United International University
Department of Computer Science and Engineering

CSE 1325: Digital Logic Design

Mid Exam: Fall 2022 Time: 1 hour and 45 Minutes Marks: 30

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Answer Any Two Questions from Q1 to Q3

1. (a) Find the value of the radix r for the statement : $\sqrt{(224)_r} = (13)_r$ [3]

   (b) Perform BCD addition between the two numbers $(23D)_{16}$ and $(F67)_{16}$ using their BCD representations. You need to show the detailed steps of number system conversion if needed. [3]

2. (a) Prove the identity of the following Boolean equation using algebraic manipulation: [3]

$$\overline{W}X(\overline{Z} + \overline{Y}Z) + X(W + \overline{W}YZ) = X$$

   (b) Convert the following expression into both canonical SOP and canonical POS forms. [3]

$$F(X, Y, Z) = (XY + Z)(Y + ZX)(X + YZ)$$

3. (a) Find the (i) dual and (ii) complement of the following function. [3]

$$F(X, Y, Z) = X(\overline{Y}Z + Y\overline{Z}) + \overline{X}(\overline{Y} + Z)(Y + \overline{Z})$$

   (b) Simplify the following Boolean Expression (using algebraic manipulation) to an expression containing a minimum number of literals. [3]

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

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. [3+2+1]

$$F(A, B, C, D) = \sum m(0, 2, 3, 4, 8, 11, 13, 14, 15 + \sum d(5, 7, 8, 10)$$

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. [2.5+2.5+1]

$$F(A, B, C, D) = \prod M(1, 3, 4, 6, 9, 11, 12, 14)$$

6. Optimize the following function using K-map. You have to show your answer in simplified sum-of-products (SOP) form. [6]

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

Answer Any One Question from Q7 to Q8

7. Design a combinational logic circuit named FCT that will take a 4-bit binary number as an input. If the corresponding decimal of the input is zero or has exactly two factors, the output of the circuit will be HIGH. For the numbers having more than three factors, the output of the circuit will be LOW.

   (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. [3+2+1]

   Few example inputs and outputs are given below:

   Input : 0001, Output: 0, Reason: 1 has one factor (1)
   Input : 0011, Output: 1, Reason: 3 has two factors (1,3)
   Input : 0100, Output: x, Reason: 4 has three factors (1,2,4)
   Input : 0110, Output: 0, Reason: 6 has four factors (1,2,3,6)

8. Design a combinational logic circuit named PD that will take a 4-bit binary number as an input. The output will be 1 if the corresponding decimal of the input is

   - an even number but not divisible by 5
   - divisible by 3 but not divisible by 5

   For all other inputs, the output will be 0. 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. [3+2+1]

   Few example inputs and outputs are given below:

   Input : 0010, Output: 1, Reason: even number
   Input : 0111, Output: 0, Reason: neither even number nor divisible by 3
   Input : 1001, Output: 1, Reason: divisible by 3
   Input : 1010, Output: 0, Reason: even number but divisible by 5