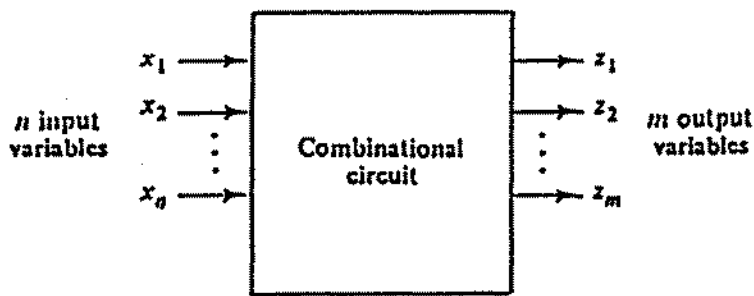


COMBINATIONAL CIRCUITS

Section 3.1

43

i.e.,

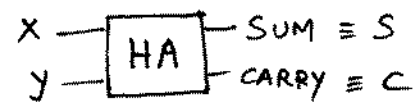


where $z_i = f(x_1, x_2, \dots, x_n), 1 \leq i \leq m$

HALF ADDER

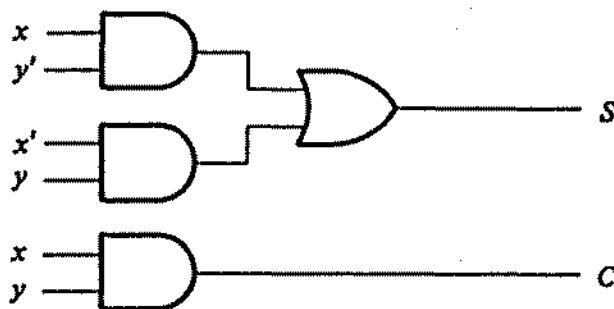
x	y	C	S
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

Section 3.8



$$S = x'y + xy' \quad \Leftarrow \sum m(1, 2)$$

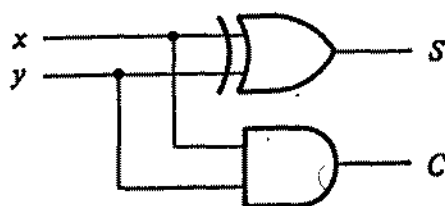
$$C = xy \quad \Leftarrow \sum m(3)$$



$$S = xy' + x'y$$

$$C = xy$$

exclusive or of x & y

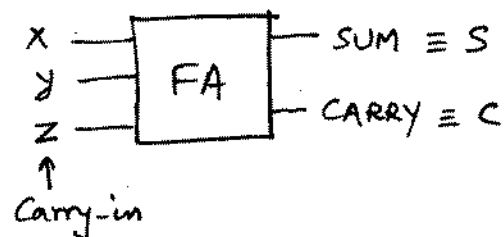


$$S = x \oplus y$$

$$C = xy$$

FULL ADDER

x	y	z	C	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

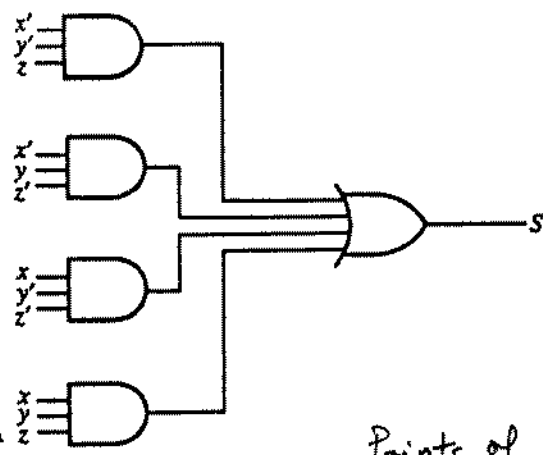


⑤

	yz	00	01	11	10
x	0		1		1
x	1	1		1	

$$S = x'y'z + x'yz' + xy'z' + xyz$$

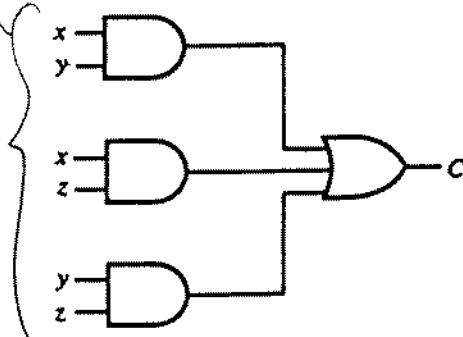
$$\begin{aligned}
 &= z'(x'y' + x'y) + z(xy' + xy) \\
 &= z'(x \oplus y) + z(xy' + xy) \\
 &= z(x \oplus y) + z(x \oplus y)'
 \end{aligned}$$



