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Question

Consider three 4-variable functions f_1, f_2, f_3 expressed as sum-of-minterms:

$$f_1 = \Sigma(0, 2, 5, 8, 14), \quad f_2 = \Sigma(2, 3, 6, 8, 14, 15), \quad f_3 = \Sigma(2, 7, 11, 14)$$

For the circuit with one AND and one XOR gate shown below, express the output function f:

$$f = (f_1 \cdot f_2) \oplus f_3$$

Solution

Step 1: Calculate $f_1 \cdot f_2$ (AND of minterms)

$$f_1 = \{0, 2, 5, 8, 14\}, \quad f_2 = \{2, 3, 6, 8, 14, 15\}$$

Intersection (AND):

$$f_1 \cdot f_2 = \{2, 8, 14\}$$

Step 2: XOR with $f_3 = \{2, 7, 11, 14\}$ yields

$$f = \{2, 8, 14\} \oplus \{2, 7, 11, 14\} = \{7, 8, 11\}$$

Therefore:

$$f = \Sigma(7, 8, 11)$$

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Truth Table for Inputs $x_3x_2x_1x_0$ and Output f

x_3	x_2	x_1	x_0	Decimal	f
0	0	0	0	0	0
0	0	0	1	1	0
0	0	1	0	2	0
0	0	1	1	3	0
0	1	0	0	4	0
0	1	0	1	5	0
0	1	1	0	6	0
0	1	1	1	7	1
1	0	0	0	8	1
1	0	0	1	9	0
1	0	1	0	10	0
1	0	1	1	11	1
1	1	0	0	12	0
1	1	0	1	13	0
1	1	1	0	14	0
1	1	1	1	15	0

The output function f after combining f_1, f_2, f_3 as given is:

$$f = \Sigma(7, 8, 11)$$

Option (A) is correct.