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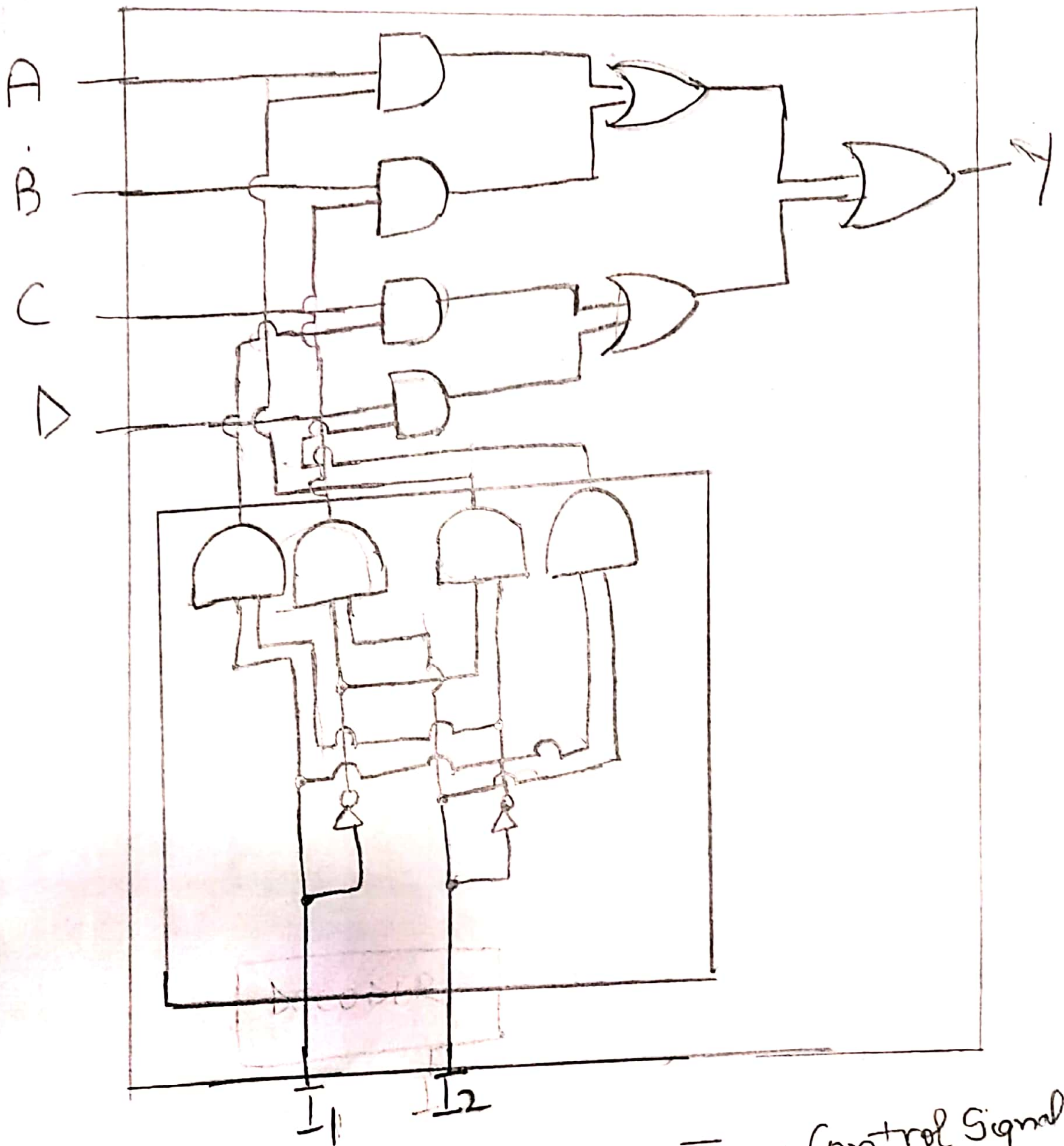
1.]



