United International University (UIU)
Dept. of Computer Science and Engineering (CSE)
CSE 1325/CSE 225, Digital Logic Design
BSCSE Mid Examination, Summer 2022

Marks: 30 **Time: 1 hour 45 minutes**

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

Answer any two questions from Q1 to Q3

1. Answer *All* of the following questions:
   a. Perform BCD addition between the following two numbers, $(24362)_{10}$ and $(78425)_{10}$ using their BCD representation. Show all the necessary steps. **[3]**
   b. Find the value of r from the below equation. **[3]**
   $((34)_r + (24)_r) \times (21)_r = (645)_{10}$

2. Consider the following expressions:
   $F_1(x, y, z) = x\bar{y} + \bar{x}y$
   $F_2(x, y, z) = (\bar{x} + y + \bar{z}) . (x + \bar{y}) . (x + z)$
   a. Find the dual of F_1. **[1]**
   b. Find the complement of F_2. **[1]**
   c. Derive the sum of minterms of both of the functions F_1 and F_2. **[2]**
   d. Show that the boolean function E contains the sum of minterms from both F_1 and F_2, where $E = F_1 + F_2$ **[2]**

3. Answer *All* of the following questions:
   a. Simplify the following Boolean Expression (using algebraic manipulation) to an expression containing a minimum number of literals. **[2]**
   $F(A, B, C, D) = AB + \bar{A}CD + A\bar{B}\bar{C} + \bar{A}C + \bar{A}\bar{B}CD$
   b. Convert the following expression into both canonical SOP and canonical POS forms. **[4]**
   $F(A, B, C, D) = (A + \bar{C})(A + \bar{B} + \bar{D}) + \bar{A}\bar{B}$

Answer any two questions from Q4 to Q6

4. 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. **[2+2+2]**

$$F(A, B, C, D) = \Sigma_m(2, 4, 5, 7, 10, 13, 15) + \Sigma_d(0, 1, 6, 8, 11)$$

5. 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. **[2+2+2]**

$$F(A, B, C, D) = \Pi_M(1, 3, 6, 9, 11, 12, 14)$$

6. Optimize the following function using K-map. You have to show your answer in simplified product-of-sums (POS) form. **[6]**

$$F(A, B, C, D) = ABC\overline{D} + ABD + \overline{A}BC + \overline{A}\,\overline{B}CD + AB\overline{C}\,\overline{D}$$

Answer any one question from Q7 to Q8

7. Design a combinational logic circuit named DET that will take a 4-bit number as input and give output 1 if the input is a multiple of 2 or 3. You have to (i) Show the truth table (ii) Find the simplified expression for the output bit in sum-of-products form (iii) Draw the circuit diagram using basic gates. **[2+2+2]**

   Few example inputs and outputs are given below:
   Input: 0000, Output: 1, Reason: 0 is a multiple of both 2 and 3
   Input: 0001, Output: 0, Reason: 1 is not a multiple of 2 or 3
   Input: 0010, Output: 1, Reason: 2 is a multiple of 2
   Input: 0101, Output: 0, Reason: 5 is not a multiple of 2 or 3
   Input: 0110, Output: 1, Reason: 6 is a multiple of both 2 and 3

8. Design a combinational logic circuit named PRIM that will take a 4-bit binary number as an input. If the corresponding decimal of the input is prime, the output of the circuit will be 1 and if the corresponding decimal is composite, the output of the circuit will be 0. Remember a prime number is such a number that has exactly two factors and if the number of factors is more than two, that is a composite number. This implies that zero (0) and one (1) are neither prime nor composite. You have to (i) Show the truth table (ii) Find the simplified expression of the output bit in Sum-of-Products form (iii) Draw the circuit diagram using basic gates. **[2+2+2]**

   Few example inputs and outputs are given below:
   Input: 0000, Output: x (don't care), Reason: 0 is neither a prime nor a composite.
   Input: 0010, Output: 1, Reason: 2 is prime.
   Input: 0011, Output: 1, Reason: 3 is prime.
   Input: 0110, Output: 0, Reason: 6 is composite.
   Input: 1001, Output: 0, Reason: 9 is composite.