ECE275 Midterm 1 Fall 2022

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Student Name: Student Email:

1 Instructions

- Time allowed is 50 minutes.
- In order to minimize distraction to your fellow students, you may not leave during the last 10 minutes of the examination.
- The examination is closed-book. One 8×11 in two-sided cheatsheet is allowed.
- Non-programmable calculators are permitted.
- The maximum number of marks is 100, as indicated; the midterm examination amounts 10% toward the final grade.
- Please use a pen or heavy pencil to ensure legibility. Colored pens/pencils are recommended for K-map grouping.
- Please show your work; where appropriate, marks will be awarded for proper and well-reasoned explanations.

Problem 1. *Number conversions:*

1. *Use repeated division to convert* 77_{10} *to octal representation (5 marks).*
2. *What is the value of* 7064_8 *in base 10 (5 marks).*
3. *An 8-bit two's complement number is* 10110011_2*. Convert it to (signed) decimal (5 marks).*
4. *Represent* -121_{10} *in 8-bit two's complement binary notation (5 marks).*

Problem 2. *Use the following 5-variable K-map for F (A, B, C, D, E), and find a minimal SOP expression for F (20 marks)*

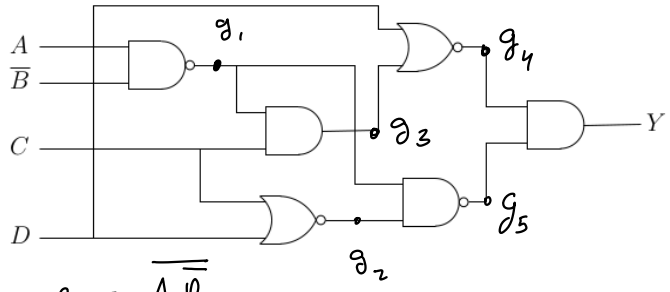
DE \ BC	00	01	11	10
00	0	0	0	1
01	d	1	1	0
11	d	1	1	0
10	0	0	0	1

A=0

DE \ BC	00	01	11	10
00	0	0	0	1
01	0	1	1	1
11	0	0	0	1
10	0	0	0	1

A=1

Problem 3. *Use Boolean algebra to find a simplified SOP expression for Y (10 marks)*



$g_1 = \overline{A\bar{B}}$

$g_2 = \overline{C+D}$

$g_4 = \overline{D + g_3}$

$= D + (\overline{A\bar{B}} \cdot C)$

$= \bar{D} \cdot \overline{(\overline{A\bar{B}}) \cdot C}$

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

$= A\bar{B}\bar{D} + \bar{C}\bar{D}$

$g_3 = g_1 \cdot C$

$= \overline{A\bar{B}} \cdot C$

$g_5 = \overline{g_1 \cdot g_2}$

$= \overline{(A\bar{B})} \cdot (\overline{C+D})$

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

$Y = g_4 \cdot g_5$

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

$(x+y)\cdot z = x\cdot z + y\cdot z$

x	$\bar{x}$	$x \cdot \bar{x}$
0	1	0
1	0	0

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

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

$+ A\bar{B}\bar{C}\bar{D} + (\bar{C}\cdot C)\bar{D} + \bar{C}(\bar{D}\cdot D)$

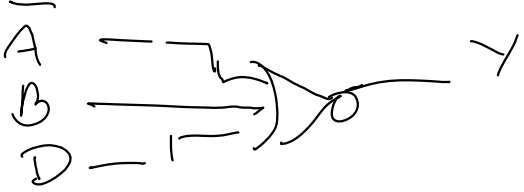
$x + \bar{x} = 1$

$x + x = x$

$= A\bar{B}\bar{D} + A\bar{B}C\bar{D} + 0 + A\bar{B}\bar{C}\bar{D} + 0 + 0$

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

$= A\bar{B}\bar{D} + A\bar{B}\bar{D} = A\bar{B}\bar{D}$



$Y = (A)(\bar{B})\bar{D}$

$= \overline{(\bar{A} + B + D)}$

Problem 4. *Consider a circuit to subtract two two-bit unsigned numbers. Denote the two bits of first number as A_1A_0 (forming the number N_A) and the two bits of second number as B_1B_0 (forming the number N_B). The circuit will find the difference $N_A - N_B$. The result will be a 2-bit difference D_1D_0. Assume that the circuit never sees an input combination in which N_A is less than N_B. In other words, we always have $N_A \geq N_B$.*

1. *Start with filling out the following truth table (3 example rows are provided) (10 marks).*
2. *Write D_1 using Maxterms notation (5 marks).*
3. *Use K-maps to find minimal Product of sum form for D_0 (20 marks).*
4. *Draw an ANSI network for D_0 using NOR gates only (10 marks).*

A_1	A_0	B_1	B_0	D_1	D_0
0	0	0	0		
0	0	0	1	d	d
0	0	1	0		
0	0	1	1		
0	1	0	0		
0	1	0	1	0	0
0	1	1	0		
0	1	1	1		
1	0	0	0		
1	0	0	1		
1	0	1	0		
1	0	1	1		
1	1	0	0		
1	1	0	1	1	0
1	1	1	0		
1	1	1	1		

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Problem 5. *Write the function* $F(A, B, C, D) = \prod M(0, 4, 5)$ *in Product of sums* ***canonical*** *form (5 marks).*