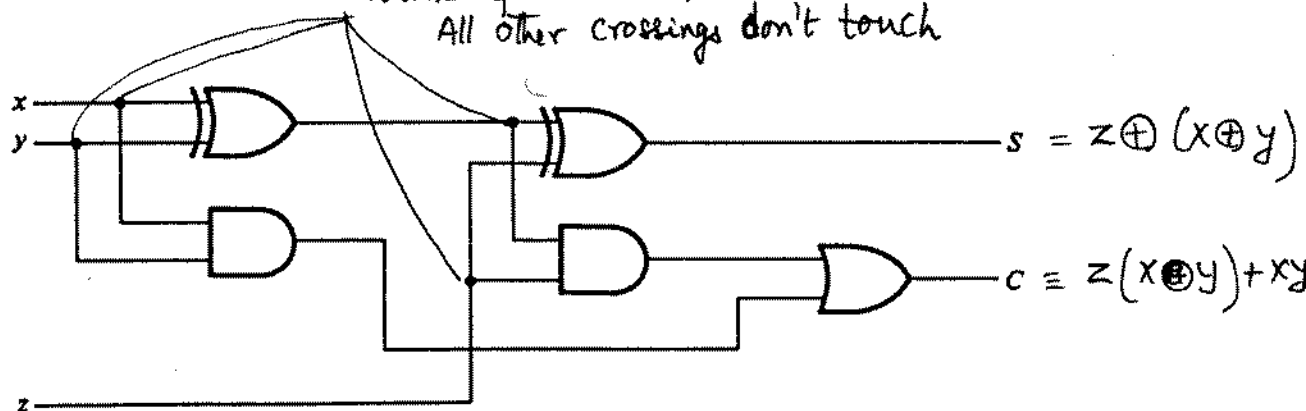
⑥

	yz	00	01	11	10
x	0			1	
x	1		1	1	1

$$\begin{aligned}
 C &= xy + xz + yz = z(xy' + x'y) + xy \\
 &= z(x \oplus y) + xy
 \end{aligned}$$



Points of Connection
All other crossings don't touch



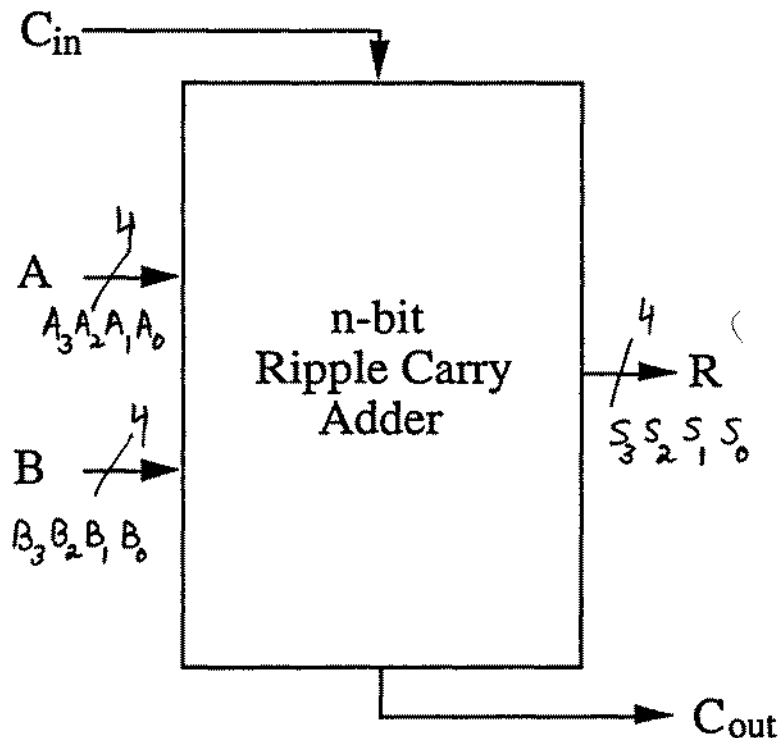
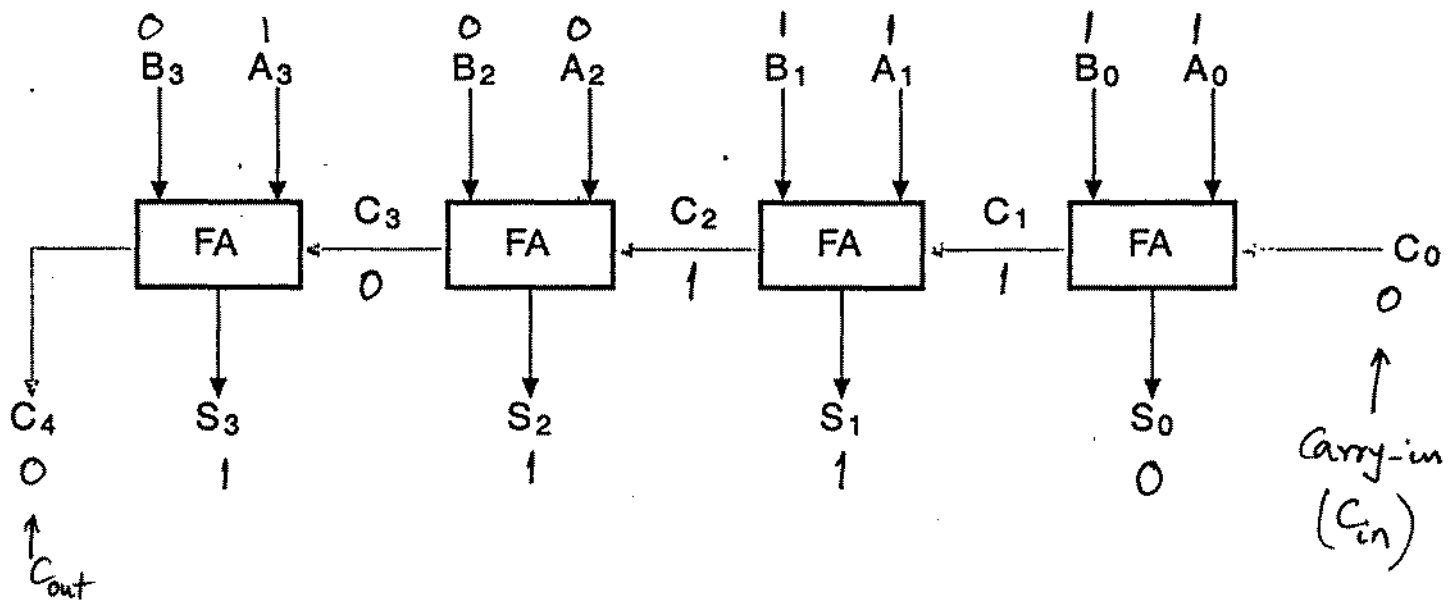
"PARALLEL" (RIPPLE CARRY) ADDER

