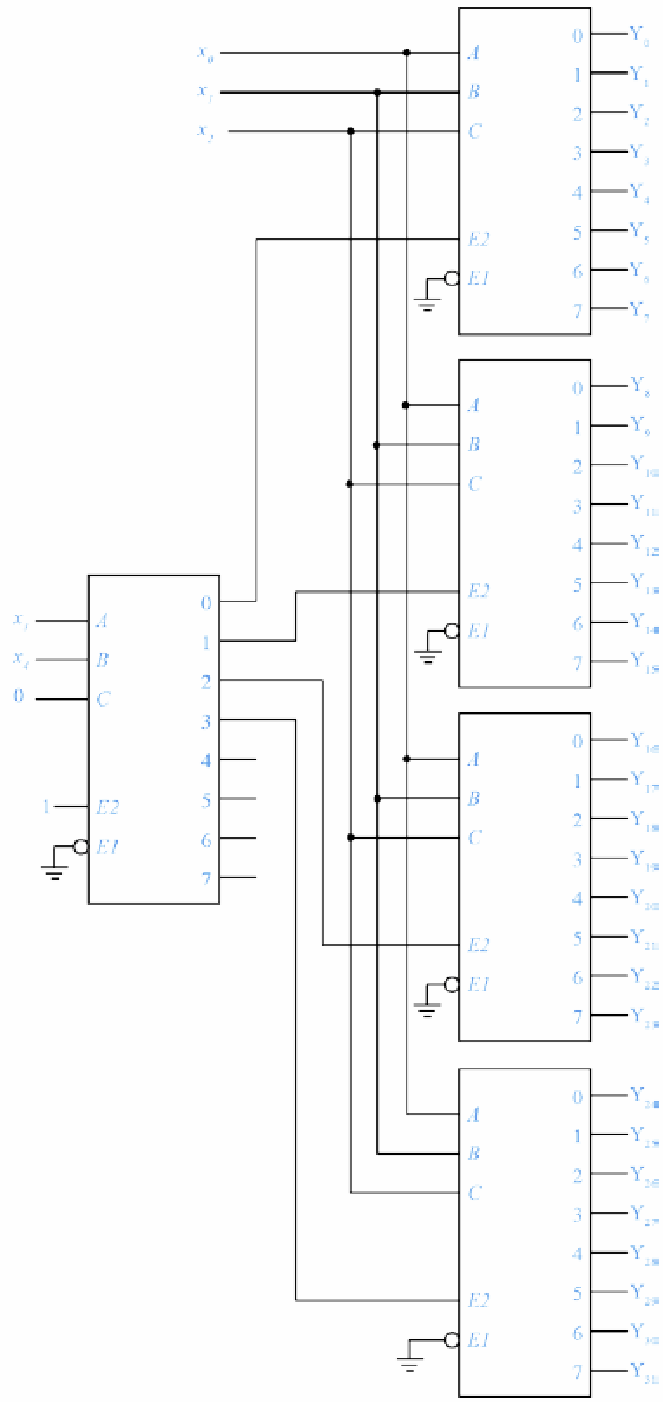
COEN/ELEN 921c

Homework Assignment 6
Solution

<u>Prob 1:</u>

Textbook 3.39 (inputs = { X4 X3 … X1 X0} ; Decoder inputs {C B A} C = msb)

3.39 Design a 5-to-32 decoder using 3-to-8 decoder modules as building blocks. Assume each 3-to-8 decoder has one active-low enable input, $\overline{E}_1$, and one active-high enable input, E_2.

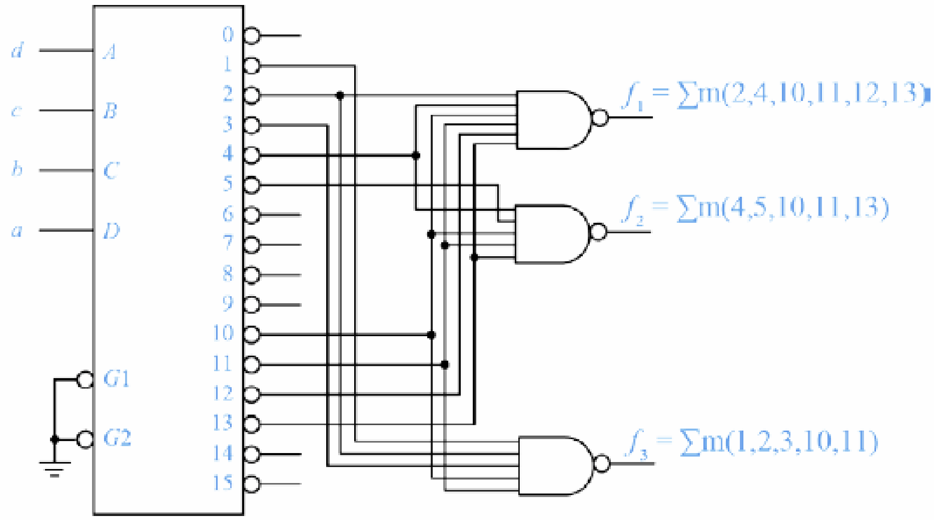


Prob 2:

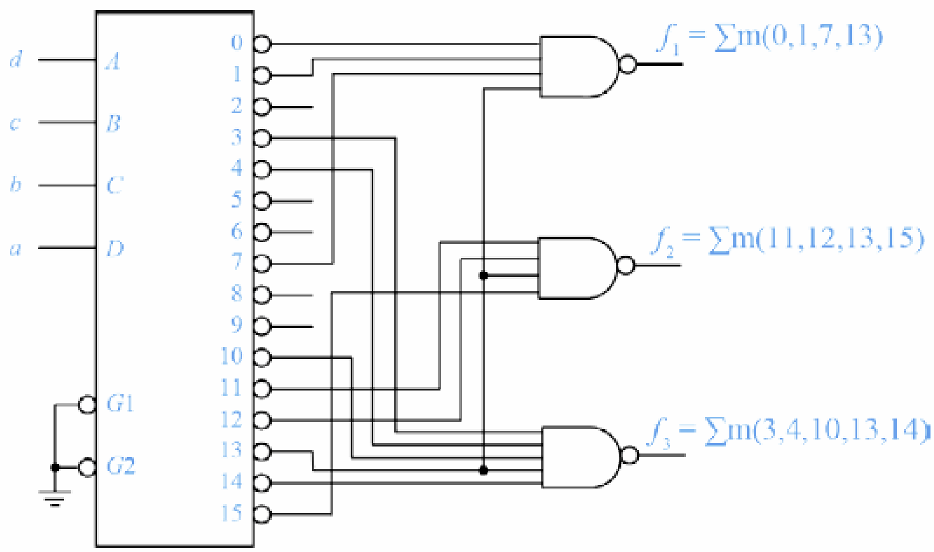
Textbook 3.40

3.40 Realize each of the following sets of functions using a 4-to-16 decoder module and output logic gates (choose NAND or AND gates to minimize the fan-in of the output gates).

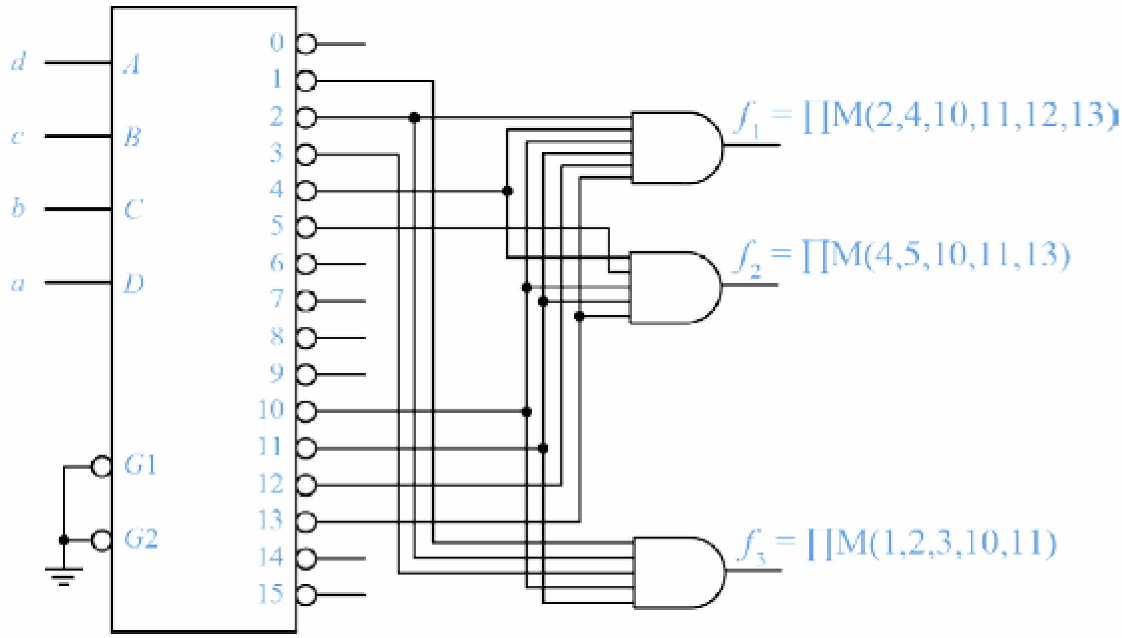
(a) $f_1(a,b,c,d) = \sum m(2,4,10,11,12,13)$
$f_2(a,b,c,d) = \prod M(0-3,6-9,12,14,15) = \sum m(4,5,10,11,13)$
$f_3(a,b,c,d) = \bar{b}c + \bar{a}\bar{b}d = \sum m(1,2,3,10,11)$



