

Answer all Questions.

Exam Duration 1 hour

No books or papers are allowed.

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**Question 1**

Using **Boolean algebra**, minimize the following functions:

a)  $F1(A,B,C,D) = ABCD + (A'BD)' + ABC'D$  3 Marks

b)  $F2(A,B,C,D) = AB(D + C'D) + B(A + A'CD)$  3 Marks

**Question 2**

Given  $f(x,y,z) = xy + xz' + yz$

a) Implement f in NOR-NOR format 3 Marks

b) Implement f in AND-OR-INVERT format 3 Marks

**Obtain optimum implementation.**

**Question 3**

Implement the following four Boolean expressions with three Half Adders:

$F1(A,B,C) = A \oplus B \oplus C$  1 Mark

$F2(A,B,C) = A'BC + AB'C$  1 Marks

$F3(A,B,C) = ABC' + (A' + B')C$  4 Marks

$F4(A,B,C) = ABC$  1 Mark

**Question 4**

a) Simplify the function F Using K-Map. Express the simplified function in SOP and POS

$F(A,B,C,D) = \sum m(1,3,8,10,15) + d \sum m(0,2,9)$  3 Marks

b) For Function F below, find all the Prime Implicants and determine which ones are essential:

$F(A,B,C,D) = \sum m(1,3,6,7,8,9,12,13,14,15)$  3 Marks

# SOLUTION

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Q1.

$$\begin{aligned}
 F1(A,B,C,D) &= ABCD + (A'BD)' + ABC'D \\
 &= ABCD + A + B' + D' + ABC'D \\
 &= A + B' + D'
 \end{aligned}$$

$$\begin{aligned}
 F1(A,B,C,D) &= AB(D + C'D) + B(A + A'CD) \\
 &= ABD + B(A + CD) \\
 &= ABD + AB + BCD \\
 &= AB + BCD
 \end{aligned}$$

Q2.

a)

$$\begin{aligned}
 f(x,y,z) &= xy + xz' + yz \\
 &= xz' + yz
 \end{aligned}$$

f in NOR-NOR format:

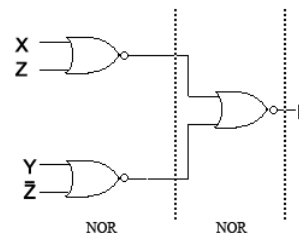
K-Map representation:

$$f(x,y,z) = (x+z) \cdot (y+z')$$

f=	Z \ XY	00	01	11	10
	0	0	0	1	1
	1	0	1	1	0

Also, using Boolean minimization,

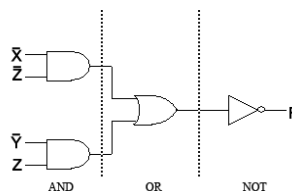
$$\begin{aligned}
 f(x,y,z) &= xz' + yz \\
 f &= \overline{\overline{(x+z)} \cdot \overline{(y+z')}} \\
 f &= \overline{(x+z) + (y+z')}
 \end{aligned}$$



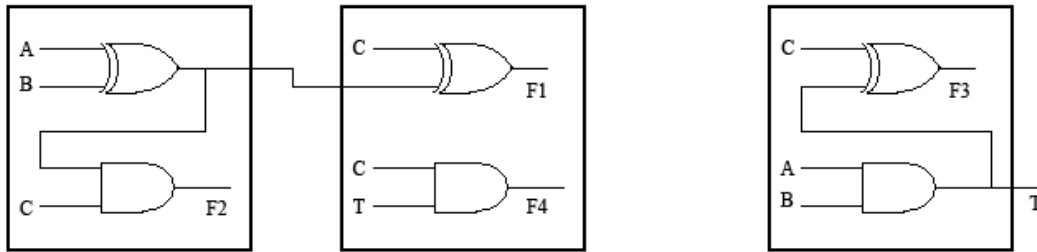
b)

f=	Z \ XY	00	01	11	10	f'=	Z \ XY	00	01	11	10
	0	0	0	1	1		0	1	1	0	0
	1	0	1	1	0		1	1	0	0	1

$$f'(x,y,z) = \overline{\overline{xz} + \overline{yz}}$$



Q3.



$$F2 = (A'B + AB').C = (A \oplus B).C$$

$$\begin{aligned} F3 &= ABC' + (A+B)C \\ &= ABC' + (AB)'C \\ &= (AB) \oplus C \end{aligned}$$

Q4.

a)

f=	CD\AB	00	01	11	10
	00	X	0	0	1
	01	1	0	0	X
	11	1	0	1	0
	10	X	0	0	1

$$SOP = \sum m(0,1,2,3) + \sum m(0,2,8,10) + \sum m(13) = \overline{A}\overline{B} + \overline{B}\overline{D} + ABCD$$

$$\begin{aligned} POS &= \prod M(4,5,12,13) \cdot \prod M(4,6,12,14) \cdot \prod M(4,5,6,7) \cdot \prod M(9,11) \\ &= (A + \overline{B})(\overline{B} + C)(\overline{B} + D)(\overline{A} + B + \overline{D}) \end{aligned}$$

b)

f=	CD\AB	00	01	11	10	
	00	0	0	1	1	$\sum m(12,13,14,15) = AB = NE$
	01	1	0	1	1	$\sum m(8,9,12,13) = A\overline{C} = E$
	11	1	1	1	0	$\sum m(6,7,14,15) = BC = E$
	10	0	1	1	0	$\sum m(1,3) = \overline{A}\overline{B}D = E, \sum m(3,7) = \overline{A}CD = NE$

E=Essential Prime Implicant

NE= Non-Essential Prime Implicant