INDRAPRASTHA INSTITUTE OF INFORMATION TECHNOLOGY, DELHI

ECE111 DC

TUTORIAL 2

1. Prove the following Boolean theorem:

   a. $x + \bar{x}.y \ = x + y$

   b. $x.y + y.z + \bar{x}.z \ = x.y + \bar{x}.z$

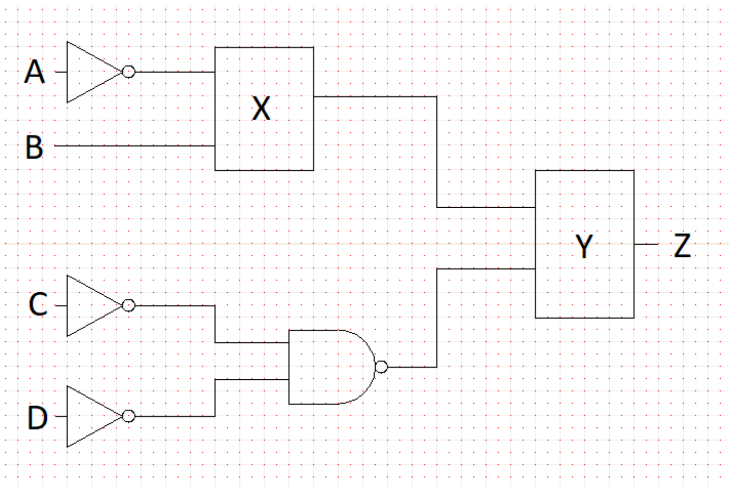
   c. $(x + y) \cdot (\bar{x} + z) \cdot (y + z) = (x + y) \cdot (\bar{x} + z)$

   d. $x + \bar{x} \cdot y = x + y$

2. Let $X=X_1X_0$ and $Y=Y_1Y_0$ be unsigned 2-bit numbers. The output function F = 1 if X is equal to or less than Y and F = 0 otherwise. Find the minimized expression for F?

3. A bulb in a staircase has two switches. One switch being at the ground floor and the other one is at the first floor. The bulb can be turned ON and also can be turned OFF by anyone of the switches irrespective of the state of the other switch. This logic of switching of the bulb is best described by which gate?

4. What should be the gate X and Y for which Z=A+$\bar{B}$+C+D.



5. Smart doorbells allow people to answer their door remotely. This means the user can talk to their visitors while they are not at home, or if they are unable to answer the door in person for any other reason, such as a disability. Smart doorbells include a camera in addition to a doorbell. If the camera detects movement, or if the doorbell is pressed, then a notification is sent to the user's smartphone. An app can then be used to view the camera and to listen to or speak with the visitor.

   Design the logic circuit required to send the notification, modelling the camera, doorbell and notification.

6. a) Draw the logic gate implementation for the below expression without simplification and after simplification. (Use laws of Boolean algebra to simplify)

$$F = A + CD + (A + \overline{D})(\bar{C} + D)$$

b) Realize the following expression using 2 input NAND gate

i. $F = AB + CD$

ii. $G = (\bar{A} + \bar{B})(C + D)$

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Tut-2

Q1 a) $x + \bar{x} \cdot y = x + y$

LHS

$x \cdot (1) + \bar{x} \cdot y$

$= x \cdot (1+y) + \bar{x} \cdot y$ $\quad (\because 1 + a = 1)$

$= x + xy + \bar{x} \cdot y = x + y(x + \bar{x})$ $\quad (\& \because a + \bar{a} = 1)$

$= x + y = RHS$

Hence Proved

b) $x \cdot y + y \cdot z + \bar{x} \cdot z = x \cdot y + \bar{x} \cdot z$

LHS

$x \cdot y + y \cdot z(1) + \bar{x} \cdot z = x \cdot y + y \cdot z(x + \bar{x}) + \bar{x} z$ $\quad (\because \bar{a} + a = 1)$

$= x \cdot y + x \cdot y \cdot z + \bar{x} \cdot y \cdot z + \bar{x} z$

$= x \cdot y(1 + z) + \bar{x} \cdot z(1 + y)$ $\quad (\because 1 + a = 1)$

$= x \cdot y + \bar{x} \cdot z$

$= RHS$

H.P

c) $(x+y) \cdot (\bar{x} + z) \cdot (y + z) = (x + y) \cdot (\bar{x} + z)$

Taking dual ~~both~~ of the statement

$xy + \bar{x}z + yz = xy + \bar{x}z$

$\Rightarrow$ It becomes 1b)

Hence, Proved

d) Same as 1a)

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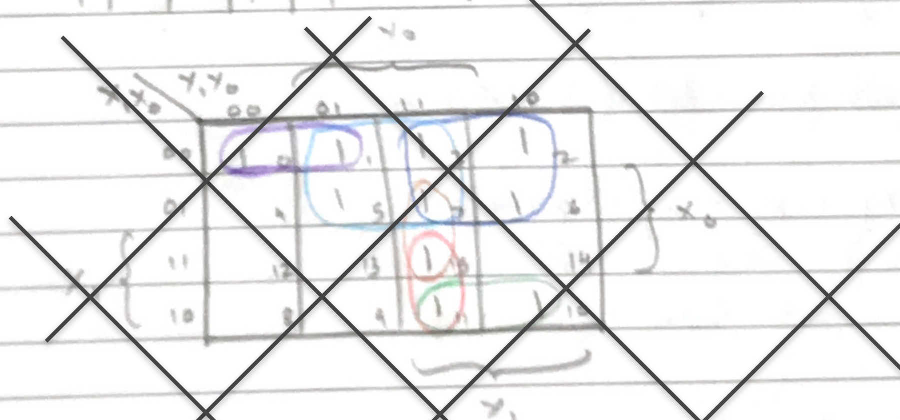
Q2 $X = X_1X_0$; $Y = Y_1Y_0$

