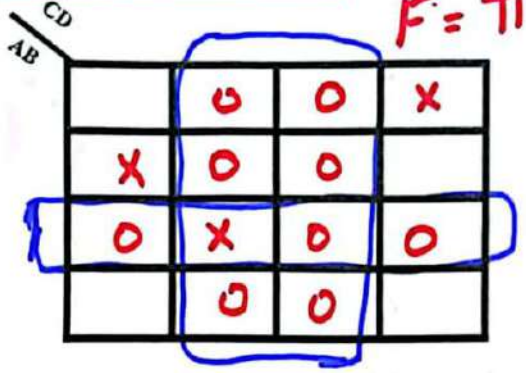
Use the Last page for rough work, perform all calculations, and write a neat and clean answer in the provided space

CLO # 01 : Apply Binary Logic, Boolean Algebra, and Karnaugh map Methods to calculate and simplify Boolean functions.

Q1: Apply the Karnaugh map on the Boolean function "F", together with the don't care conditions "d" and find the simplified POS equation: **F(A, B, C, D) = Σ(0,6,8,10,13) and d(A, B, C, D) = Σ(2,4,13)** **[10 marks]**

$F = \Pi(1,2,3,4,5,7,9,11,12,14,15)$



Simplified equation with all possible step (if any):

$F' = D + AB$

$(F)' = (D + AB)'$

$F = D'.(A' + B')$

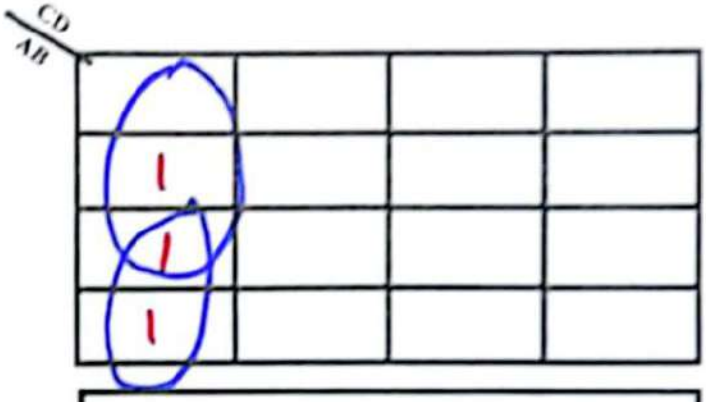
CLO # 02: Use digital circuit-solving techniques to obtain truth tables, Boolean functions, and timing diagrams for combinational circuits, and State equations, state tables, and state diagrams for sequential circuits.

Q2: Design a combinational circuit with four inputs (A, B, C, D) and two outputs (X, Y). The output x will be high if the input is divisible by 4, while output y will indicate high if any two neighboring input variables are set to 1. **[15 marks]**

a. Draw the truth table (5 Marks)
b. Derive a simplified Boolean expression using K-Map (5 Marks)
c. Implement the circuit diagram using NAND gates only (5 Marks)

A	B	C	D	X	Y
0	0	0	0	0	0
0	0	0	1	0	0
0	0	1	0	0	0
0	0	1	1	0	1
0	1	0	0	1	0
0	1	0	1	0	0
0	1	1	0	0	1
0	1	1	1	0	1
1	0	0	0	1	0
1	0	0	1	0	0
1	0	1	0	0	0
1	0	1	1	0	1
1	1	0	0	1	1
1	1	0	1	0	1
1	1	1	0	0	1
1	1	1	1	0	1

for X

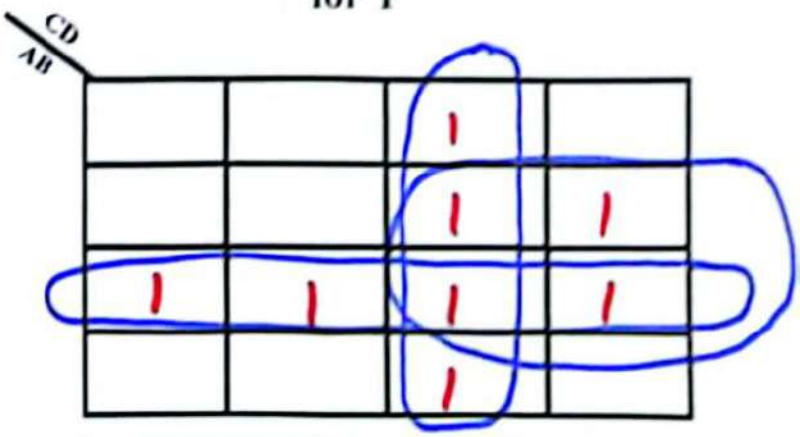


Equation with all possible step:

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

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

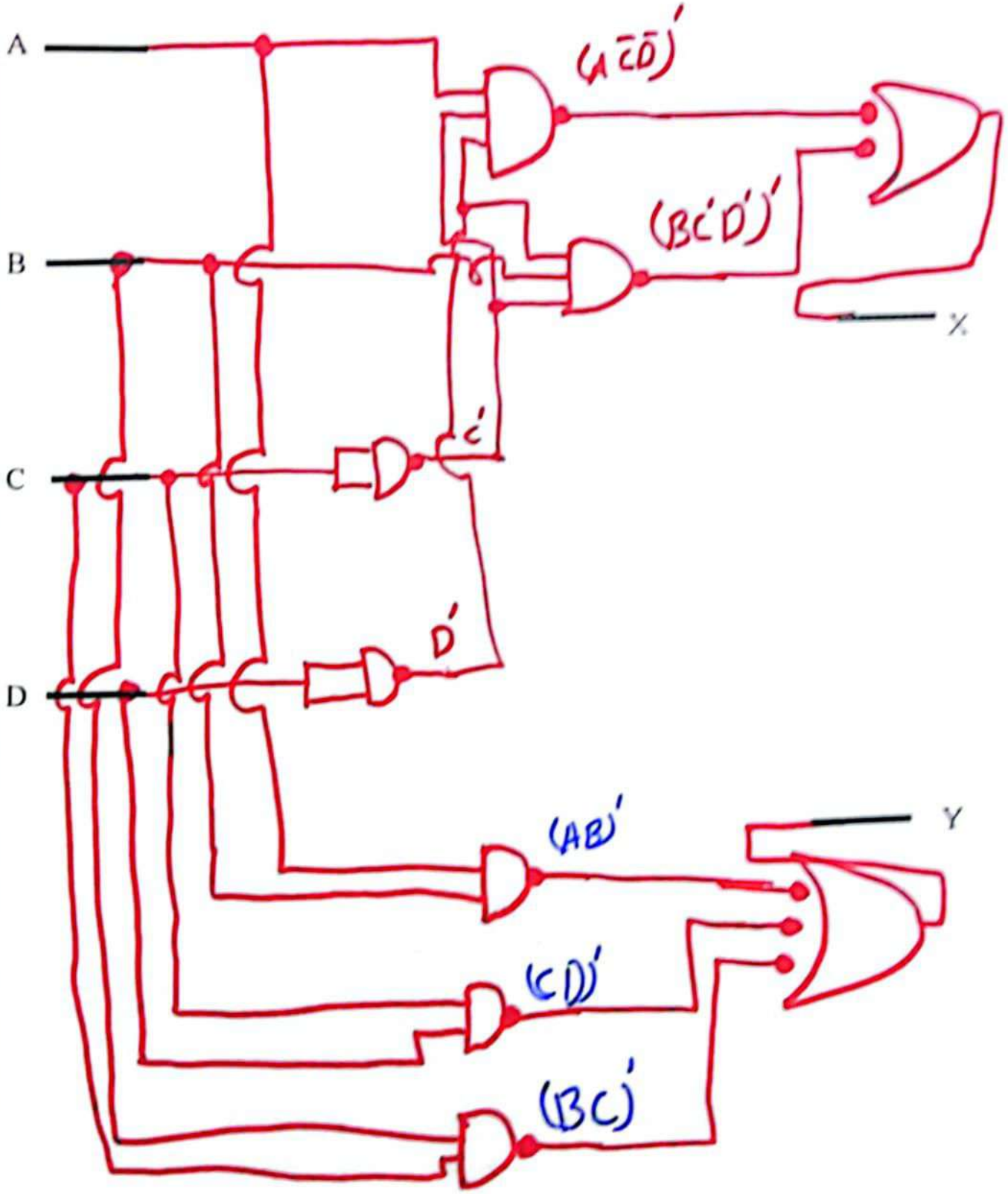
for Y



Equation with all possible step:

