1. For the following 4-bit addition operations use equations 11.4-11.7 and fig. 11.12 to

a) compute $G_0, G_1, G_2, G_3, G_4, P_0, P_1, P_2, P_3$, and P_4.

b) use the results from a) to compute $G_{0:0}, G_{1:0}, G_{2:0}$, and $G_{3:0}$.

c) use the results from a) and b) to compute the sum bits, $S_1 - S_4$, and carry-out (overflow) bit, C_{out}, of the operations and verify by converting to decimal.

1011	1000	0011
+0111	+1111	+1010
-------	-------	-------

1.

$$\begin{array}{r} 1011 \\ +0111 \\ \hline 10010 \end{array}$$

$$\downarrow$$

$$\begin{array}{r} 11 \\ +\ 7 \\ \hline 18 \end{array}$$

a. $G_0 = C_{in} = 0$ $\quad P_0 = 0$ #

$G_1 = 1 \cdot 1 = 1$ $\quad P_1 = 1 \oplus 1 = 0$

$G_2 = 1 \cdot 1 = 1$ $\quad P_2 = 1 \oplus 1 = 0$

$G_3 = 0 \cdot 1 = 0$ $\quad P_3 = 0 \oplus 1 = 1$

$G_4 = 1 \cdot 0 = 0$ $\quad P_4 = 1 \oplus 0 = 1$

b. $G_{0:0} = G_0 = 0$

$G_{1:0} = G_{1:1} + P_{1:1} \cdot G_{0:1} = 1$

$G_{2:0} = G_{2:2} + P_{2:2} \cdot G_{1:0} = 1$

$G_{3:0} = G_{3:3} + P_{3:3} \cdot G_{2:0} = 0 + 1 = 1$

$G_{4:0} = G_{4:4} + P_{4:4} \cdot G_{3:0} = 0 + 1 = 1$

c. $S_1 = P_1 \oplus G_{0:0} = 0 \oplus 0 = 0$

$S_2 = P_2 \oplus G_{1:0} = 0 \oplus 1 = 1$