Adds two sequence of bits

4-Bit Ripple Carry Adder

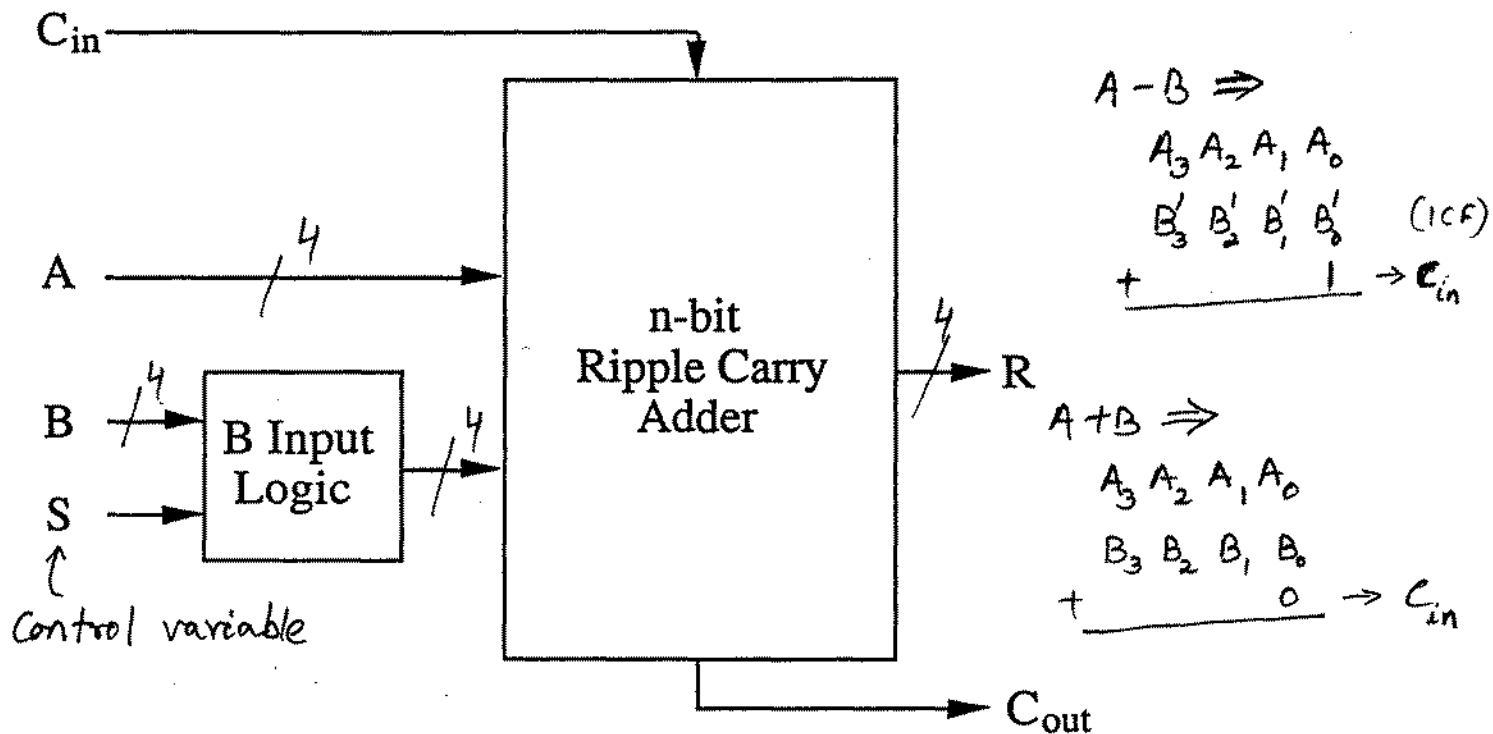
$$\begin{array}{r} A \\ + B \\ \hline R \end{array} \quad \begin{array}{r} A_3 A_2 A_1 A_0 \\ B_3 B_2 B_1 B_0 \\ \hline S_3 S_2 S_1 S_0 \end{array}$$

