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CT-032

CT-32

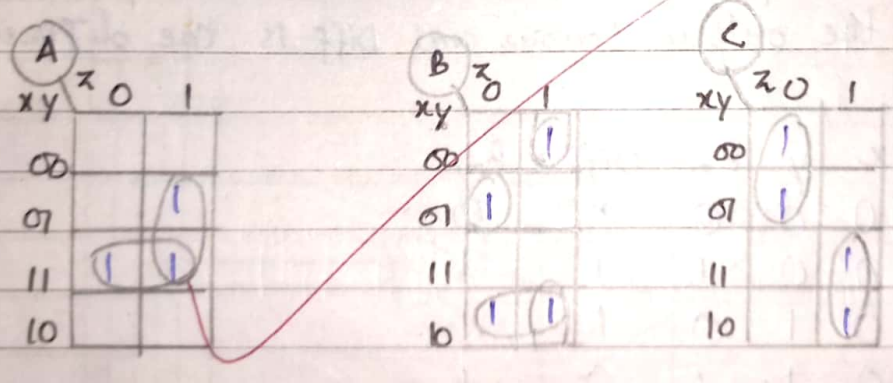
Date:

10/10

Question No 1:

Construct a combinational circuit with three inputs x, y and z and three outputs A, B, and C. When the binary input is 0, 1, 2 and 3; the binary output is one greater than the input. When the binary input is 4, 5, 6 or 7, the binary output is two less than the input.

x	y	z	A	B	C
0	0	0	0	0	1
0	0	1	0	1	0
0	1	0	0	1	1
0	1	1	1	0	0
1	0	0	0	1	0
1	0	1	0	1	1
1	1	0	1	0	0
1	1	1	1	0	1



$A = xy + yz$

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

$C = \bar{x}\bar{z} + xz$

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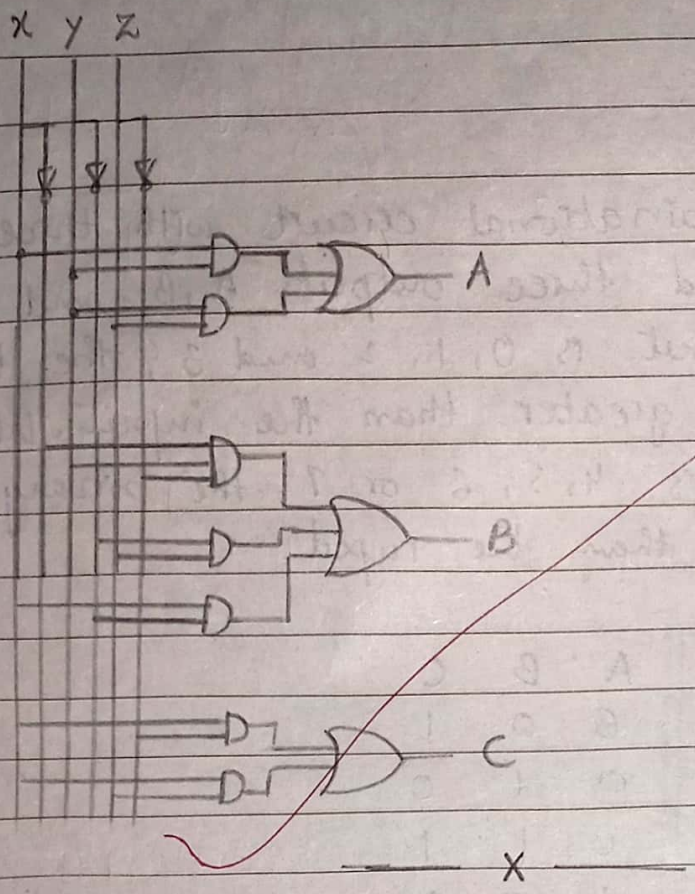

Question Number 2:

Construct a full-subtractor circuit with three inputs x, y, Bin and two outputs Diff and Bout. The circuit subtracts x - y - Bin, where Bin is the input borrow, Bout is the output borrow, and Diff is the difference

x	y	Bin	Diff	Bout
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

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Diff

xy \ Bin	0	1
00		1
01	1	
11		1
10	1	

$Diff = \bar{x}\bar{y}B_{in} + \bar{x}y\bar{B_{in}} + xyB_{in} + x\bar{y}\bar{B_{in}}$

$Diff = \bar{x}(\bar{y}B_{in} + y\bar{B_{in}}) + x(yB_{in} + \bar{y}\bar{B_{in}})$

$Diff = \bar{x}(y \oplus B_{in}) + x\overline{(y \oplus B_{in})}$

$\boxed{Diff = x \oplus (y \oplus B_{in})}$

Bout

xy \ Bin	0	1
00		1
01	1	1
11		1
10		

From K-map:

$B_{out} = \bar{x}yB_{in} + \bar{x}y + yB_{in}$

$\boxed{B_{out} = \bar{x}y + B_{in}(\bar{x} + y)}$

From Truth Table:

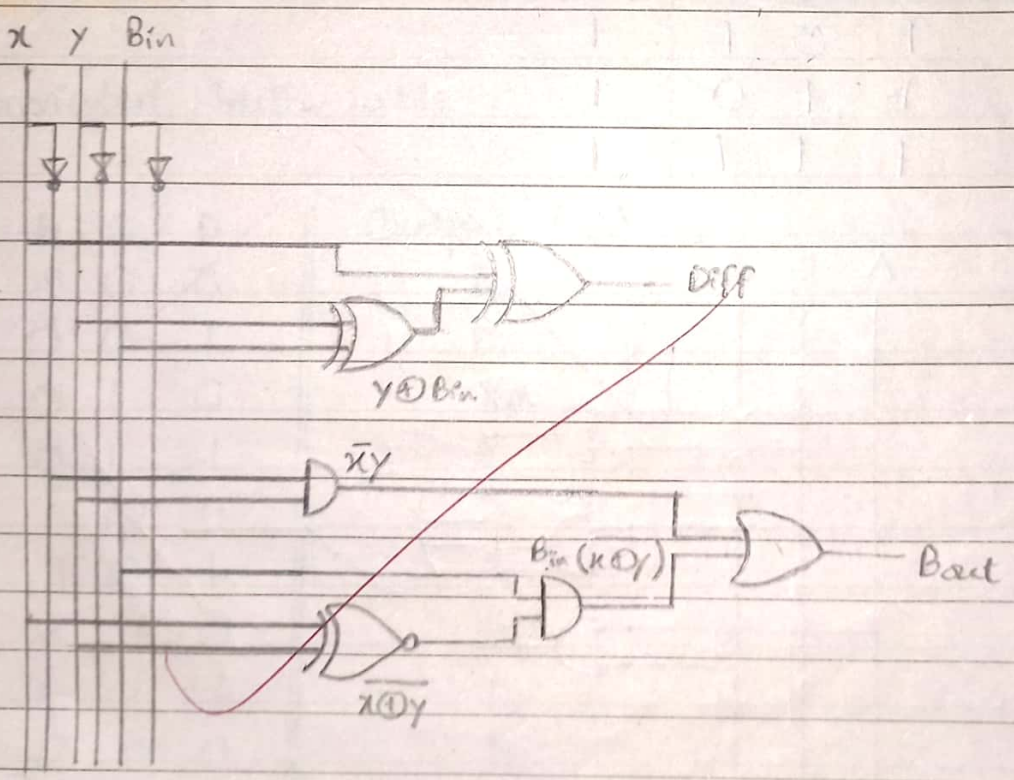
$B_{out} = \bar{x}\bar{y}B_{in} + \bar{x}y\bar{B_{in}} + \bar{x}yB_{in} + xyB_{in}$

