Your Name:_____**Sample Solution**_____

Your Student ID: _____

Your Instructor Name:_____

Your Section #:_____ ; Your Lecture Times:_____

Read The Following Instructions Carefully:

1. This exam booklet has 6 numbered pages and 9 problems. Check that your exam includes all 6 pages. Show ALL of your work on these pages. Two blank pages are added at the end for your scratch work.

2. WRITE your name (in Arabic) and student number in the spaces above. Also, make sure to write your instructor's name, section # and lecture times.

3. You are NOT permitted to use notes, books, calculators, or mobile phones during this exam.

4. This exam lasts for 75 minutes. Point values are listed for each problem to assist you in making the best use of time.

Problem	Max Points	Score
1	4	
2	2	
3	5	
4	4	
5	2	
6	2	
7	4	
8	2	
9	5	
Total	30	

Problem 1 (4 points)
Perform the following conversions. Show the details of your solution in the space below.

    a. Decimal 41 to octal is _____51_____

```
41 / 2 = 20      rem   1
20 / 2 = 10            0
10 / 2 = 5            0
5  / 2 = 2            1
2  / 2 = 1            0
1  / 2 = 0            1

41 in binary is 101 001
In octal          5   1
```

Grading: One point for each part. The answer must be correct; no partial credit is given if there are some correct and incorrect digits.

The student gets full mark for (b) and (c) even when the point is missing

    b. Decimal 0.375 to binary is _____0.011_____

```
0.375  * 2 =    0.75
0.75   * 2 =    1.5
0.5    * 2 =    1.0
```

    c. Octal 0.1234 to Hexadecimal is _____0.29C _____

```
Converting from octal to binary          0.001 010 011 100
Collect four digits and add padding 0's  0.0010 1001 1100
Convert from binary to hexadecimal       0.2    9    C
```

    d. Binary 1100100 to decimal is _____100_____

```
6543210
  1100100 = 64 + 32 + 4 = 100
```

Problem 2 (2 points)

    a) If the ASCII code of 'A' is $100\ 0001_2$, the ASCII code of 'a' is

        _____110 0001$_2$_____

    b) For the following 8-bit binary number, add a parity bit to achieve odd parity for the resulting 9-bit number.

        0 0 1 0 1 0 0 1 _

        0 0 1 0 1 0 0 1 0

Grading: One point for each part
The answer must be correct; no partial credit is given if there are some correct and incorrect digits

Problem 3 (5 points)
In the blank in front of each expression in the left hand column, write the letter (P – Z) corresponding to the equivalent expression in the right hand column. Not all answers in the right hand column will be used and some may be used more than once.

(i)   __P__ $F(A, B, C) = \sum m(3,5,6)$

(ii) __S__ $F(A, B, C) = \prod M(0,1,2,5,6)$

(iii) __R__ $\overline{(\overline{B} + C + \overline{D})} + \overline{(A + \overline{BD})} + A\,\overline{B}\,D$

(iv) __P__ $B(A \oplus C) + C(A \oplus B)$

(v)   __U__ $(A + \overline{B})(\overline{A} + B + C)(\overline{B} + C)$

P) $\overline{A}\,BC + A\,\overline{B}\,C + AB\,\overline{C}$

Q) $A\,\overline{B}\,C + A\,\overline{B}\,D$

R) $B\,\overline{C}\,D + \overline{A}\,BD + A\,\overline{B}\,D$

S) $\overline{A}\,BC + A\,\overline{B}\,\overline{C} + ABC$

T) $AB + AC + BC$

U) $AB\,\overline{C} + \overline{A}\,\overline{B} + \overline{B}\,C$

Z)   None of the above

(P) $\Sigma m\,(3, 5, 6) = \overline{A}\,B\,C + A\,\overline{B}\,C + A\,B\,\overline{C}$

(S) $\Pi M\,(0, 1, 2, 5, 6) = \Sigma m\,(3, 4, 7) = \overline{A}\,B\,C + A\,\overline{B}\,\overline{C} + A\,B\,C$

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

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

$= \overline{B}\,C\,(A + 1) + \overline{A}\,\overline{B}\,(1 + \overline{C}) + A\,B\,\overline{C} = A\,B\,\overline{C} + \overline{A}\,\overline{B} + \overline{B}\,C$

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

(P) $B\,(A \oplus C) + C\,(A \oplus B) = B\,(\overline{A}\,C + A\,\overline{C}) + C\,(\overline{A}\,B + A\,\overline{B})$

$= B\,\overline{A}\,C + B\,A\,\overline{C} + C\,\overline{A}\,B + C\,A\,\overline{B} = \overline{A}\,B\,C + A\,B\,\overline{C} + A\,B\,\overline{C}$
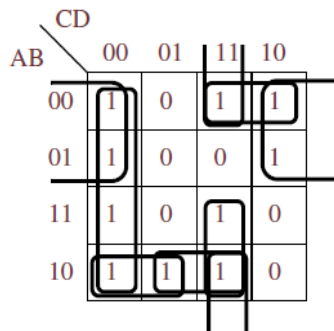