Ex: 1011
0011



ADDER/SUBTRACTOR

46

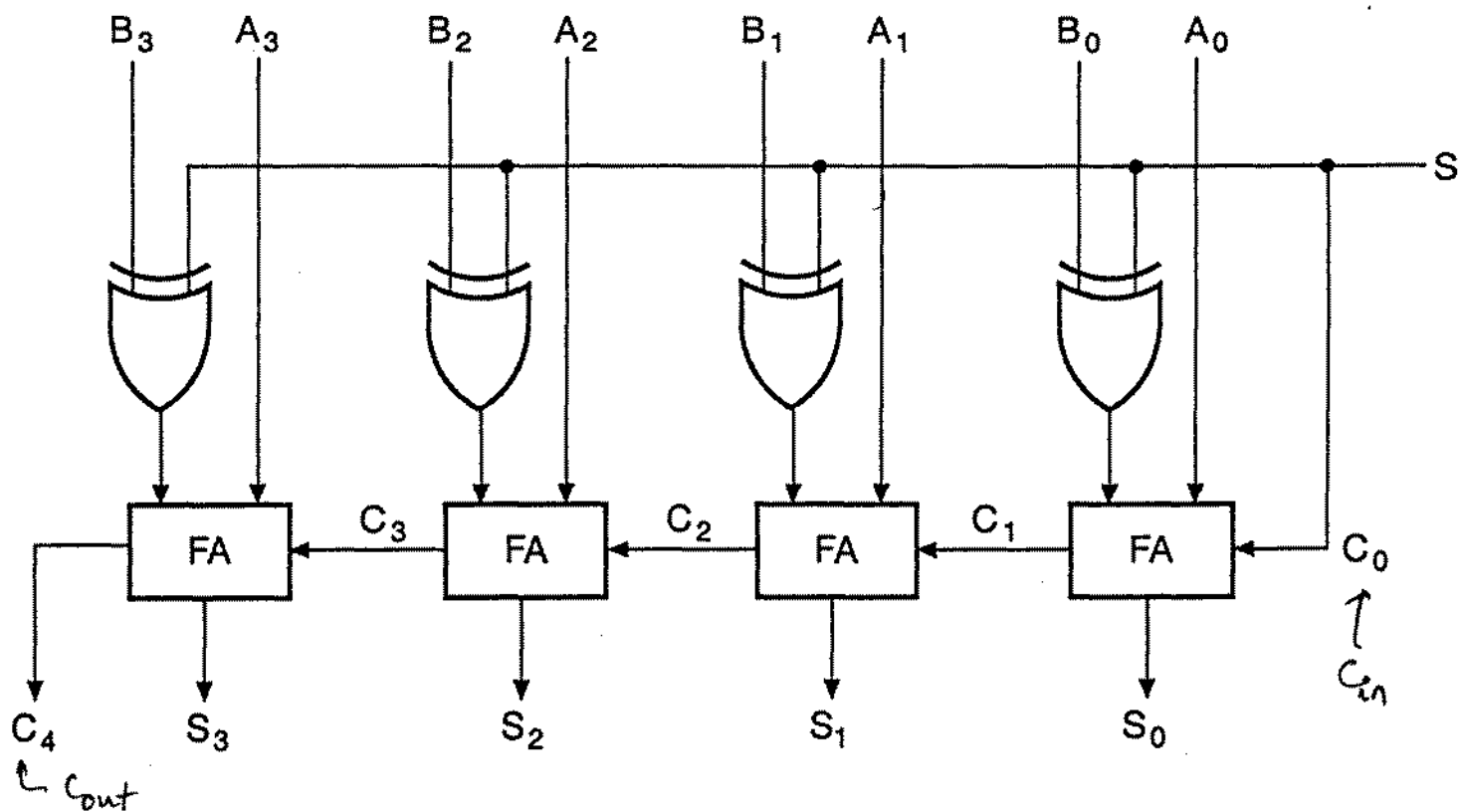


$S = 0 \Rightarrow$ ADDER (i.e. $A + B$ in 2CF)

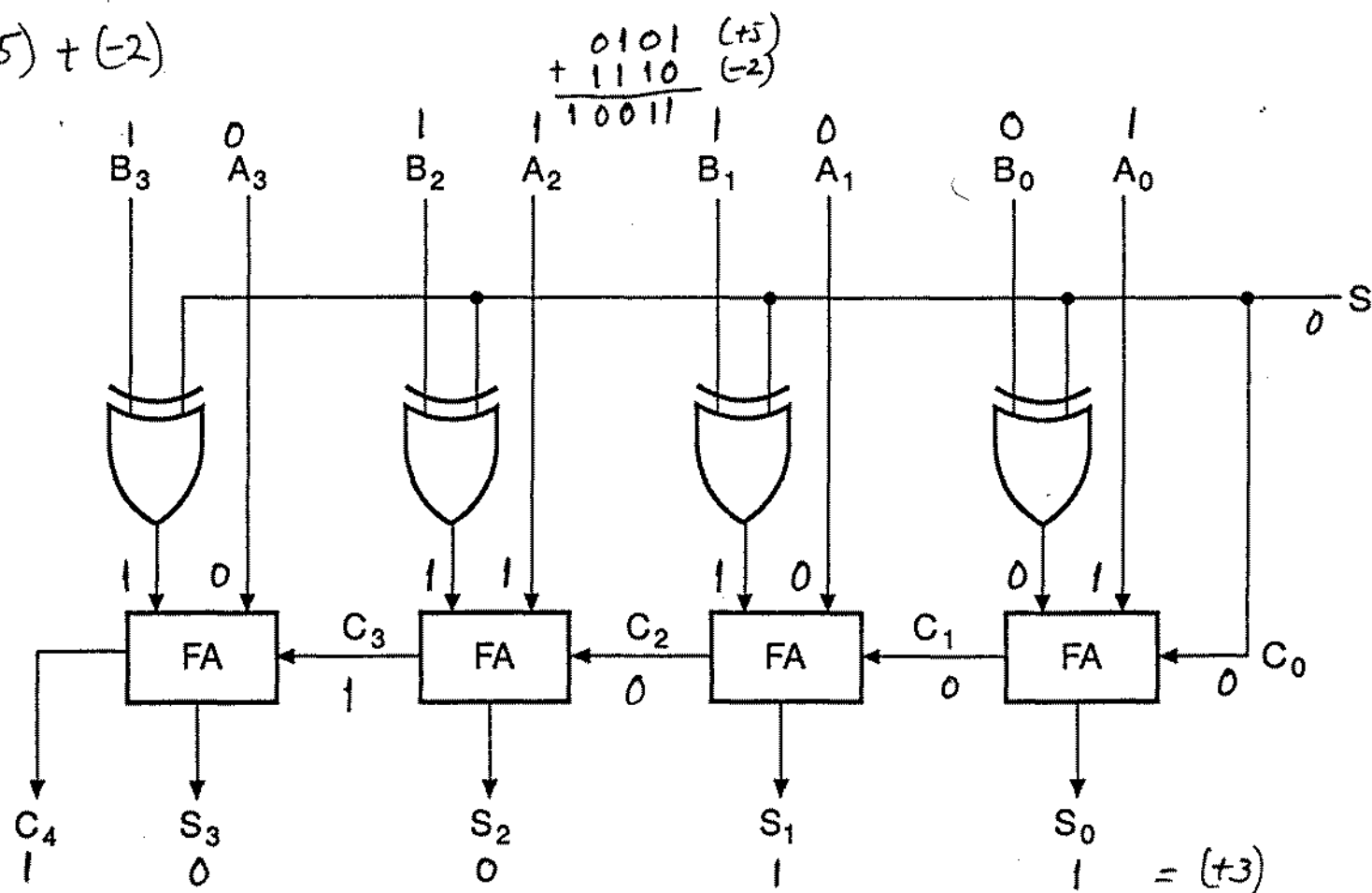
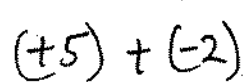
$S = 1 \Rightarrow$ SUBTRACTOR (i.e. $A - B$ in 2CF)