$B_{out} = \bar{x}\bar{y}B_{in} + xyB_{in} + \bar{x}yB_{in} + \bar{x}y\bar{B_{in}}$

$B_{out} = B_{in}(\bar{x}\bar{y} + xy) + \bar{x}y(B_{in} + \bar{B_{in}})$

$B_{out} = B_{in}(\overline{x \oplus y}) + \bar{x}y(1)$

$\boxed{B_{out} = \bar{x}y + B_{in}(\overline{x \oplus y})}$



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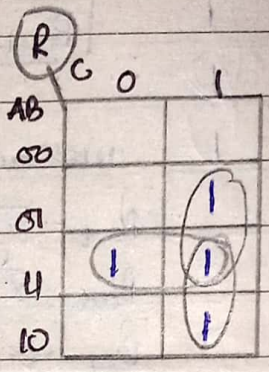
Question Number 3:

A committee of three individuals decides issues for an organization. Each individual votes either yes or no for each proposal that arises. A proposal is passed if receives at least two yes votes. Construct a circuit that determines whether a proposal passes.

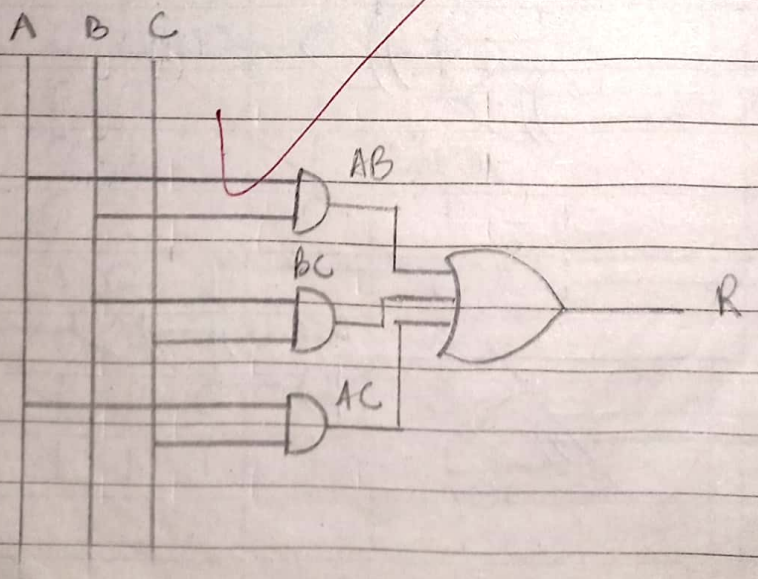
A · 1 ⇒ Yes

0 ⇒ NO

A	B	C	R
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1



$R = AB + BC + AC$



X

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Question Number 4:

Construct a BCD-to-decimal decoder using the unused combinations of the BCD code as don't care conditions.

A	B	C	D	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9
0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	0	0	1	0	1	0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0	0	0	0	0	0	0
0	0	1	1	0	0	0	1	0	0	0	0	0	0
0	1	0	0	0	0	0	0	1	0	0	0	0	0
0	1	0	1	0	0	0	0	0	1	0	0	0	0
0	1	1	0	0	0	0	0	0	0	1	0	0	0
0	1	1	1	0	0	0	0	0	0	0	1	0	0
1	0	0	0	0	0	0	0	0	0	0	0	1	0
1	0	0	1	0	0	0	0	0	0	0	0	0	1
1	0	1	0										

Abbreviated Truth Table:

A	B	C	D	Output (0)
0	0	0	0	D_0
0	0	0	1	D_1
0	0	1	0	D_2
0	0	1	1	D_3
0	1	0	0	D_4
0	1	0	1	D_5
0	1	1	0	D_6
0	1	1	1	D_7
1	0	0	0	D_8
1	0	0	1	D_9

