King Fahd University of Petroleum and Minerals
Department of Computer Engineering

DIGITAL LOGIC DESIGN COE 202

Homework 3, December 21, 2008

Problems	Grading
1	
2	
3	
4	
5	
6	
TOTAL	

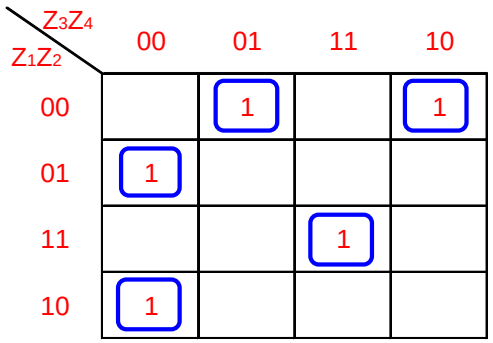
Student Name:……

Student ID:……

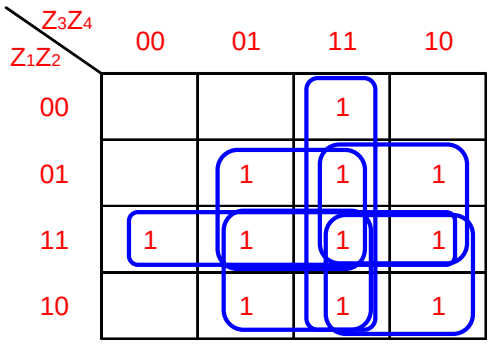
Question1:

As a ***design engineer*** your manager asks you to design a circuit that will be used in an electronic safety device used for toddlers. The circuit monitors an area that will be used by toddlers. The area is divided into 4 zones, Z_1, Z_2, Z_3, and Z_4. Each zone has an installed body-heat sensor. If the sensor detects the presence of a toddler in its zone, then the sensor produces a binary "1," and it produces a binary "0" otherwise. Your circuit receives the readings from each sensor installed in each of the 4 zones. Furthermore, your circuit controls 2 light bulbs, L_1 and L_2. Both L_1 and L_2 will be turned **off** (i.e. binary "0") if the circuit detects the presence of **no** toddlers in all 4 zones. Only L_1 will be turned **on** if the circuit detects the presence of toddler(s) in exactly **one** of the 4 zones. Only L_2 will be turned **on** if the circuit detects the presence of toddler(s) in either **two** or **three** of the 4 zones. Both L_1 and L_2 will be turned **on** if the circuit detects the presence of toddler(s) in all 4 zones. Design the circuit using all **NAND** gates.

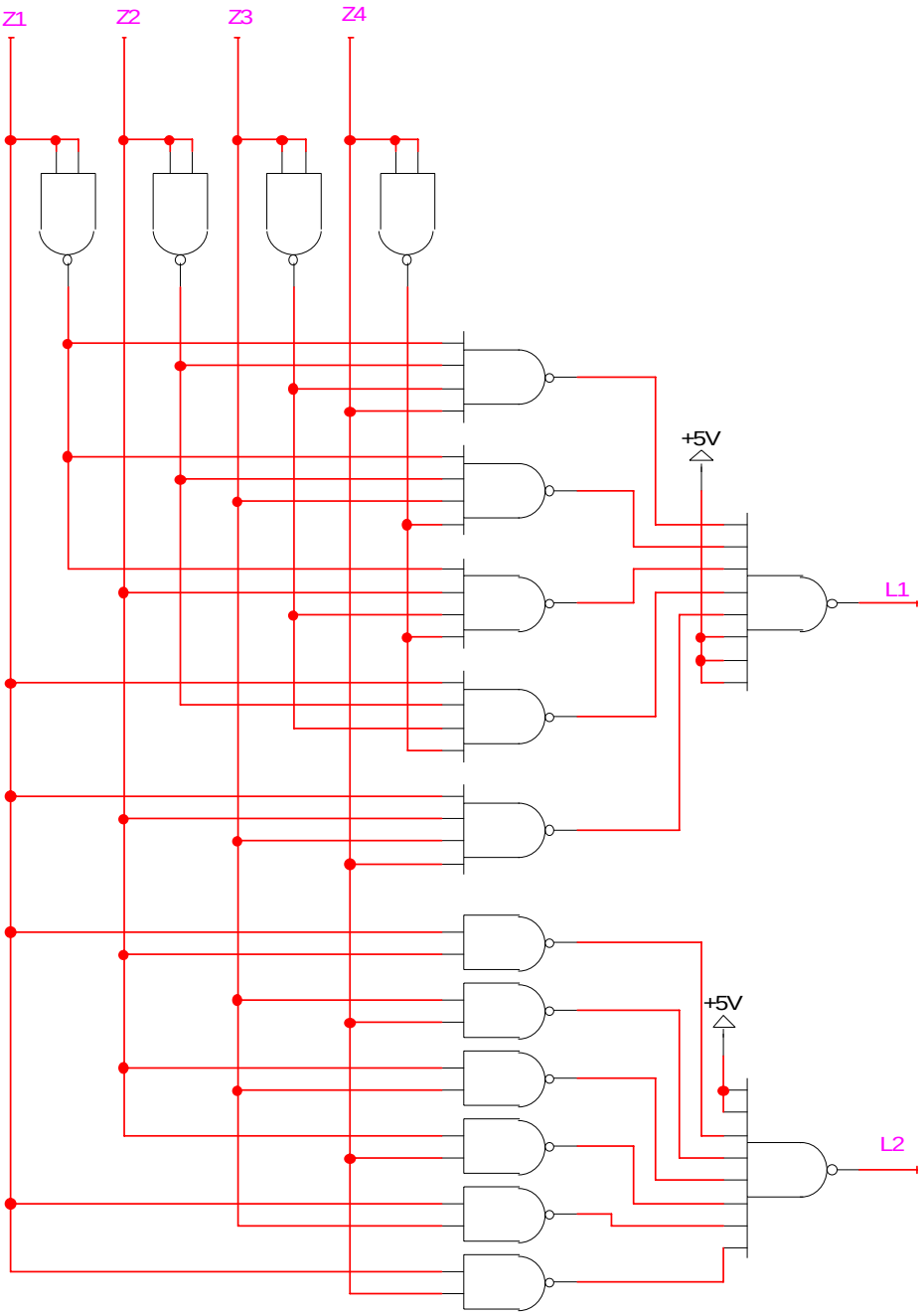
Z_1	Z_2	Z_3	Z_4	L_1	L_2
0	0	0	0	0	0
0	0	0	1	1	0
0	0	1	0	1	0
0	0	1	1	0	1
0	1	0	0	1	0
0	1	0	1	0	1
0	1	1	0	0	1
0	1	1	1	0	1
1	0	0	0	1	0
1	0	0	1	0	1
1	0	1	0	0	1
1	0	1	1	0	1
1	1	0	0	0	1
1	1	0	1	0	1
1	1	1	0	0	1
1	1	1	1	1	1