$$A - B = A + 2CF(B)$$

$$B_i \oplus 0 = B_i ; \quad B_i \oplus 1 = B'_i$$

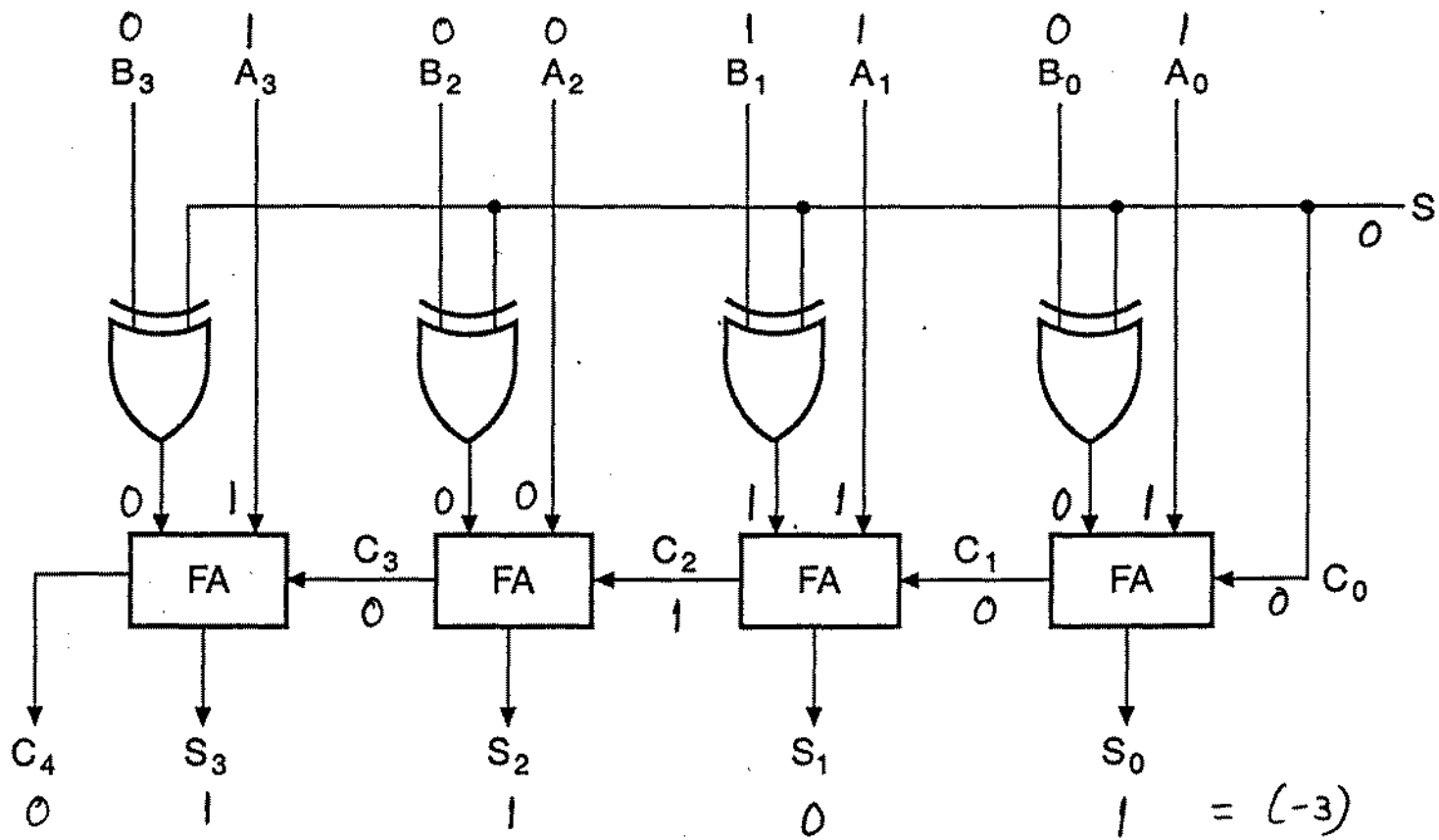


47



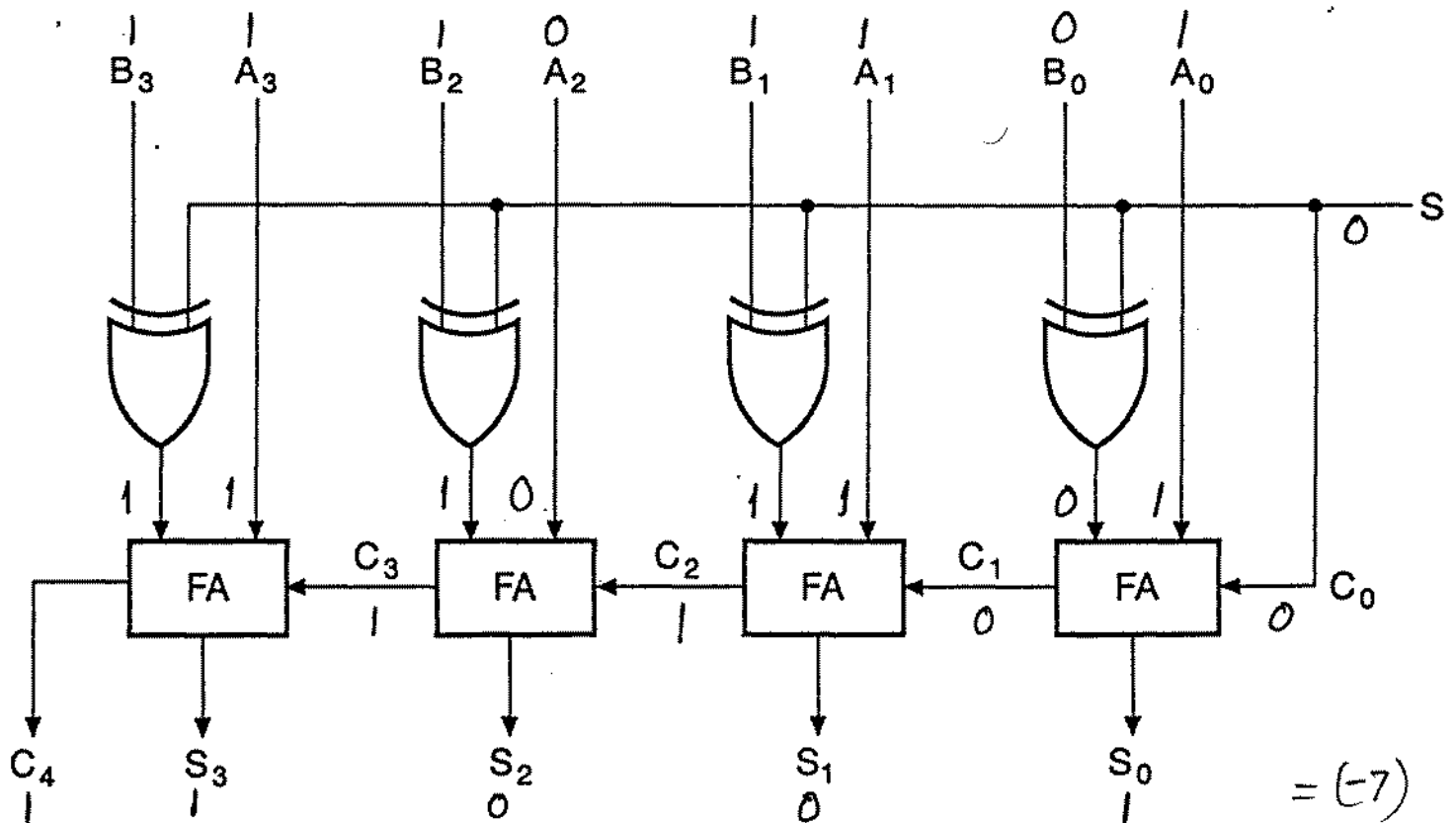
$$(-5) + (+2)$$

$$\begin{array}{r} 1011 \text{ } (-5) \\ + 0010 \text{ } (+2) \\ \hline 1101 \text{ } (-3) \end{array}$$



$$(-5) + (-2)$$

$$\begin{array}{r} 1011 \text{ } (-5) \\ + 1110 \text{ } (-2) \\ \hline 11001 \end{array}$$