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D_0

AB \ CD	00	01	11	10
00	1			
01				
11	X	X	X	X
10			X	X

D_1

AB \ CD	00	01	11	10
00		1		
01				
11	X	X	X	X
10			X	X

D_2

AB \ CD	00	01	11	10
00				1
01				
11	X	X	X	X
10			X	X

D_3

AB \ CD	00	01	11	10
00			1	
01				
11	X	X	X	X
10			X	X

D_4

AB \ CD	00	01	11	10
00				
01	1			
11	X	X	X	X
10			X	X

D_5

AB \ CD	00	01	11	10
00				
01		1		
11	X	X	X	X
10			X	X

D_6

AB \ CD	00	01	11	10
00				
01				1
11	X	X	X	X
10			X	X

D_7

AB \ CD	00	01	11	10
00				
01			1	
11	X	X	X	X
10			X	X

D_8

AB \ CD	00	01	11	10
00				
01				
11	X	X	X	X
10	1		X	X

D_9

AB \ CD	00	01	11	10
00				
01				
11	X	X	X	X
10		1	X	X

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Equations:

$D_0 = \bar{A}\,\bar{B}\,\bar{C}\,\bar{D}$

$D_1 = \bar{A}\,\bar{B}\,\bar{C}\,D$

$D_2 = \bar{B}\,C\,\bar{D}$

$D_3 = \bar{B}\,C\,D$

$D_4 = B\,\bar{C}\,\bar{D}$

$D_5 = B\,\bar{C}\,D$

$D_6 = B\,C\,\bar{D}$

$D_7 = B\,C\,D$

$D_8 = A\,\bar{D}$

$D_9 = A\,D$.

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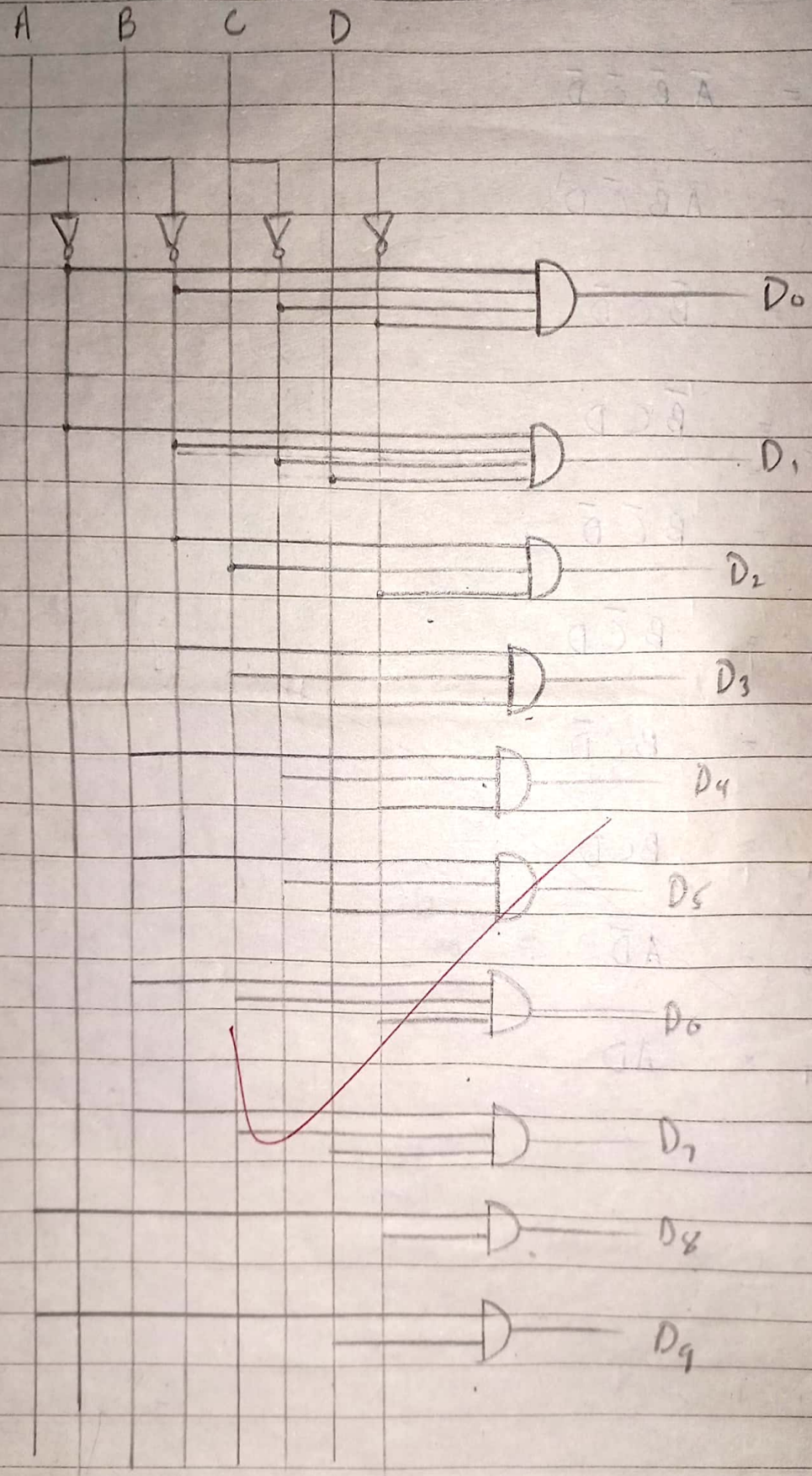