Grading
One point for each part

No credit is given if there are multiple answers to same question

Problem 4 (4 points)

Given the Karnaugh map below, list ALL of the prime implicants in algebraic form and circle them in the map. For each prime implicant, circle "ess" if it is an essential prime implicant of this function. (You should not need all of the lines provided.)
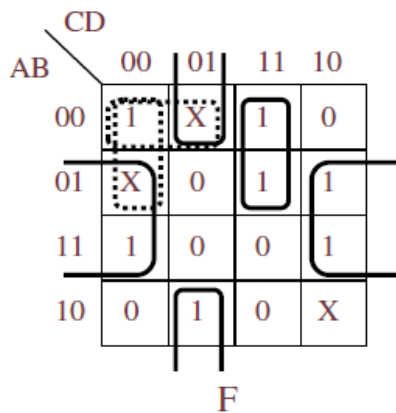
Prime implicants:

$\overline{A}\,\overline{D}$	(ess)	$A\,\overline{C}\,D$ (ess)
$\overline{C}\,\overline{D}$	(ess)	$\overline{B}\,C\,D$ ess
$\overline{A}\,B\,C$	ess	_____ ess
$A\,\overline{B}\,\overline{C}$	ess	_____ ess
$A\,B\,\overline{D}$	ess	_____ ess

> **Grading**: 0.4 points for each correct prime implicant
>
> 0.4 points for each correct essential prime implicant

Problem 5 (2 points)

A function is defined by the Karnaugh map on the right. On the line below, write an expression for a minimal sum-of-products implementation of this function

$$F(A,B,C,D) = \overline{B}\,\overline{D} + \overline{B}\,C\,D + A\,\overline{C}\,D + \{\,\overline{A}\,B\,\overline{C} \text{ or } \overline{A}\,C\,\overline{D}\,\}$$

> **Grading**:
>
> + 0.5 points for each correct term in the answer expression
>
> - 0.5 points for each incorrect term in the answer expression

Problem 6 (2 points)
A function is defined by the Karnaugh map on the right. On the line below, write an expression for a minimal product-of-sums implementation of this function.

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

H

$H(A,B,C,D) = \underline{\qquad (\overline{B} + \overline{D})(\overline{B} + \overline{C})(\overline{C} + \overline{D}) \qquad\qquad}$

Grading:

+ 0.7 points for each correct term in the answer expression

- 0.7 points for each incorrect term in the answer expression

Problem 7 (4 points)

Perform the arithmetic shown in the table below. The numbers in the leftmost column are decimal. Represent each decimal number using 8-bit binary signed representation. An example is shown in the first row. Do the rest of the calculations in the same way. If the calculation produces an overflow, write **"OVERFLOW"** and ignore the answer.

| **Problem**	**Sign-Magnitude**	**2's Complement**
12 + 5	0 0 0 0 1 1 0 0 + 0 0 0 0 0 1 0 1 0 0 0 1 0 0 0 1	0 0 0 0 1 1 0 0 + 0 0 0 0 0 1 0 1 0 0 0 1 0 0 0 1
111 + (-33)	0 1 1 0 1 1 1 1 + 1 0 1 0 0 0 0 1 0 1 0 0 1 1 1 0	0 1 1 0 1 1 1 1 + 1 1 0 1 1 1 1 1 1 0 1 0 0 1 1 1 0 (ignore carry) 0 1 0 0 1 1 1 0
111 + 33	**OVERFLOW**	**OVERFLOW**

Grading: One point for each part.
The answer must be correct, no partial credit is given.

Problem 8 (2 points)

A combinational circuit is specified by the following three Boolean function:

$$F (A, B, C) = \Pi M (1, 2, 5, 7)$$

Implement the function using the decoder with appropriate size and any other necessary external gates.
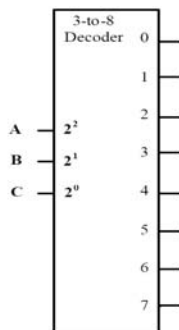
F: use OR with minterms (0,3,4,6)

   or

     Use Nor with minterms (1,2,5,7)

Grading:
One point for Use NOR with minterms (1, 2, 5, 7) or Use OR with minterms (0, 3, 4, 6)
One point Assigned for the Decoder size and input assignments

Problem 9 (5 points)
Design a 4x2 priority encoder such that priority is assigned to inputs as follows:

$I_0 > I_1 > I_2 > I_3$

$Q_1 = I_2'I_1'I_0 + I_3'I_1'I_0$ $Q_0 = I_1'I_0 + I_3'I_2'I_0$

Input I_3	Input I_2	Input I_1	Iutput I_0	Output Q_1	Output Q_0
x	x	x	1	0	0
x	x	1	0	0	1
x	1	0	0	1	0
1	0	0	0	1	1

Grading:

One point for truth table
One point for output1 k-map
One point for output2 k-map
One point for output1 equation
One point for output2 equation
No partial credit is given if there are some correct and incorrect answers.