$$(+5) - (+2)$$

$$S_0 = 1$$

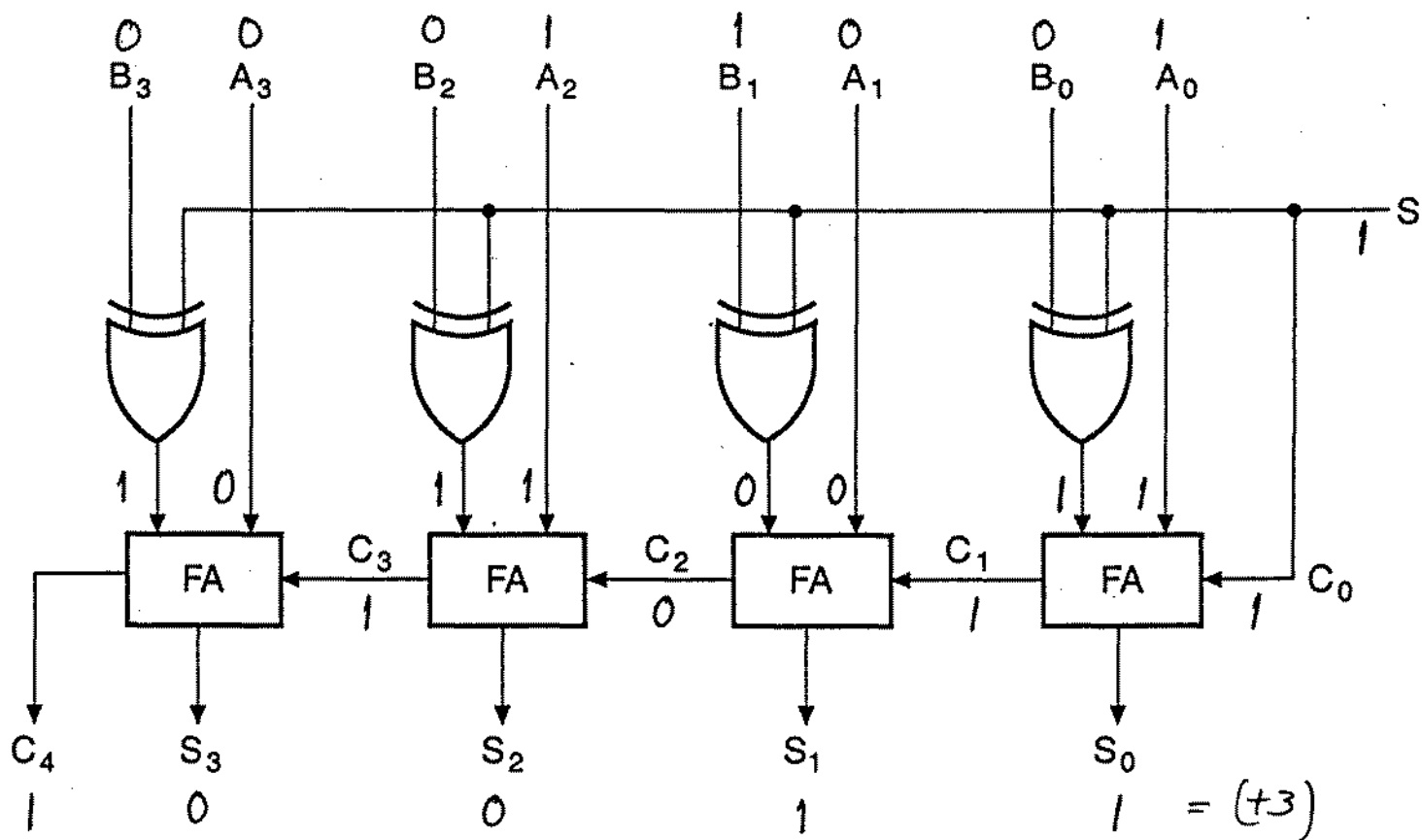
$$C_0 = 1$$

$$\begin{array}{r} 0101 \\ -0010 \\ \hline \end{array} \Rightarrow$$

$$\begin{array}{r} 0101 \\ 1110 \\ \hline 10011 \end{array}$$

(in 2CF)

