Instructions: This exam booklet has 5 numbered pages and 6 problems. Two blank pages are added at the end for your scratch work.

The exam is closed book and notes. Calculators are not permitted. For partial credit, show your work. Please note that a prime (') means a complement (over-bar ‾). *Answer all problems.* Good Luck!

Your Name:______________ **Sample Solution**_______________

Your Student ID: _____________**0000000**____________

Your Instructor:_____________________________________

Your Section #:____________________ ; Your Lecture Times:___________________

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

Problem 1 (4 points) Fill in the blanks

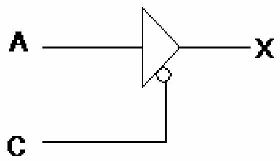
(a) The **decimal** equivalent of the binary number $\mathbf{(00101100)_2}$ is: **$(44)_{10}$**

(b) The **hexadecimal** equivalent of the decimal number $\mathbf{(238)_{10}}$ is : **$(EE)_{16}$**

(c) The **Octal** equivalent of the hexadecimal number $\mathbf{(3.6)_{16}}$ is : **$(3.3\ )_8$**

(d) Complete the truth table of the following **three-state buffer**:

(00: 0, 01: HiZ, 10:1, 11:HiZ)



A	C	X
0	0	
0	1	
1	0	
1	1	

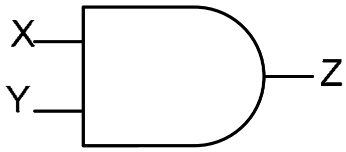
Problem 2 (3 points)

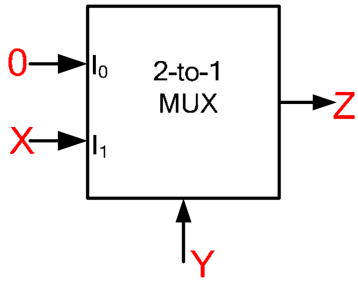
Use a single 2-to-1 MUX to construct the gates shown below. Your need to Label the MUX input signals in such a way that it behaves like the required gate.

Gate	Equivalent MUX Implementation

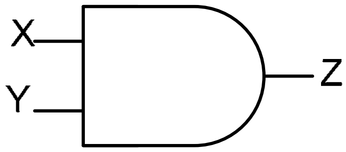
(a) **(1.5 points) This part has the following 4 different correct answers**

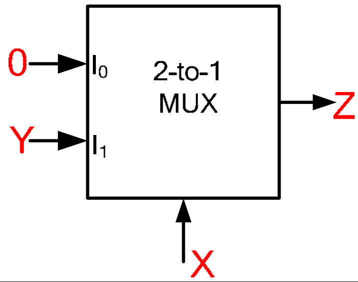
ONE



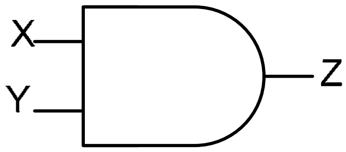


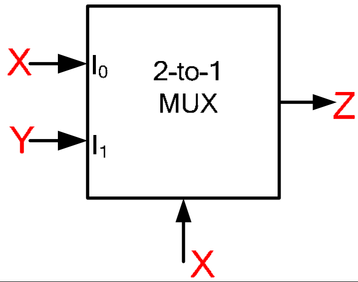
TWO



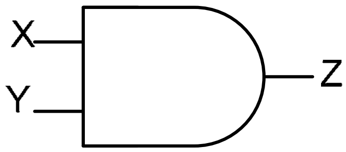


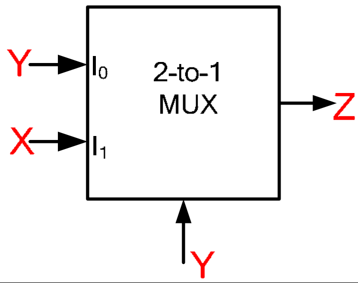
THREE



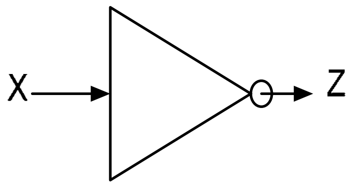


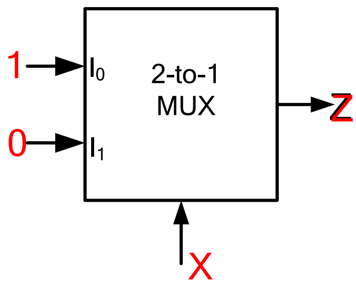
FOUR





(b) **(1.5 points)**



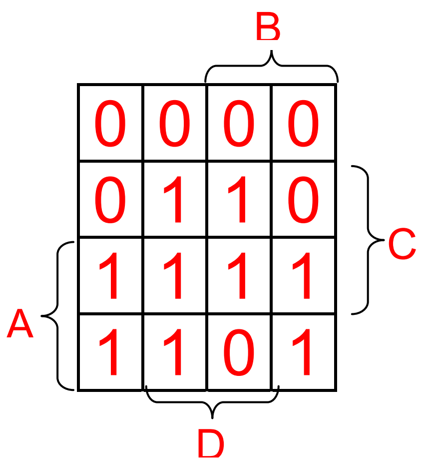


Problem 3 (6 points)

For the following expression, derive a simplified ***sum of products, (SOP)***, *expression* using a Karnaugh map. In the table on the right, identify the prime implicants, indicating which are essential.

