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Homework 3

- All homework must be turned in on PDF format. This can be scanned or typed in any paper size, but the format must be PDF and the file must be readable. This document can be modified for your homework submission. An additional homework template is available on Canvas to assist you in creating your answers, and content from lecture notes can be used.
- All final answers must be circled or in green.
- All homework must have a name on the top of **every** page.
- Submission errors (not in PDF, illegible, etc.) will not be re-graded.

Problem 1

Show how the following operations would be performed in an 8-bit 2's complement computer. Carry bits for 2's complement operations must be shown. Note any irregularities in your answer.

1. $-127_{10} + 53_{10}$
2. $-100_{10} - 100_{10}$

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1.

① $-127_{10} + 53_{10}$

$$\begin{array}{r} 127 \\ -64 \\ \hline 63 \\ -32 \\ \hline 31 \\ -16 \\ \hline 15 \\ -8 \\ \hline 7 \\ -4 \\ \hline 3 \\ -2 \\ \hline 1 \\ -1 \end{array}$$

0 1111111

↳ 10000001

+ 00110101

10110110

2's

$-(01001010) = 2^6 + 2^3 + 2^1 = -74$

64 8 2

$$\begin{array}{r} 53 \\ -32 \\ \hline 21 \\ -16 \\ \hline 5 \\ -4 \\ \hline 1 \\ -1 \\ \hline 0 \end{array}$$

00110101

② $(-100_{10}) + (-100_{10})$

$$\begin{array}{r} 100 \\ -64 \\ \hline 36 \\ -32 \\ \hline 4 \\ -4 \\ \hline 0 \end{array}$$

01100100

↳ 10011011

10011100

10011100

+ 10011100

00111000 ⇒ overflow

It cannot be represented

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Problem 2

Write the ASCII code representing the string "*Problem 2*" (the answer does not include the quotation marks).

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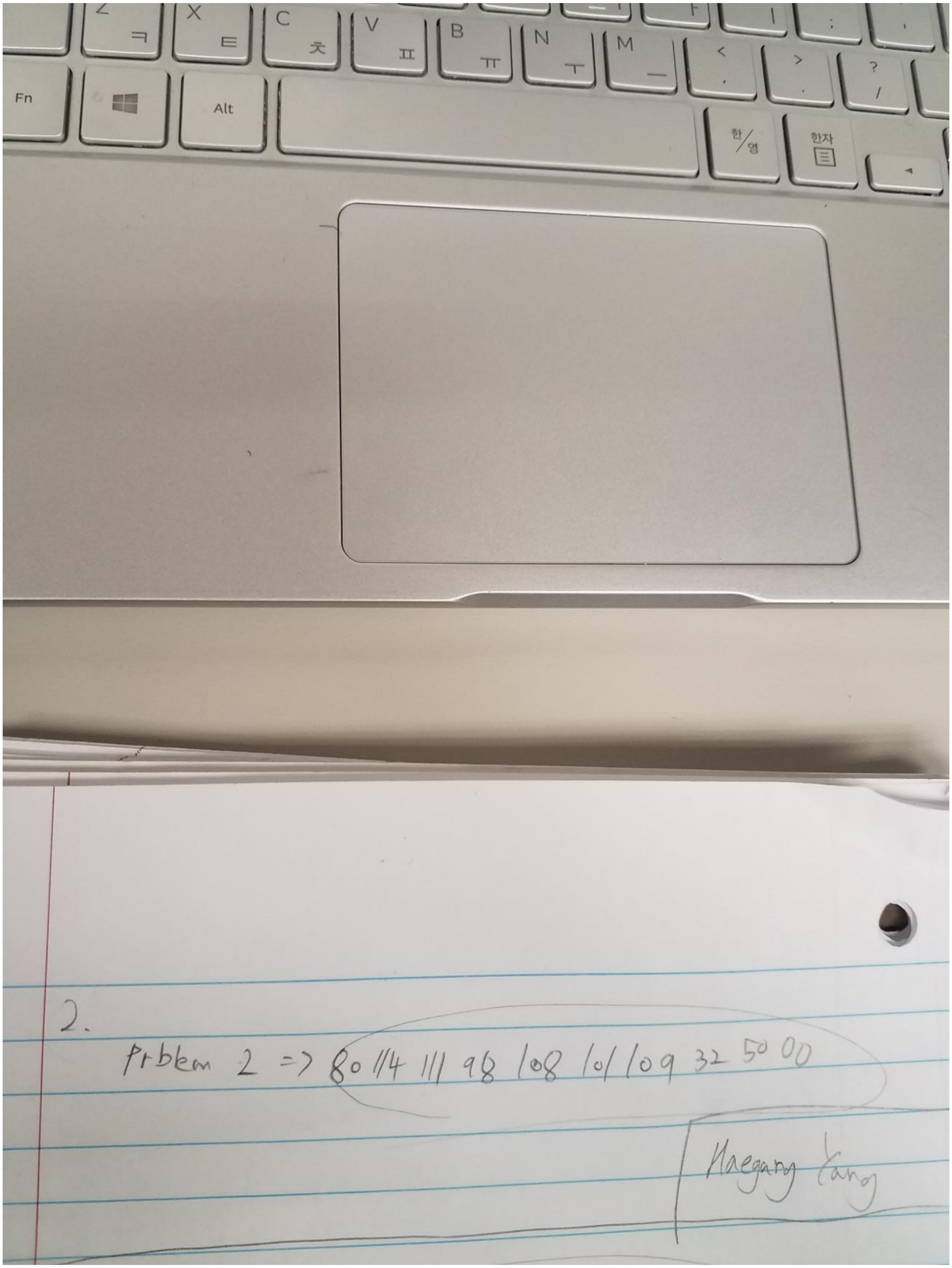

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Problem 3

Write the BCD representation of the number “1,538,012”.