$$L_1 = \bar{Z}_1\bar{Z}_2\bar{Z}_3Z_4 + \bar{Z}_1\bar{Z}_2Z_3\bar{Z}_4 + \bar{Z}_1Z_2\bar{Z}_3\bar{Z}_4 + Z_1\bar{Z}_2\bar{Z}_3\bar{Z}_4 + Z_1Z_2Z_3Z_4$$

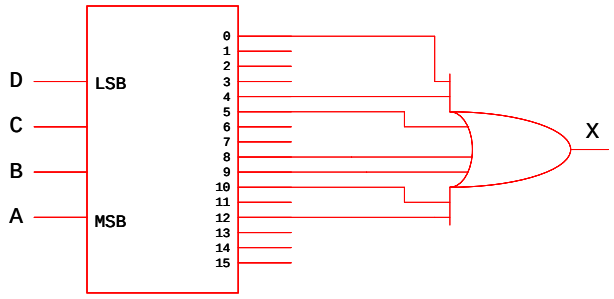


$$L_2 = Z_1Z_2 + Z_3Z_4 + Z_1Z_3 + Z_1Z_4 + Z_2Z_3 + Z_2Z_4$$



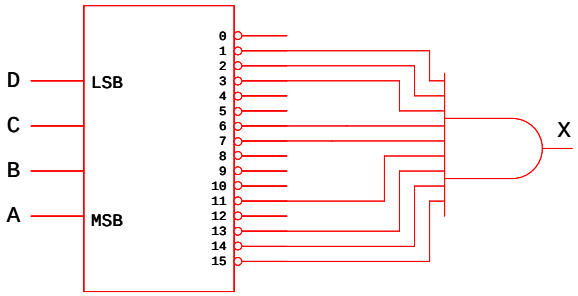
Problem # 2 (10 points): Use a 4×16 **non-inverted-output decoder** and external gate(s) to implement the following function:

$$X_{A,B,C,D} = \sum(0,4,5,8,9,10,12)$$

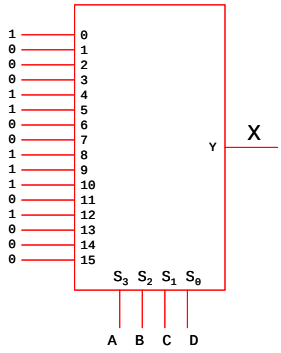


Problem # 3 (10 points): Repeat problem # 2 but use a **4×16 inverted-output decoder** and external gate(s).

$$X_{A,B,C,D} = \sum(0,4,5,8,9,10,12) = \prod(1,2,3,6,7,11,13,14,15)$$

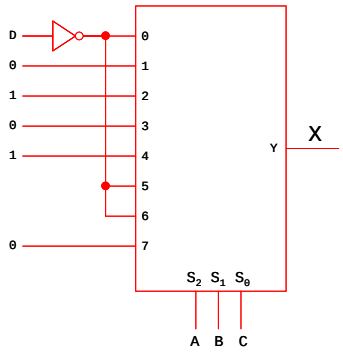


Problem # 4 (10 points): Repeat problem # 2 but use a **16×1 MUX** and external gate(s).



Problem # 5 (10 points): Repeat problem # 2 but use an **8×1 MUX** and external gate(s). Connect ***A*, *B*, and *C*** to S_2, S_1, and S_0, respectively.

	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7
D'	0	2	4	6	8	10	12	14
D	1	3	5	7	9	11	13	15
	D'	0	1	0	1	D'	D'	0



Problem # 6 (10 points): Repeat problem # 2 but use an **8×1 MUX** and external gate(s). Connect ***A*, *C*, and *D*** to S_2, S_1, and S_0, respectively.

	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7
B'	0	1	2	3	8	9	10	11
B	4	5	6	7	12	13	14	15
	1	B	0	0	1	B'	B'	0