F = $A\cdot\overline{B}+\overline{A}\cdot C\cdot D+A\cdot B\cdot\overline{D}+A\cdot B\cdot C\cdot D$

Solution and Grading:



prime implicants	Essential?	
	yes	no
$A\cdot\overline{B}$	☒	☐
$A\cdot C$	☐	☒
$C\cdot D$	☒	☐
$A\cdot\overline{D}$	☒	☐
	☐	☐
	☐	☐
	☐	☐

Simplified SOP expression: ____ $A\cdot\overline{B}+C\cdot D+A\cdot\overline{D}$ ______________

Grading:
1 point per {prime implicant / essential (yes, no)} correct answer
2 points for the correct SOP expression

Problem 4 (6 points)

A logic circuit is required to implement the Boolean function:

$$F(A,B,C,D) = A'\,C \;+\; A\,C'\,D' \;+\; A\,B\,D$$

It was found that the input combination both **A=1** and **C=1** can never occur. Find a simplified Sum-of-Products (SOP) expression for **F** using a Karnaugh map.

Solution and Grading:

Don't Cares when A = C = 1 → occur at minterms 10, 11, 14, 15

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

minimum SOP of F = $C + A \cdot B + A \cdot \overline{D}$ or $C + A \cdot (B + \overline{D})$

Grading:

- K-map → 2 points:
  - 1 point for the 1's
  - 1 point for the X's
- Minimum SOP Expression → 3 points:
  - 1 point per term if correct and minimum

Problem 5 (6 points)

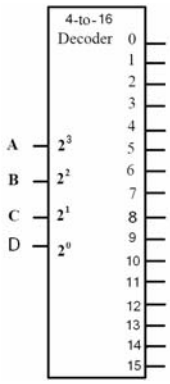
A combinational circuit is specified by the following three Boolean functions:

$$F1(A, B, C, D) = \sum m\,(0, 1, 2, 3, 7, 9, 11, 13, 14, 15)$$
$$F2(A, B, C) = \Pi M\,(0, 4, 6, 7)$$
$$F3(A, B, C) = A'B'C' + A'BC + A'B'C + ABC$$

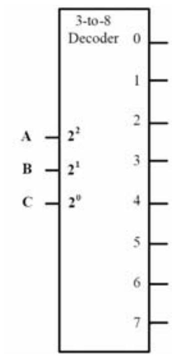
Implement the functions (*F1, F2 and F3*) using the decoders with appropriate size and any other necessary external gates. Implement each function on a separate decoder.

Solution and Grading:

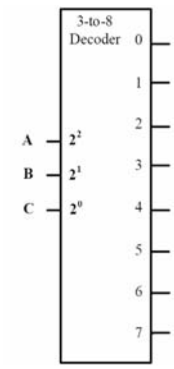
F1:



F2:



F3:



F1: Use OR with the minterms (0, 1, 2, 3, 7, 9, 1, 14, 15) [1.5 points]

F2: Use OR with minterms (1, 2, 3, 5) [1.5 points]
Use NOR with minterms (0, 4, 6, 7) [1 points]

F3: Use OR with minterms (0, 3, 7) [1.5 points]

Note: for each function 0.5 is assigned for the Decoder size and input assignments

Problem 6 (6 points)

x is a decimal number that can have one of the following values { 0, 1, 2, 4, 5, 7 }.
A function, ***f(x),*** is defined as follows:

f(x) = 2x + 3 when ***x*** **is equal to 0, *1, 2***
f(x) = 2x + 2 when ***x*** **is equal to *4, 5***
f(x) = 2x + 1 when ***x*** **is equal to *7***

You have been requested to design a combinational logic circuit to generate ***f(x)*** represented in binary. ***x*** is also available in binary for your circuit.

(a) What is the number of input and output lines of your circuit?
(b) Show the truth table of your circuit. Make sure you label the binary variables of the input and output columns

Solution and Grading:

(a) Three inputs (X, Y, Z) and Four outputs (A,B,C,D) … (2 points)
(b) Truth table … (4 points, each combination .5 point)

Input x		***Output F***
0		3
1		5
2		7
3		not given
4		10
5		12
6		not given
7		15

Input X	***Input Y***	***Input Z***		***Output A***	***Output B***	***Output C***	***Output D***
0	0	0		0	0	1	1
0	0	1		0	1	0	1
0	1	0		0	1	1	1
0	1	1		X	X	X	X
1	0	0		1	0	1	0
1	0	1		1	1	0	0
1	1	0		X	X	X	X
1	1	1		1	1	1	1