I_1 — Control Signal

I_2 — Control Signal

I_1	I_2	Y
0	0	A
0	1	B
1	0	C
1	1	D

$$Y \Rightarrow ((\bar{I_1} \cdot \bar{I_2} \cdot A) + (\bar{I_1} \cdot I_2 \cdot B) + (I_1 \cdot \bar{I_2} \cdot C) + (I_1 \cdot I_2 \cdot D))$$

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2.

x_2	x_1	x_0	f_1	f_2	f_3	f_4
0	0	0	0	0	1	0
0	0	1	0	1	1	0
0	1	0	0	1	1	0
0	1	1	1	0	1	0
1	0	0	0	1	0	1
1	0	1	1	0	0	1
1	1	0	1	0	0	1
1	1	1	0	1	0	1

Logic Equations:

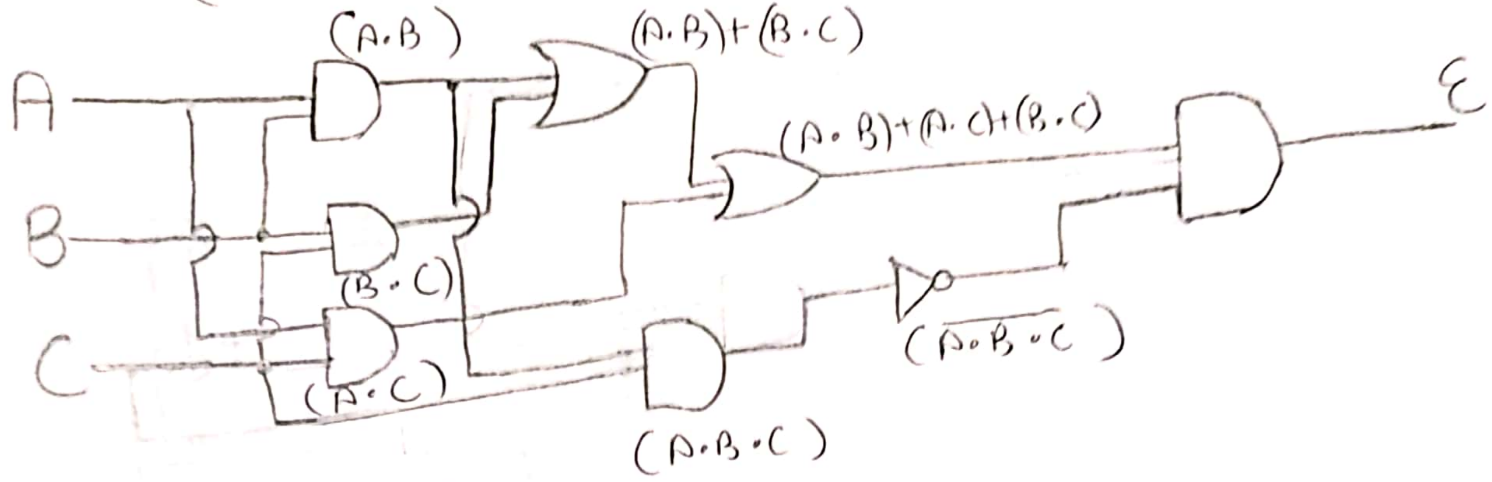
f_1 : $\overline{x_2}\cdot x_1\cdot x_0 + x_2\cdot\overline{x_1}\cdot x_0 + x_2\cdot x_1\cdot\overline{x_0}$

f_2 : $\overline{x_2}\cdot\overline{x_1}\cdot x_0 + \overline{x_2}\cdot x_1\cdot\overline{x_0} + x_2\cdot\overline{x_1}\cdot\overline{x_0} + x_2\cdot x_1\cdot x_0$

