QUESTION ONE 30 MARKS (COMPULSORY)

a. By use of operator tables to form a truth table, prove the given Boolean equation

$$x \cdot (y + z) = (x \cdot y) + (x \cdot z)$$ 4 Marks

b. Solve

i. $35_{10} - 72_{10}$ using two's complement format with 8-bit numbers. 3 Marks

ii. $65_{10} - 25_{10}$ using one's complement format with 8-bit numbers. 3 Marks

c. Design and implement a circuit that counts the number of 1's present in 3 inputs A, B and C. Its output is a two-bit number X_1X_0, representing that count in binary. Using a K-map, find the minimized logic equations for outputs X_1 and X_0. Assume active-HIGH logic. 7 Marks

d. Simplify the given Boolean equation 3 Marks

$$\left(\overline{A}\overline{B}\overline{C}\right) + \left(\overline{A}\overline{B}\overline{C}\right)$$

e. Simplify the Boolean expression F = C(B + C)(A + B + C). 3 Marks

f. Simplify the following expression into sum of products using Karnaugh map F(A,B,C,D)

$$= \sum (1,3,4,5,6,7,9,12,13)$$ 7 Marks

QUESTION TWO 20 MARKS

a. By use of the postulates learnt in class, prove the following: i. x + x = x and ii. x · x = x 5 Marks

b. Express the Boolean function F = xy + x'z as a product of maxterms. 6 Marks

c. Simplify the Boolean function 5 Marks

d. Implement the following Boolean function with NAND gates: F(x.y. z)= (1.2. 3. 4. 5. 7) 4 Marks

QUESTION THREE 20 MARKS

a. Use K-map to find the minimum-cost SOP expression for the function 4 Marks

b. Write the expression for Boolean function F (A, B, C) = ∑m (1,4,5,6,7) in standard POS form. 4 Marks

c. Implement the following function using a 3 line to 8 line decoder. 4 Marks

S (A,B,C) = ∑m(1,2,4,7)

C (A,B,C) = ∑m (3,5,6,7)

d. What are universal gates? Construct a logic circuit using NAND gates only for the expression X = A.(B + C). 5 Marks

e. Compare and contrast combinational and sequential digital circuits 3 Marks

QUESTION FOUR 20 MARKS

a. With relevant logic diagram and truth table explain the working of a two input EX-OR gate. 7 Marks

b. With relevant diagram explain the working of master-slave JK flip flop. 8 Marks

c. State and prove Demorgan's laws. 5 Marks

QUESTION FIVE 20 MARKS

a. What is a flip-flop? State the difference between a latch and a flip-flop and list out the applications of flip-flop. 4 Marks

b. Implement $f_1(X_2; X_1) = \sum m(0; 3)$; $f_2(X_2; X_1) = \overline{x_2 + x_1}$; $f_3(X_2; X_1) = \pi M\,(1)$ with a 4 x 3 ROM 9 Marks

c. With the help of a truth table explain the working of a half Subtractor. Draw the logic diagram using gates. 7 Marks