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3.

1538012. => 0001010100111000 0000 0001 0010

1 5 3 8 0 1 2

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Problem 4

For the truth table below, fill in the missing entries which correspond to the given functions. For this problem, no intermediary work is necessary: only the results will be graded.

$$f_1(A, B, C) = (A \cdot \bar{B} \cdot C) \oplus B$$

$$f_2(A, B, C) = A + C$$

$$f_3(A, B, C) = A \cdot (B + \bar{C})$$

Inputs			**Outputs**		
A	B	C	f_1	f_2	f_3
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

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4.

Input			output		
A	B	C	f_1	f_2	f_3
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	1	0	0
0	1	1	1	1	0
1	0	0	0	1	1
1	0	1	1	1	0
1	1	0	1	1	1
1	1	1	0	1	1

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Problem 5

Use Boolean algebra (i.e., do not exhaustively prove using a truth table) to show whether the given equations are true. You must label each theorem or postulate with either its name or number. For reference, a table of all theorems and postulates is provided below.

1. $\overline{AB} + C\bar{A} + \bar{B}C = \overline{AB}$ (Hint: $\bar{A} + \bar{B} = \overline{AB} \because T8$)
2. $AB + \bar{A}\bar{C}\bar{D} + \bar{B}\bar{C}\bar{D} = AB + \bar{C}\bar{D}$(Hint: $\bar{A} + \bar{B} = \overline{AB} \because T8$)
3. $AB + BC + \bar{A}C + \bar{A}\bar{B}C = AB\bar{C} + AB + \bar{A}C$

	Expression	Dual
P2	$a + 0 = a$	$a \cdot 1 = a$
P3	$a + b = b + a$	$ab = ba$
P4	$a + (b + c) = (a + b) + c$	$a(bc) = (ab)c$
P5	$a + bc = (a + b)(a + c)$	$a(b + c) = ab + ac$
P6	$a + \bar{a} = 1$	$a \cdot \bar{a} = 0$
T1	$a + a = a$	$a \cdot a = a$
T2	$a + 1 = 1$	$a \cdot 0 = 0$
T3	$\bar{\bar{a}} = a$	
T4	$a + ab = a$	$a(a + b) = a$
T5	$a + \bar{a}b = a + b$	$a(\bar{a} + b) = ab$
T6	$ab + a\bar{b} = a$	$(a + b)(a + \bar{b}) = a$
T7	$ab + a\bar{b}c = ab + ac$	$(a + b)(a + \bar{b} + c) = (a + b)(a + c)$
T8	$\overline{a + b} = \bar{a}\bar{b}$	$\overline{ab} = \bar{a} + \bar{b}$
T9	$ab + \bar{a}c + bc = ab + \bar{a}c$	$(a + b)(\bar{a} + c)(b + c) = (a + b)(\bar{a} + c)$
T10(a)	$f(x_1, x_2, \ldots, x_n) = x_1(f(1, x_2, \ldots, x_n) + \overline{x_1} f(0, x_2, \ldots, x_n)$	
T10(b)	$f(x_1, x_2, \ldots, x_n) = [x_1 + f(0, x_2, \ldots, x_n)][\overline{x_1} + f(1, x_2, \ldots, x_n)]$	

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5.

① $\overline{AB} + C\overline{A} + \overline{B}C$ P6?

T8 $= \overline{AB} + C(\overline{A} + \overline{B})$

$= \underbrace{\overline{AB}}_{a} + \underbrace{C}_{b}\,\underbrace{\overline{AB}}_{\bar{a}}$

T4 $= \overline{AB}$

$\Rightarrow$ True

② $AB + \overline{A}\,\overline{C}\,\overline{D} + \overline{B}\,\overline{C}\,\overline{D}$ P5

$= AB + \overline{C}\,\overline{D}(\overline{A} + \overline{B})$

T8 $= \underbrace{AB}_{a} + \underbrace{\overline{AB}}_{\bar{a}}\,\underbrace{\overline{C}\,\overline{D}}_{b}$

T5 $= AB + \overline{C}\,\overline{D}$

$\Rightarrow$ True

③ $AB + BC + \overline{A}C + \overline{A}\,\overline{B}C$ P6

$= AB + C(B + \underbrace{\overline{A}}_{a} + \underbrace{\overline{A}}_{\tilde{a}}\,\underbrace{\overline{B}}_{b})$

T4 $= AB + C(B + \overline{A})$ P5

$= AB + \overline{A}C + BC$

T9 $= AB + \overline{A}C$

$\Rightarrow$ False

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