United International **University (UIU)**

Department of Computer Science and Engineering

CSE 1325: DIGITAL LOGIC DESIGN, Midterm Spring 2023

Total Marks: **30** Duration: 1 hour 45 minutes

[Any examinee found adopting unfair means including copy from another examinee will be expelled from the trimester/program as per UIU disciplinary rules.]

Answer Any 2 Questions from Q1 to Q3 (Do not mix-up answers of two questions)

1.	a) Determine the radix r from the following equation: $(405)_r = (261)_{10}$ b) Encode the following numbers $(157)_8$ and $(234)_8$ to BCD binary format and perform BCD addition.	[3] [3]
2.	a) Prove the identity of the following Boolean equation, using algebraic manipulation: $\bar{X}\bar{Y} + \bar{Y}Z + XZ + XY + Y\bar{Z} = \bar{X}\bar{Y} + XZ + Y\bar{Z}$ b) Prove that the dual of $A\bar{B} + \bar{A}B$ is also its complement.	[3] [3]
3.	a) Convert the following expressions into canonical sum-of-products and canonical product-of sums forms: $\bar{X} + X\,(X + \bar{Y})(Y + \bar{Z})$ b) Given that $A.B = 0$ and $A + B = 1$, use algebraic manipulation to prove that $(A + C).(\bar{A} + B).(B + C) = B.C$	[3] [3]

Answer Any 1 Question from Q4 to Q5

4. You have to design a combinational circuit that will take a 4-bit binary number as input and check whether the bit pattern is palindrome or not. The output will be 1 if the input bit pattern is palindrome, otherwise output will be 0. (A pattern is palindrome if the reverse of that pattern is similar to the original pattern.) [3] [2] [1]

You have to:

(i) Show the truth table.

(ii) Find the simplified expression for the output bit in Product-of-Sum (POS) form.

(iii) Draw the circuit diagram using basic gates.

Few example inputs and outputs are given below:

Input	Output	Reason
0000	1	Reverse pattern: 0000 = Input
0001	0	Reverse pattern: 1000 ≠ Input
0110	1	Reverse pattern: 0110 = Input
1101	0	Reverse pattern: 1011 ≠ Input

5.	You have to design a combinational circuit that will take a 4-bit binary number as input and detect which bit is major in count. If the number of 0's is greater than the number of 1's, then the output will be 0. If the number of 1's is greater than the number of 0's, then the output will be 1. For all other cases, consider don't care as output. You have to: (i) Show the truth table. (ii) Find the simplified expression for the output bit in Sum-of-Product (SOP) form. (iii) Draw the circuit diagram using basic gates. Few example inputs and outputs are given below:	[3] [2] [1]

Input	Output	Reason
0001	0	Number of 0's: 3 > Number of 1's: 1
0101	x	Number of 0's: 2 = Number of 1's: 2
1010	x	Number of 0's: 2 = Number of 1's: 2
1101	1	Number of 0's: 1 < Number of 1's: 3

Answer <u>Any 2</u> Question from Q6 to Q8

6.	Find the optimized sum-of-products (SOP) of the following function considering don't-care conditions. In your solution, you have to show (i) all prime implicants, (ii) essential prime implicants, and (iii) apply the selection rule. $F(P, Q, R, S) = \sum m(0, 1, 7, 9, 10, 11, 12, 15) + \sum d(2, 3, 5, 8, 13)$	[3] [2] [1]
7.	Optimize the following function in i) simplified sum-of-products (SOP) and ii) simplified product-of-sums (POS) form. Between simplified SOP and POS, which one should you implement? Justify your answer. $F(A,B,C,D) = \prod M(0,2,4,7,8,10,12,13)$	[2.5] [2.5] [1]
8.	Optimize the following function using K-map. You have to show your answer in simplified product-of-sum (POS) as well as simplified sum-of products (SOP) form. $(\bar{A}+\bar{B}+C+\bar{D}).(A+B+\bar{C}+\bar{D}).(A+\bar{B}+C+\bar{D}).(A+\bar{B}+\bar{C}+\bar{D})$	[3] [3]