$S_3 = P_3 \oplus G_{2:0} = 1 \oplus 1 = 0$

$S_4 = P_4 \oplus G_{3:0} = 1 \oplus 1 = 0$

$C_{out} = G_{4:0} = 1$ ans = 10010 = 18

$$\begin{array}{r} 1000 \\ +1111 \\ \hline 10111 \end{array}$$

↓

$$\begin{array}{r} 8 \\ +15 \\ \hline 23. \end{array}$$

a. $G_0 = C_{in} = 0$ $P_0 = 0$

$G_1 = 0 \cdot 1 = 0$ $P_1 = 0 \oplus 1 = 1$

$G_2 = 0 \cdot 1 = 0$ $P_2 = 0 \oplus 1 = 1$

$G_3 = 0 \cdot 1 = 0$ $P_3 = 0 \oplus 1 = 1$

$G_4 = 1 \cdot 1 = 1$ $P_4 = 1 \oplus 1 = 0$

b. $G_{0:0} = 0$

$G_{1:0} = 0$

$G_{2:0} = 0$

$G_{3:0} = 0$

$G_{4:0} = 1$

c. $S_1 = 1$

$S_2 = 1$

$S_3 = 1$

$S_4 = 0$

$C_{out} = 1$

ans = 10111

0011
1010
1101

↓

3
+10
13

a. $G_0 = 0$ $P_0 = 0$

$G_1 = 0$ $P_1 = 1$

$G_2 = 1$ $P_2 = 0$

$G_3 = 0$ $P_3 = 0$

$G_4 = 0$ $P_4 = 1$

b. $G_{0:0} = 0$

$G_{1:0} = 0$

$G_{2:0} = 1$

$G_{3:0} = 0$

$G_{4:0} = 0$

c. $S_1 = 1$

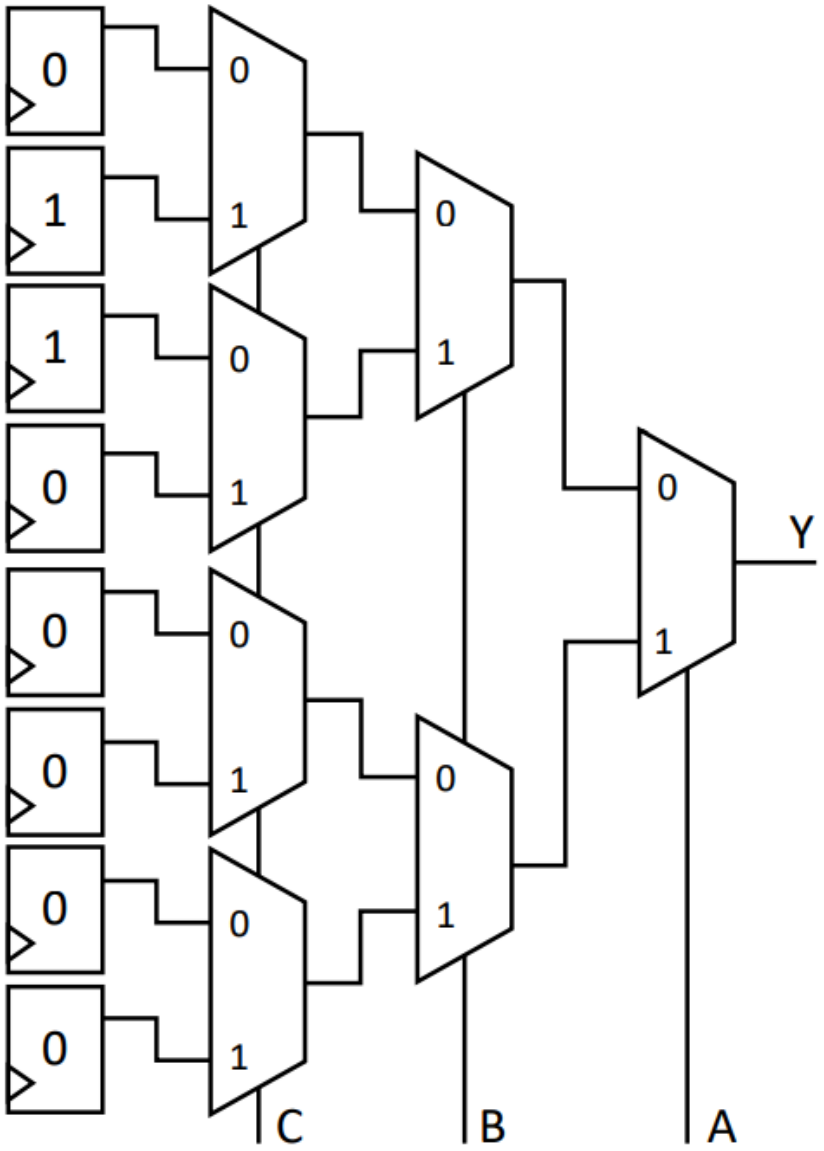
$S_2 = 0$

$S_3 = 1$

$S_4 = 1$

$C_{out} = 0$ ans = 1101

2. Find the logic operation implemented by the lookup table (LUT) depicted. A value inside a memory cell, indicates that that is the value stored in that cell.



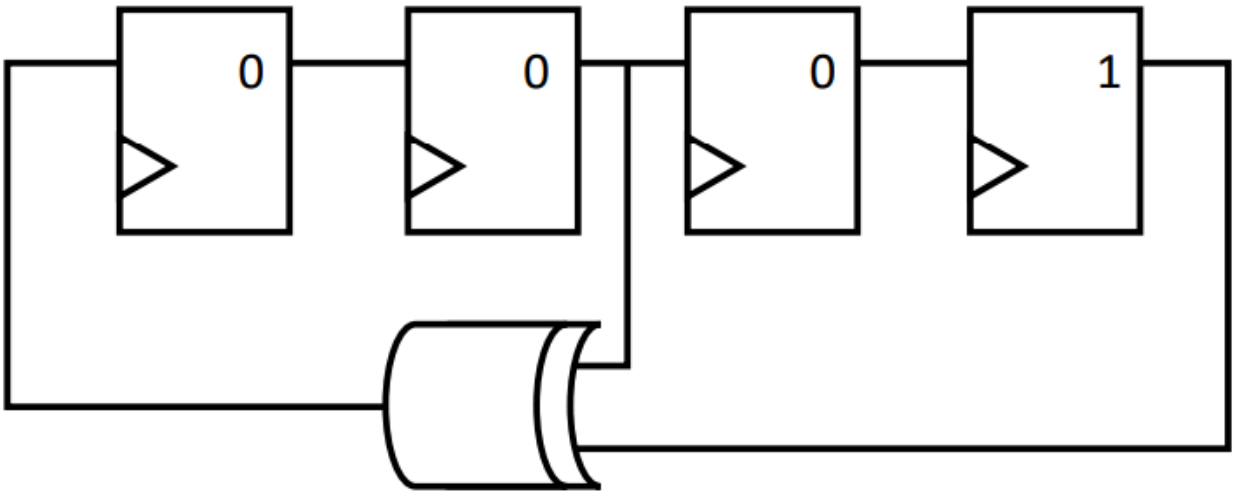
2. Truth Table.