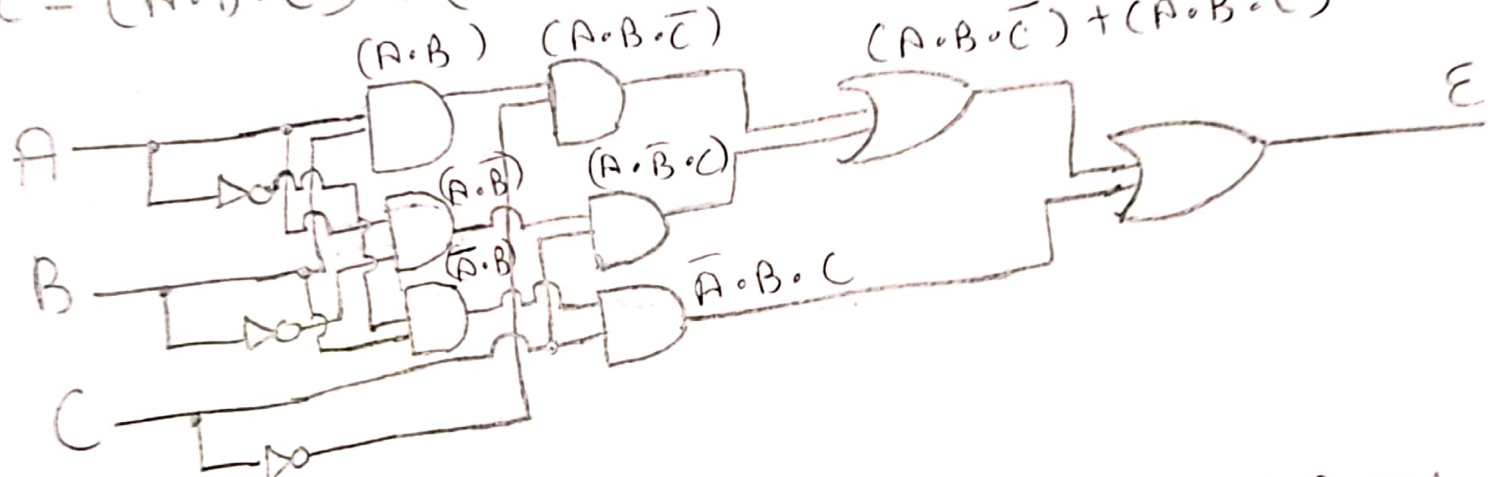
f_3 : $\overline{x_2}\cdot\overline{x_1}\cdot\overline{x_0} + \overline{x_2}\cdot\overline{x_1}\cdot x_0 + \overline{x_2}\cdot x_1\cdot\overline{x_0} + \overline{x_2}\cdot x_1\cdot x_0$

f_4 : $x_2\cdot\overline{x_1}\cdot\overline{x_0} + x_2\cdot\overline{x_1}\cdot x_0 + x_2\cdot x_1\cdot\overline{x_0} + x_2\cdot x_1\cdot x_0$

3.] $E = ((A \cdot B) + (A \cdot C) + (B \cdot C)) \cdot (\overline{A \cdot B \cdot C})$



$E = (A \cdot B \cdot \overline{C}) + (A \cdot \overline{B} \cdot C) + (\overline{A} \cdot B \cdot C)$



The first equation is more efficient in terms of the number of 2-input gates because it has a total of 7 gates whereas, equation two uses a total of 8 gates. Thus, less gates means low power usage, better performance and energy efficiency.

4.)

$$E = ((A \cdot B) + (A \cdot C) + (B \cdot C)) \cdot (\overline{A \cdot B \cdot C})$$

$$\Rightarrow ((A \cdot B) + (A \cdot C) + (B \cdot C)) \cdot (\overline{A} + \overline{B} + \overline{C})$$ [De morgan's law $\overline{A \cdot B} = \overline{A} + \overline{B}$]

$$((A \cdot B) \cdot (\overline{A} + \overline{B} + \overline{C})) + ((A \cdot C) \cdot (\overline{A} + \overline{B} + \overline{C})) + ((B \cdot C) \cdot (\overline{A} + \overline{B} + \overline{C}))$$

1 [Distributive law] 2 3

$$① \Rightarrow ((A \cdot B \cdot \overline{A}) + (A \cdot B \cdot \overline{B}) + (A \cdot B \cdot \overline{C}))$$ [Inverse law $A \cdot \overline{A} = 0$]

$$① \Rightarrow (0 + 0 + (A \cdot B \cdot \overline{C}))$$

$$② \Rightarrow ((A \cdot C \cdot \overline{A}) + (A \cdot C \cdot \overline{B}) + (A \cdot C \cdot \overline{C}))$$ [Inverse law $A \cdot \overline{A} = 0$]

$$② \Rightarrow (0 + (A \cdot C \cdot \overline{B}) + 0)$$

$$③ \Rightarrow ((B \cdot C \cdot \overline{A}) + (B \cdot C \cdot \overline{B}) + (B \cdot C \cdot \overline{C}))$$ [Inverse law $\overline{A} \cdot A = 0$]

$$③ \Rightarrow ((B \cdot C \cdot \overline{A}) + 0 + 0)$$

∴, Putting ①, ② & ③ back, we get

$$E = (A \cdot B \cdot \overline{C}) + (A \cdot \overline{B} \cdot C) + (\overline{A} \cdot B \cdot C)$$ [Commutative law: $A \cdot B = B \cdot A$]

Hence Proved

5.]