$Y = AB + CD + BC$

Implement the circuit diagram using NAND Gates only



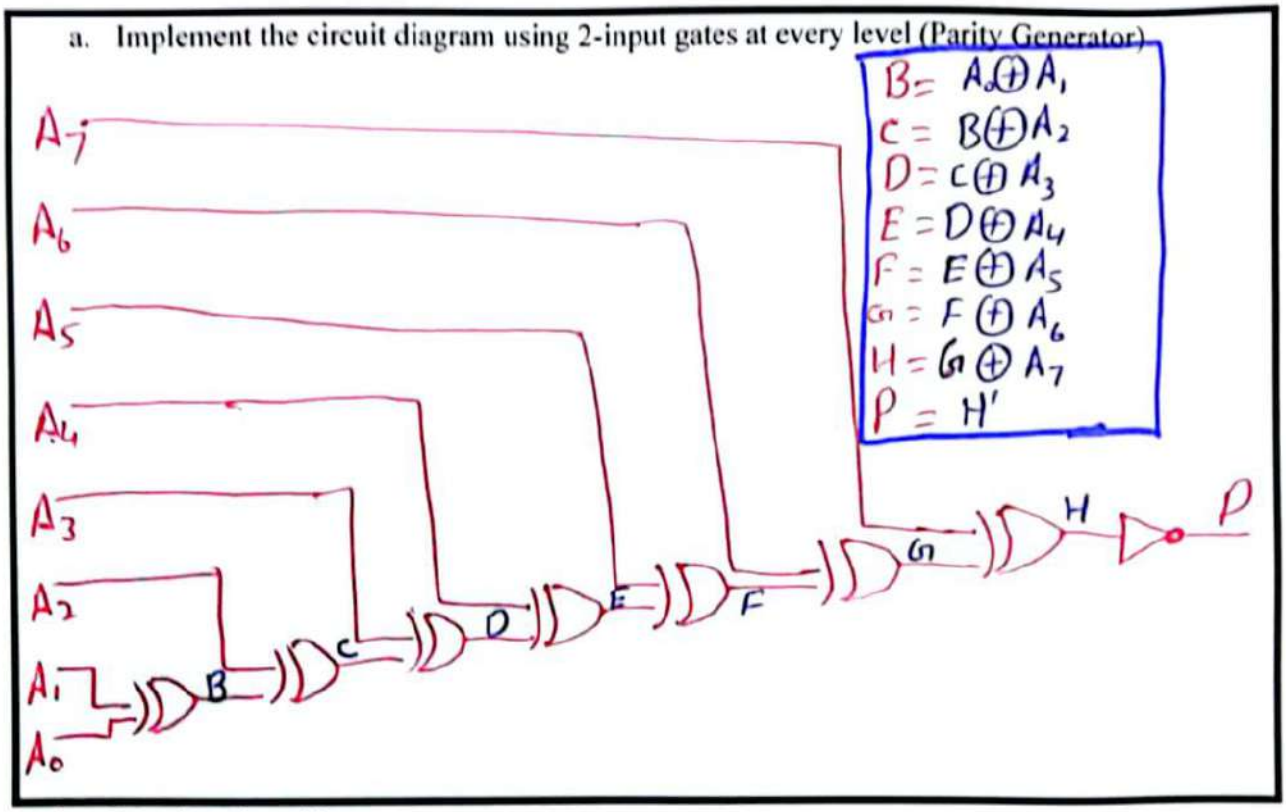
CLO # 02 : Use digital circuit-solving techniques to obtain truth tables, Boolean functions, and timing diagrams for combinational circuits, and State equations, state tables, and state diagrams for sequential circuits

Q3: Design the 8-bit odd-parity generator and checker. Also give five examples (given in following table with the help of ASCII Codes) of the input patterns to show that the generator and checker are working as expected For a 8-bit system using odd parity scheme: **[20 marks]**

a. Design circuit of 8-bit parity generator [5 marks]
b. Complete the table [5 marks]
c. Design circuit of 8-bit parity checker [5 marks]
d. Complete the table [5 marks]

Note: A neat and clean Circuit diagram is important. Cutting and overwriting can directly affect your marks (more than 2 cutting directly mark as zero). Label every point and attempt all the best practices. We know that ASCII of "A=65" and "a=97")