Question no 5: Date: _____

Q: Construct a 5-bit parity system.

Parity Generator:

A	B	C	D	P_{odd}	P_{even}
0	0	0	0	1	0
0	0	0	1	0	1
0	0	1	0	0	1
0	0	1	1	1	0
0	1	0	0	0	1
0	1	0	1	1	0
0	1	1	0	1	0
0	1	1	1	0	1
1	0	0	0	0	1
1	0	0	1	1	0
1	0	1	0	1	0
1	0	1	1	0	1
1	1	0	0	1	0
1	1	0	1	0	1
1	1	1	0	0	1
1	1	1	1	1	0

P_{odd}

AB \ CD	00	01	11	10
00	1		1	
01		1		1
11	1		1	
10		1		1

P_{even}

AB \ CD	00	01	11	10
00		1		1
01	1		1	
11		1		1
10	1		1	

P_{odd}:

$$P_{odd} = \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}C\bar{D} + \bar{A}B\bar{C}\bar{D} + \bar{A}BCD + AB\bar{C}\bar{D} + ABC\bar{D} + AB\bar{C}D + A\bar{B}C\bar{D}$$

$$P_{odd} = \bar{A}\bar{B}(\bar{C}D + C\bar{D}) + \bar{A}B(\bar{C}\bar{D} + CD) + AB(\bar{C}\bar{D} + CD) + A\bar{B}(\bar{C}D + C\bar{D})$$

$$P_{odd} = \bar{A}\bar{B}(C \oplus D) + \bar{A}B(\overline{C \oplus D}) + AB(C \oplus D) + A\bar{B}(\overline{C \oplus D})$$

$$P_{odd} = \bar{A}[\bar{B}(C \oplus D) + B(\overline{C \oplus D})] + A[B(C \oplus D) + \bar{B}(\overline{C \oplus D})]$$

$$P_{odd} = \bar{A}(B \oplus C \oplus D) + A(B \oplus C \oplus D)$$

$$\boxed{P_{odd} = A \oplus (B \oplus C \oplus D)}$$

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P_{even} :

$$P_{even} = \bar{A}\bar{B}CD + \bar{A}B\bar{C}\bar{D} + \bar{A}BC\bar{D} + \bar{A}BCD + AB\bar{C}D + ABC\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}CD$$

$$P_{even} = \bar{A}\bar{B}(\bar{C}D + C\bar{D}) + \bar{A}B(\bar{C}\bar{D} + CD) + AB(\bar{C}D + C\bar{D}) + A\bar{B}(\bar{C}\bar{D} + CD)$$

