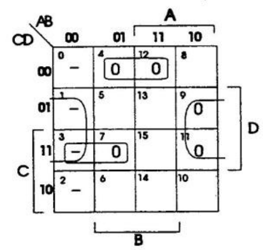
3.53 Determine the minimum POS form for the following functions.

(a)
$$\begin{aligned} f(A,B,C,D) &= \prod M(4,7,9,11,12)\cdot D(0,1,2,3) \\ &= (\bar{B}+C+D)(B+\bar{D})(A+\bar{C}+\bar{D}) \end{aligned}$$



CHAPTER 4 PROBLEMS

4.1 Derive switching expressions for outputs 5 and 11 of the 74154 decoder module. Using these expressions, describe the operation of the decoder and the function of the enable inputs.

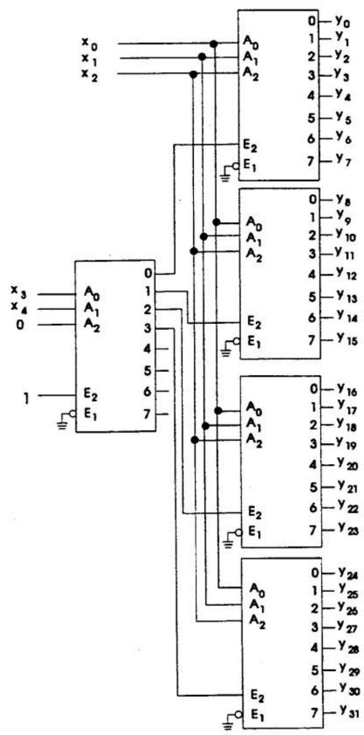
Output 5: $\overline{(\overline{G1} \cdot \overline{G2})\bar{D}C\bar{B}A} = \overline{(\overline{G1} \cdot \overline{G2}) \cdot m_5}$

Output 11: $\overline{(\overline{G1} \cdot \overline{G2})D\bar{C}BA} = \overline{(\overline{G1} \cdot \overline{G2}) \cdot m_{11}}$

When $G1 = 1$ or $G2 = 1$, $(\overline{G1} \cdot \overline{G2}) = 0$, and all outputs are 1 (disabled).

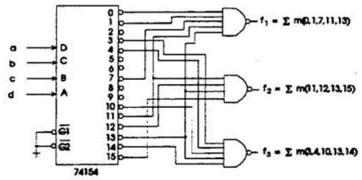
When $G1 = 0$ and $G1 = 0$, $(\overline{G1} \cdot \overline{G2}) = 1$, and the outputs correspond to minterms.

4.3 Design a 5-to-32 decoder using only 3-to-8 decoder modules. Assume that each 3-to-8 decoder has one active-low enable input, $\bar{E}_1$, and one active-high enable input, E_2.

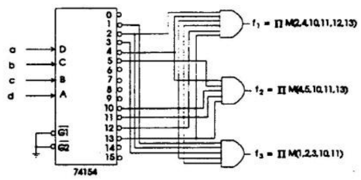


4.4 (b)

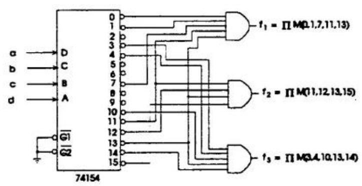
$$
\begin{aligned}
f_1(a,b,c,d) &= \sum m(0,1,7,13) \\
f_2(a,b,c,d) &= ab\bar{c} + acd = \sum m(11,12,13,15) \\
f_3(a,b,c,d) &= \prod M(0-2,5-9,11,12,15) = \sum m(3,4,10,13,14)
\end{aligned}
$$



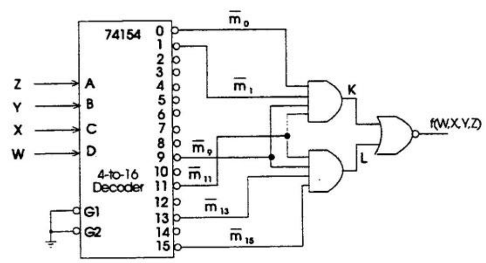
c. Repeat part (a) for the complements of the three functions.



d. Repeat part (b) for the complements of the three functions.



4.5 Given the circuit of Fig. P4.5, with the decoder having active low outputs as shown, find the minimum switching expression for $f(W,X,Y,Z)$ in SOP form.



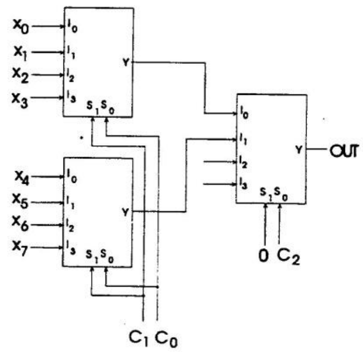
$$
\begin{aligned}
f(W,X,Y,Z) &= \overline{K+L} \\
&= (\overline{\bar{m}_0\bar{m}_1\bar{m}_9\bar{m}_{11}})(\overline{\bar{m}_9\bar{m}_{11}\bar{m}_{13}\bar{m}_{15}}) \\
&= (m_0+m_1+m_9+m_{11})(m_9+m_{11}+m_{13}+m_{15}) \\
&= m_9+m_{11} \\
&= W\bar{X}\bar{Y}Z + W\bar{X}YZ \\
&= W\bar{X}Z
\end{aligned}
$$

4.11 The 74147 ten-line priority encoder has active-low inputs and outputs. Determine the output, $DCBA$, of the module for the following input combinations.

(a) $(0, 1, \ldots, 9) = (1,0,0,0,0,0,1,1,1,1)$
Input 5 is the highest numbered active input. Therefore, $DCBA = \bar{0}\bar{1}\bar{0}\bar{1} = 1010$.

(b) $(0, 1, \ldots, 9) = (1,0,0,0,1,0,0,0,1,0)$
Input 9 is the highest numbered active input. Therefore, $DCBA = \bar{1}\bar{0}\bar{0}\bar{1} = 0110$.

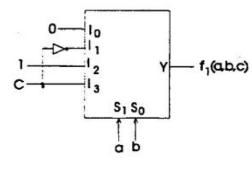
4.15 Design an 8-to-1 multiplexer, using only 4-to-1 multiplexer modules without enable lines. (Do not use any additional gates.)



4.18 Realize the following functions with a four-to-one multiplexer module.

(a) $f_1(a,b,c) = \sum m(2,4,5,7)$
$= (\bar{a}\bar{b})\cdot 0 + (\bar{a}b)\bar{c} + (a\bar{b})\cdot 1 + (ab)c$

a	b	c	f_1	
0	0	0	0	$I_0 = 0$
0	0	1	0	
0	1	0	1	$I_1 = \bar{c}$
0	1	1	0	
1	0	0	1	$I_2 = 1$
1	0	1	1	
1	1	0	0	$I_3 = c$
1	1	1	1	



(b) $$f_2(a,b,c) = \prod M(0,6,7) = \sum m(1,2,3,4,5)$$
$$= (\bar{a}\bar{b})c + (\bar{a}b)\cdot 1 + (a\bar{b})\cdot 1 + (ab)\cdot 0$$

a	b	c	f_2	
0	0	0	0	$I_0 = c$
0	0	1	1	
0	1	0	1	$I_1 = 1$
0	1	1	1	
1	0	0	1	$I_2 = 1$
1	0	1	1	
1	1	0	0	$I_3 = 0$
1	1	1	0