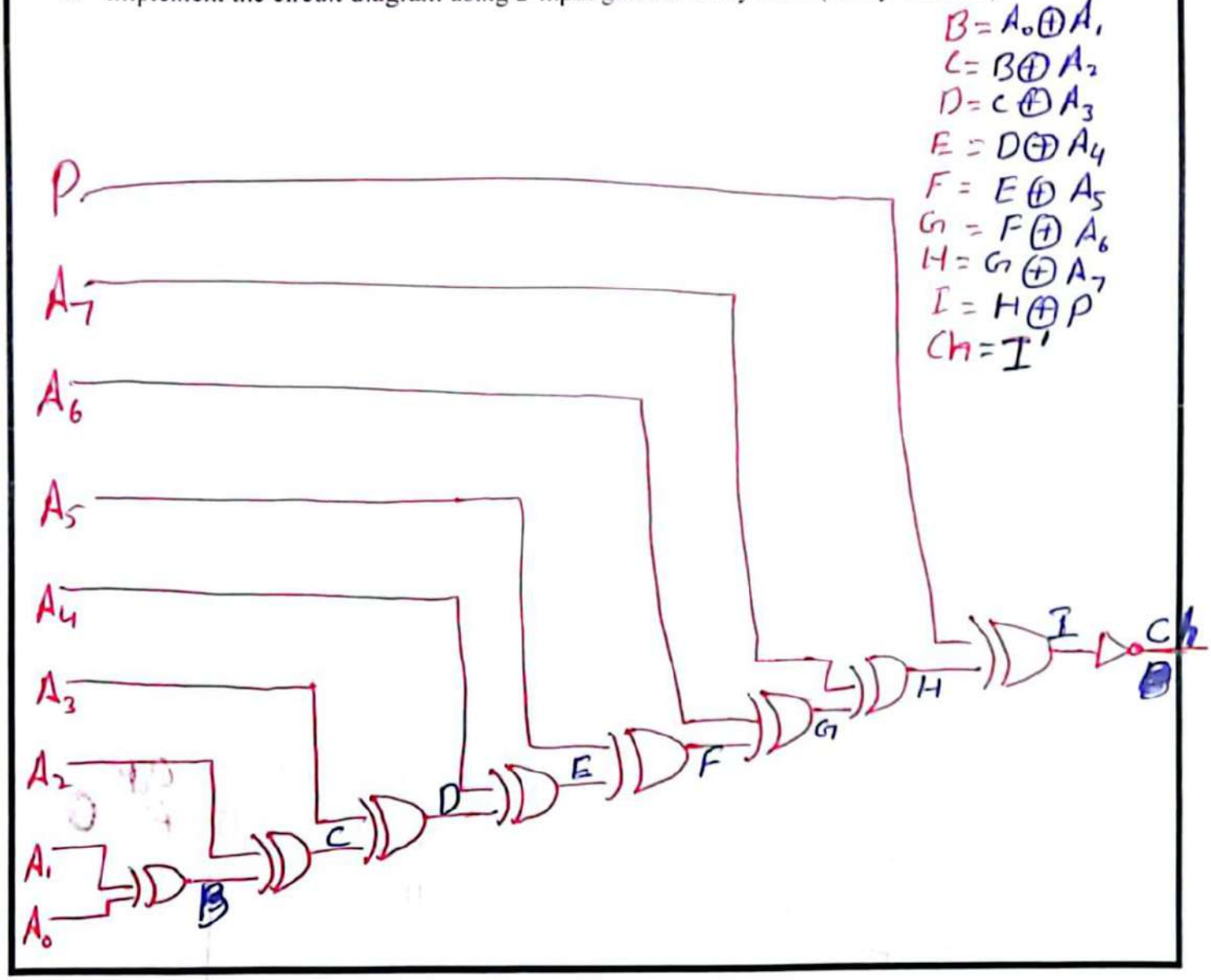
a. Implement the circuit diagram using 2-input gates at every level (Parity Generator)



b. Complete the table:

	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0	Parity
A	0	1	0	0	0	0	0	1	1
d	0	1	1	0	0	1	0	0	0
e	0	1	1	0	0	1	0	1	1
e	0	1	1	0	0	1	0	1	1
l	0	1	1	0	1	1	0	0	1

c. Implement the circuit diagram using 2-input gates at every level (Parity Checker)

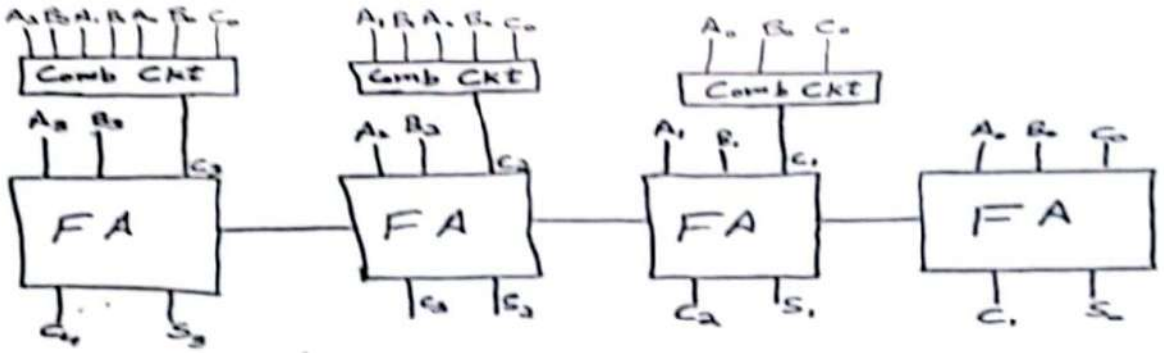


d. Complete the rest of the table according to part 3(b):