$$P_{even} = \bar{A}\bar{B}(C \oplus D) + \bar{A}B(\overline{C \oplus D}) + AB(C \oplus D) + A\bar{B}(\overline{C \oplus D})$$

$$P_{even} = \bar{A}\left[\bar{B}(C \oplus D) + B(\overline{C \oplus D})\right] + A\left[B(C \oplus D) + \bar{B}(\overline{C \oplus D})\right]$$

$$P_{even} = \bar{A}(B \oplus C \oplus D) + A(\overline{B \oplus C \oplus D})$$

$$\boxed{P_{even} = A \oplus (B \oplus C \oplus D)}$$

Parity Checker :

P_e/P_o	A	B	C	D	C_{odd}	C_{even}
0	0	0	0	0	1	0
0	0	0	0	1	0	1
0	0	0	1	0	0	1
0	0	0	1	1	1	0
0	0	1	0	0	0	1
0	0	1	0	1	1	0
0	0	1	1	0	1	0
0	0	1	1	1	0	1
0	1	0	0	0	0	1
0	1	0	0	1	1	0
0	1	0	1	0	1	0
0	1	0	1	1	0	1
0	1	1	0	0	1	0
0	1	1	0	1	0	1
0	1	1	1	0	0	1

P_e/P_o	A	B	C	D	C_{odd}	C_{even}
0	1	1	1	1	1	0
1	0	0	0	0	0	1
1	0	0	0	1	1	0
1	0	0	1	0	1	0
1	0	0	1	1	0	1
1	0	1	0	0	1	0
1	0	1	0	1	0	1
1	0	1	1	0	0	1
1	0	1	1	1	1	0
1	1	0	0	0	1	0
1	1	0	0	1	0	1
1	1	0	1	0	0	1
1	1	0	1	1	1	0
1	1	1	0	0	0	1
1	1	1	0	1	1	0
1	1	1	1	0	1	0
1	1	1	1	1	0	1

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C_{odd}

$P_o A$ \ BCD	000	001	011	010	110	111	101	100
00	1		1		1		1	
01		1		1		1		1
11	1		1		1		1	
10		1		1		1		1

$$C_{odd} = P_o\bar{A}\bar{B}\bar{C}D + P_oA\bar{B}\bar{C}D + P_o\bar{A}BC\bar{D} + P_oABC\bar{D} + P_oAB\bar{C}D + P_o\bar{A}B\bar{C}D + P_oA\bar{B}CD + P_oABCD + P_oA\bar{B}C\bar{D} + P_o\bar{A}BCD + P_o\bar{A}\bar{B}C\bar{D}.$$

$$C_{odd} = \bar{P}_o(\bar{A}\bar{B}\bar{C}D + \bar{A}BCD + \bar{A}BC\bar{D} + ABC\bar{D} + AB\bar{C}D + A\bar{B}CD + A\bar{B}C\bar{D} + ABCD + AB\bar{C}\bar{D}) + P_o(A\bar{B}\bar{C}D + A\bar{B}CD + ABC\bar{D} + AB\bar{C}D + \bar{A}B\bar{C}D + \bar{A}BCD + \bar{A}\bar{B}C\bar{D})$$

$$C_{odd} = \bar{P}_o[\bar{A}\{\bar{B}(\bar{C}D + C\bar{D}) + B(C\bar{D} + \bar{C}D)\} + A\{\bar{B}(C\bar{D} + \bar{C}D) + B(CD + \bar{C}\bar{D})\}] + P_o[A\{\bar{B}(\bar{C}D + C\bar{D}) + B(CD + \bar{C}\bar{D})\} + \bar{A}\{\bar{B}(C\bar{D} + \bar{C}D) + B(CD + \bar{C}\bar{D})\}]$$

