 6 or greater than 8.

[Notice that BCD is one representation form in which each integer of a decimal number is represented by a 4-bit binary number. For example, binary number (**b3b2b1b0 = 0011**) represents 3 in decimal (**d = 3**)]

- a. Draw the truth table for this function. **[5 points]**

Binary				Decimal	Output
b3	b2	b1	b0	d	F
0	0	0	0	0	0
0	0	0	1	1	1
0	0	1	0	2	0
0	0	1	1	3	1
0	1	0	0	4	0
0	1	0	1	5	1
0	1	1	0	6	0
0	1	1	1	7	0
1	0	0	0	8	0
1	0	0	1	9	1
1	0	1	0	don't care	X
1	0	1	1	don't care	X
1	1	0	0	don't care	X
1	1	0	1	don't care	X
1	1	1	0	don't care	X
1	1	1	1	don't care	X

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b. Draw the K-map for this function.

[5 points]

		<b>b1b0</b>			
		00	01	11	10
<b>b3b2</b>	00	0	1	1	0
	01	0	1	0	0
	11	X	X	X	X
	10	0	1	X	X

c. Show all the “**Prime Implicants**” and “**Essential Prime Implicants**”.  
[5 points]

Prime Implicants:  $b_2'b_0$ ,  $b_3b_0$ ,  $b_1'b_0$

Essential Prime Implicants:  $b_2'b_0$ ,  $b_1'b_0$

d. Simplify the function

[5 points]

$$F = b_2'b_0 + b_1'b_0$$

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**Q2: Size-Delay trade off**

**[20 points]**

Show the trade-off in delay vs. size for the circuit representing function F.

$$F(a,b,c,d,e,f) = abcd + abe + cdf$$

You can use the following gate library showing costs for different gates:

Gate	Cost
2-input AND	4
3-input AND	6
4-input AND	8
2-input OR	4
3-input OR	6
4-input OR	8

**Solution:**

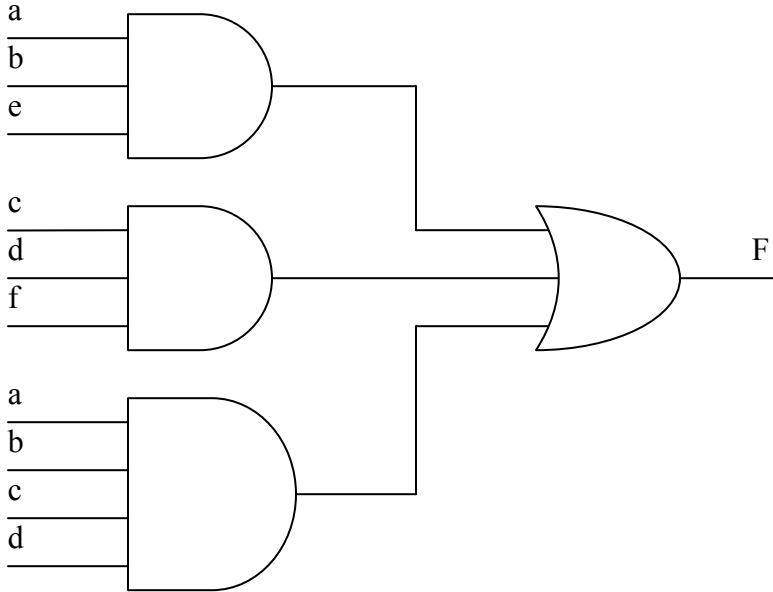
The tradeoff is shown on the next page:

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Size: 26

Delay: 2 gate delays



Size: 24

Delay: 4 gate delays

$$abcd + abe + cdf = ab(cd + e) + cdf$$