$XOR = (A \cdot \overline{B}) + (\overline{A} \cdot B)$

$XOR = (A + B) \cdot (\overline{A \cdot B})$

$XOR = (A + B) \cdot (\overline{A \cdot B})$

$\Rightarrow (A + B) \cdot (\overline{A} + \overline{B})$ [DeMorgan's law $\overline{A \cdot B} = \overline{A} + \overline{B}$]

$\Rightarrow ((A \cdot \overline{A}) + (A \cdot \overline{B}) + (B \cdot \overline{A}) + (B \cdot \overline{B}))$

$\Rightarrow (0 + (A \cdot \overline{B}) + (\overline{A} \cdot B) + 0]$ [Inverse law $A \cdot \overline{A} = 0$ Commutative law $A \cdot B = B \cdot A$]

$\Rightarrow (A \cdot \overline{B}) + (\overline{A} \cdot B)$

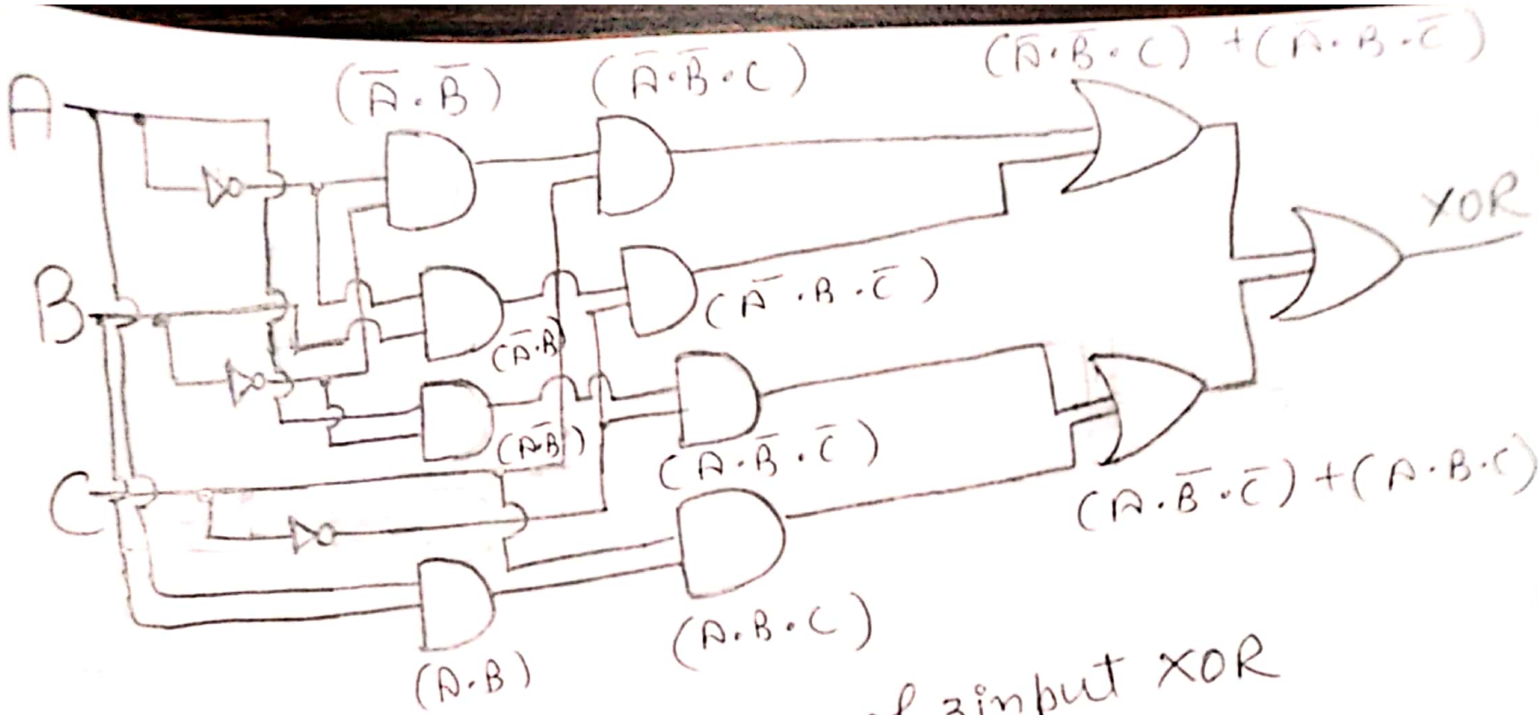
Hence Proved

6.]

A	B	C	XOR
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

[XOR function outputs 1 when the true value occurs in a odd number]

$XOR = (\overline{A} \cdot \overline{B} \cdot C) + (\overline{A} \cdot B \cdot \overline{C}) + (A \cdot \overline{B} \cdot \overline{C}) + (A \cdot B \cdot C)$



Schematic Diagram of 3input XOR

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