$$= \bar{P}_o[\bar{A}\{\bar{B}(\overline{C \oplus D}) + B(C \oplus D)\} + A\{\bar{B}(C \oplus D) + B(\overline{C \oplus D})\}] + P_o[A\{\bar{B}(\overline{C \oplus D}) + B(C \oplus D)\} + \bar{A}\{\bar{B}(C \oplus D) + B(\overline{C \oplus D})\}]$$

$$= \bar{P}_o[\bar{A}\{B \oplus (C \oplus D)\} + A\{B \oplus (C \oplus D)\}] + P_o[A\{B \oplus (C \oplus D)\} + \bar{A}\{B \oplus (C \oplus D)\}].$$

$$= \bar{P}_o[A \oplus \{B \oplus (C \oplus D)\}] + P_o[A \oplus \{B \oplus (C \oplus D)\}].$$

$$C_{odd} = P_o \oplus (A \oplus B \oplus C \oplus D).$$

$$C_{even} = P_e\bar{A}\bar{B}\bar{C}D + P_eA\bar{B}\bar{C}D + P_e\bar{A}BC\bar{D} + P_eABC\bar{D} + P_eAB\bar{C}D + P_e\bar{A}B\bar{C}D + P_eA\bar{B}CD + P_eABCD + P_eA\bar{B}C\bar{D} + P_e\bar{A}BCD + P_e\bar{A}\bar{B}C\bar{D}.$$

$$C_{even} = \bar{P}_e[\bar{A}\bar{B}\bar{C}D + \bar{A}BC\bar{D} + \bar{A}BCD + A\bar{B}C\bar{D} + A\bar{B}CD + AB\bar{C}\bar{D} + ABCD + AB\bar{C}D] + P_e(A\bar{B}\bar{C}D + A\bar{B}CD + ABC\bar{D} + AB\bar{C}D + \bar{A}BCD + \bar{A}BC\bar{D} + \bar{A}\bar{B}C\bar{D} + \bar{A}\bar{B}\bar{C}D)$$

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$$C_{even} = \bar{P_e}\left[\bar{A}\{\bar{B}(\bar{C}D+C\bar{D})+B(CD+\bar{C}\bar{D})\}+A\{\bar{B}(\bar{C}\bar{D}+CD)+B(C\bar{D}+\bar{C}D)\}\right]+P_e\left[A\{\bar{B}(\bar{C}D+C\bar{D})+B(CD+\bar{C}\bar{D})\}+\bar{A}\{\bar{B}(\bar{C}\bar{D}+CD)+B(C\bar{D}+\bar{C}D)\}\right].$$