X_1	X_0	Y_1	Y_0	F	SNo
0	0	0	0	1	0
0	0	0	1	1	1
0	0	1	0	1	2
0	0	1	1	1	3
0	1	0	0	0	4
0	1	0	1	1	5
0	1	1	0	1	6
0	1	1	1	1	7
1	0	0	0	0	8
1	0	0	1	0	9
1	0	1	0	1	10
1	0	1	1	1	11
1	1	0	0	0	12
1	1	0	1	0	13
1	1	1	0	0	14
1	1	1	1	1	15



$F = \bar{X}_1 Y_0 + \bar{X}_1 Y_1 + \bar{X}_1 \bar{X}_0 \bar{Y}_1 + Y_0 Y_1 X_0 + Y_0 Y_1 X_1 + X_1 \bar{X}_0 Y_1$

x_1x_0 \ y_1y_0	00	01	11	10
00	1 (0)	1 (1)	1 (3)	1 (2)
01	(4)	1 (5)	1 (7)	1 (6)
11	(12)	(13)	1 (15)	(14)
10	(8)	(9)	1 (11)	1 (10)

y_0: columns 01, 11; y_1: columns 11, 10; x_0: rows 01, 11; x_1: rows 11, 10

$$F = \bar{x}_1\bar{x}_0 + \bar{x}_1 y_0 + \bar{x}_1 y_1 + y_0 y_1 + x_1 y_1$$

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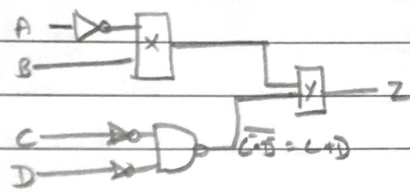
Q3 The XOR gate best describe the logic of switching of the bulb as when both of the switches are in same ~~to position~~ states the bulb switches off ~~and~~ else one.

Q4

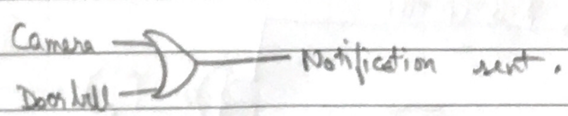
$Z = A + \bar{B} + C + D$



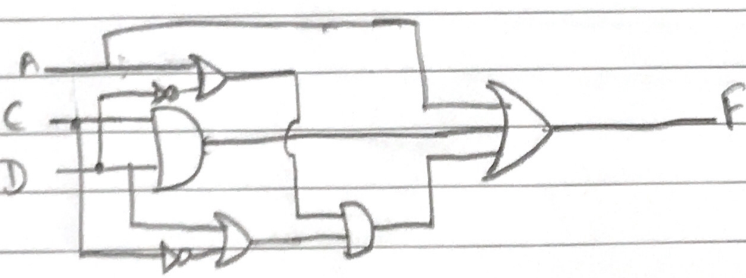
⇒ The eqⁿ is only satisfied for X = NAND & Y = OR

Q5 The notification is sent when either camera detects motion or doorbell is ring

⇒ OR need to be used



Q6 a) without simplification



$$F = A + CD + A\bar{C} + AD + \bar{C}\bar{D} + \bar{D}D$$

$$= A(1+\bar{C}) + (CD + \bar{C}\bar{D}) + \bar{D}D \qquad (\because x \cdot \bar{x} = 0)$$

$$(x + \bar{x} = 1)$$

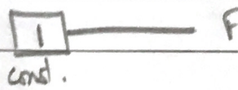
$$(1 + x = 1)$$

$$= A$$

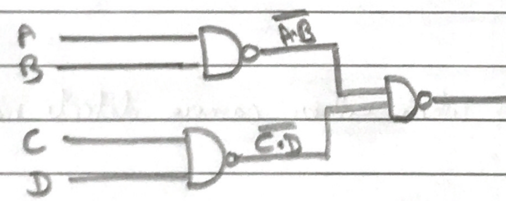
$$= A + 1 + 0$$

$$F = 1$$

After simplification

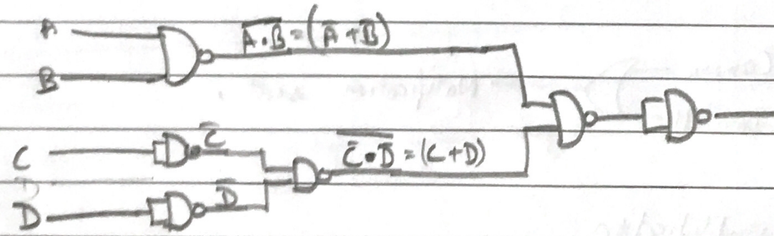


d) i)



$F = \overline{\overline{AB} \cdot \overline{CD}} = AB + CD$

ii)



$G = (\bar{A} + \bar{B}) \cdot (C + D)$