	A7	A6	A5	A4	A3	A2	A1	A0	Parity	Checker
A	0	1	0	0	1	0	0	1	1	1
d	0	1	1	1	1	1	0	0	0	0
e	0	1	1	0	0	0	0	1	1	1
e	0	1	1	0	0	1	0	1	1	0
l	0	1	1	0	1	1	0	0	1	0

CLO # 02 : Use digital circuit-solving techniques to obtain truth tables, Boolean functions, and timing diagrams for combinational circuits, and State equations, state tables, and state diagrams for sequential circuits

Q4: Following figure shows a Carry Look Ahead Adder which can be designed from four (4) full adder. Addition of 4-bit number using parallel adder is difficult due to delay in the circuit. This can be overcome with the help of carry look ahead adder circuit. In this question you are required to add the below 4-bit number by using the Carry Look ahead adder shown below. **[10 marks]**



a. The value of O is "1101" and P is "101" [5 marks]

$O = 1101 \quad P = 0101$ (We know that $G_i = O_i P_i$, $A_i = P_i \oplus O_i$)

$O_3 = 1$, $O_2 = 1$, $O_1 = 0$, $O_0 = 1$

$P_3 = 0$, $P_2 = 1$, $P_1 = 0$, $P_0 = 1$

⇒ Carry

C_0 = Direct Input → 0

$C_1 = G_0 + A_0 C_0$

$C_1 = 1 + 0$

$C_1 = 1$

$C_2 = A_1 A_0 C_0 + A_1 G_0 + G_1$

$C_2 = 0 + 0 + 0$

$C_2 = 0$

$C_3 = G_2 + A_2 A_1 G_0 + A_2 A_1 A_0 C_0 + A_2 G_1$

$C_3 = 1 + 0 + 0 + 0$

$C_3 = 1$

$C_4 = G_3 + A_3 G_2 + A_3 A_2 A_1 G_0 + A_3 A_2 A_1 A_0 C_0 + A_3 A_2 G_1$

$C_4 = 0 + 1 + 0 + 0 + 0 \Rightarrow 1$

Sum

$S_0 = A_0 \oplus C_0$

$S_0 = 0 \oplus 0$

$S_0 = 0$

$S_1 = A_1 \oplus C_1$

$= 0 \oplus 1$

$S_1 = 1$

$S_2 = A_2 \oplus C_2$

$= 0 \oplus 0$

$S_2 = 0$

$S_3 = A_3 \oplus C_3$

$= 1 \oplus 1$

$S_3 = 0$

b. The value of O is "1110" and P is "1001" [5 marks]

→ Carry

C_0 = Direct Input

$\boxed{C_0 = 0}$

$C_1 = G_0 + A_0C_0$

$C_1 = 0 + 0$

$\boxed{C_1 = 0}$

$C_2 = A_1A_0C_0 + A_1G_0 + G_1$

$C_2 = 0 + 0 + 0$

$\boxed{C_2 = 0}$

$C_3 = G_2 + A_0A_1G_0 + A_2A_1C_0 + A_0G_1$

$C_3 = 0 + 0 + 0 + 0$

$\boxed{C_3 = 0}$

$C_4 = G_3 + A_3G_2 + A_3A_2A_1G_0 + A_3A_2A_1A_0C_0 + A_3A_2G_1$

$C_4 = 1 + 0 + 0 + 0 + 0$

$\boxed{C_4 = 1}$

→ Sum

$S_0 = A_0 \oplus C_0$

$= 1 \oplus 0$

$\boxed{S_0 = 1}$

$S_1 = A_1 \oplus C_1$

$S_1 = 1 \oplus 0$

$\boxed{S_1 = 1}$

$S_2 = A_2 \oplus C_2$

$S_2 = 1 \oplus 0$

$\boxed{S_2 = 1}$

$S_3 = A_3 \oplus C_3$

$= 0 \oplus 0$

$\boxed{S_3 = 0}$

$O_3 = 1$

$O_2 = 1$

$O_1 = 1$

$O_0 = 0$

$P_3 = 1$

$P_2 = 0$

$P_1 = 0$

$P_0 = 1$