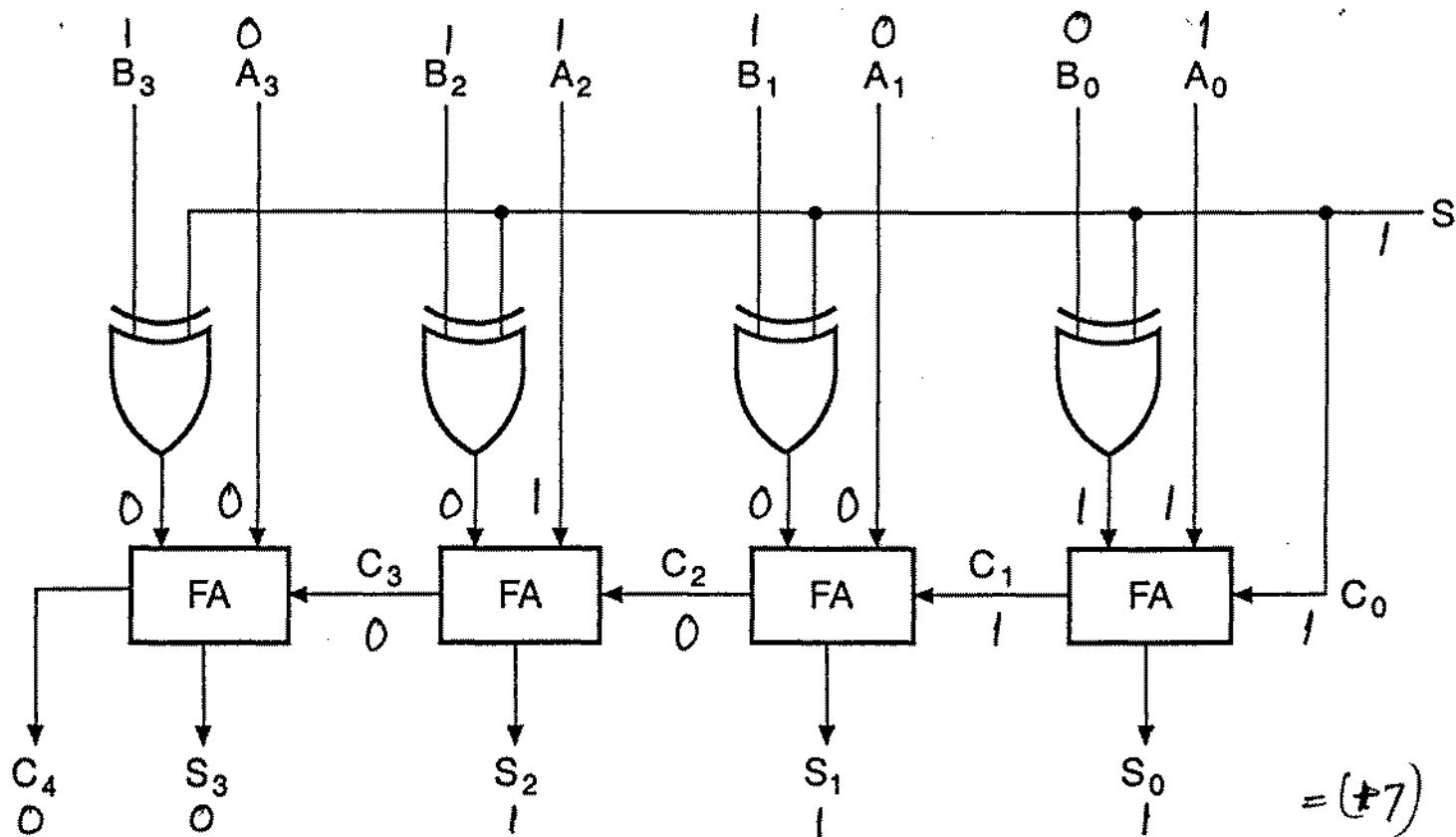
49



$$+5 - (-2)$$

$$\begin{array}{r} 0101 \\ -1110 \\ \hline \end{array} \Rightarrow$$

$$\begin{array}{r} 0101 \\ 0010 \\ \hline 0111 \end{array}$$



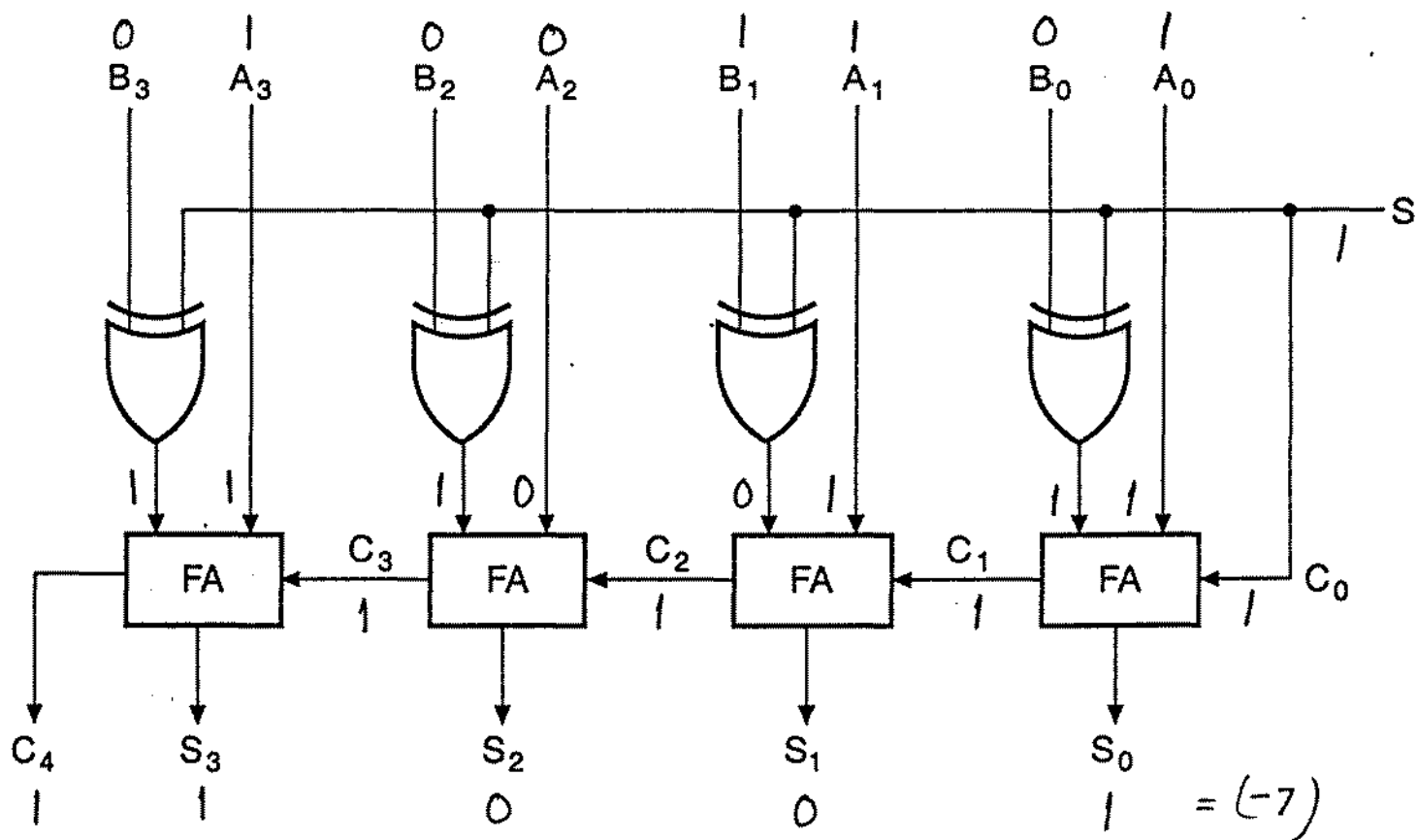
$$(-5) - (+2)$$

$$\begin{array}{r} 1011 \\ - 0010 \\ \hline 1001 \end{array}$$

 $\Rightarrow$

$$\begin{array}{r} 1011 \\ + 1110 \\ \hline 11001 \end{array}$$

50



$$(-5) - (-2)$$