A	B	C	Y	
0	0	0	0	looks like xor (B, C)
0	0	1	1	
0	1	0	1	
0	1	1	0	
1	0	0	0	looks like $\bar{A}$
1	0	1	0	
1	1	0	0	
1	1	1	0	

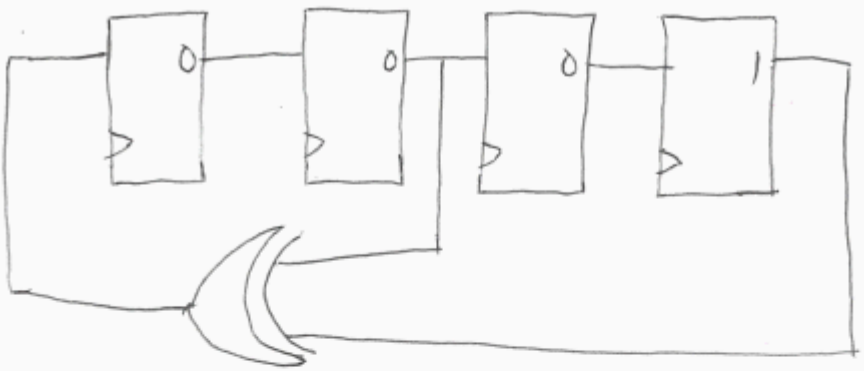
Answer → $\bar{A}(B \oplus C)$ [just one expression]

Other forms exist such as the minterm expression ($\bar{A}\bar{B}C + \bar{A}B\bar{C}$), Maxterm expression, etc.

3. Predict the output of the following LFSR assuming it starts in the 0001 state and has a steady clock input. What is the cycle length of this LFSR? Redesign the circuit so it has a cycle of maximal-length (length 15). (The weird-looking gate is an XOR)



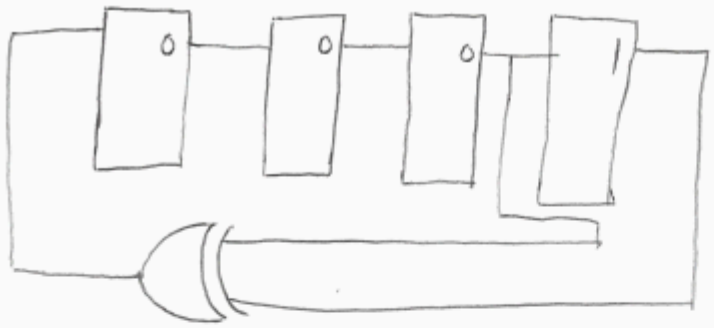
3.



→ 0 0 0 1
1 0 0 0
0 1 0 0
1 0 1 0
0 1 0 1
0 0 1 0
→ 0 0 0 1

cycle length = 6

6 steps to get back to the start



~~0 0 0 0~~

0 0 0 1
1 0 0 0
0 1 0 0
0 0 1 0
1 0 0 1
1 1 0 0
0 1 1 0
1 0 1 1
0 1 0 1
1 0 1 0
1 1 0 1
1 1 1 0
1 1 1 1

0 1 1 1
0 0 1 1
0 0 0 1

Cycle length = 15