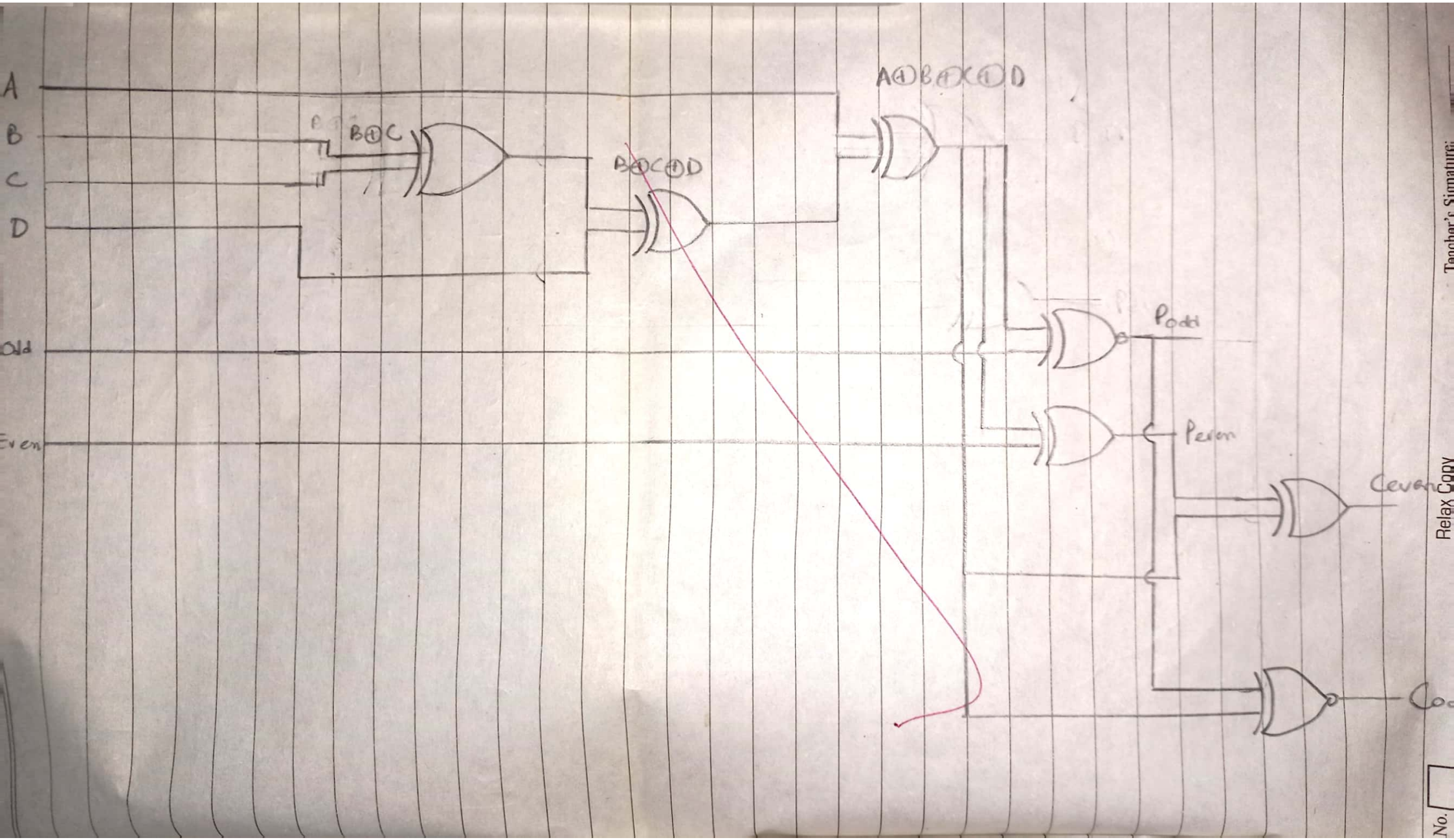
$$= \bar{P_e}\left[\bar{A}\{\bar{B}(C\oplus D)+B\overline{(C\oplus D)}\}+A\{\bar{B}\overline{(C\oplus D)}+B(C\oplus D)\}\right]+P_e\left[A\{\bar{B}(C\oplus D)+B\overline{(C\oplus D)}\}+\bar{A}\{\bar{B}\overline{(C\oplus D)}+B(C\oplus D)\}\right].$$

$$= \bar{P_e}\left[\bar{A}\{B\oplus\overline{(C\oplus D)}\}+A\{B\oplus(C\oplus D)\}\right]+P_e\left[A\{B\oplus\overline{(C\oplus D)}\}+\bar{A}\{B\oplus(C\oplus D)\}\right]$$

$$= \bar{P_e}\left[A\oplus\{B\oplus(C\oplus D)\}\right]+P_e\left[\overline{A\oplus\{B\oplus(C\oplus D)\}}\right]$$

$$\boxed{C_{even} = P_e \oplus (A\oplus B\oplus C\oplus D)}$$

Ceva / P_eA \ BC	00	01	11	10	110	111	101	100
00		1		1		1		1
01	1		1		1		1	
11		1		1		1		1
10	1		1		1		1	


A
B
C
D
Odd
Even
B⊕C
B⊕C⊕D
A⊕B⊕C⊕D
Podd
Peven
Ceven