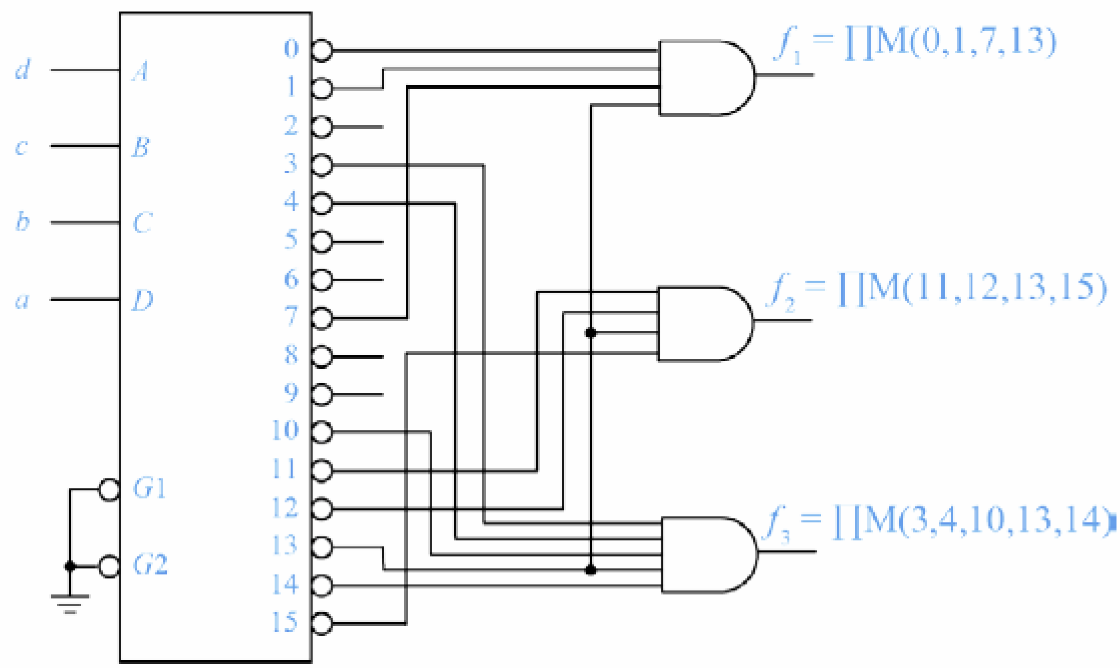
(b) $f_1(a,b,c,d) = \sum m(0,1,7,13)$
$f_2(a,b,c,d) = ab\bar{c} + acd = \sum m(11,12,13,15)$
$f_3(a,b,c,d) = \prod M(0,1,2,5,6,7,8,9,11,12,15) = \sum m(3,4,10,13,14)$



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



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



Prob 3: Textbook 3.61

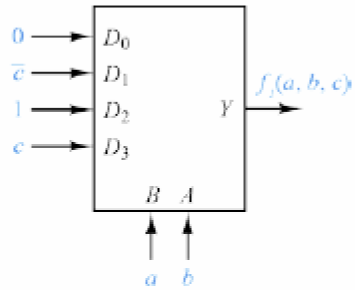
3.61 Realize each of the following functions with a 4-to-1 multiplexer module.

(a) $f_1(a,b,c) = \sum m(2,4,5,7)$

$$= \bar{a}b\bar{c} + a\bar{b}\bar{c} + a\bar{b}c + abc$$

$$= (\bar{a}\bar{b})\cdot 0 + (\bar{a}b)\bar{c} + (a\bar{b})\cdot 1 + (ab)c$$

a	b	c	f_i	
0	0	0	0	$D_0 = 0$
0	0	1	0	
0	1	0	1	$D_1 = \bar{c}$
0	1	1	0	
1	0	0	1	$D_2 = 1$
1	0	1	1	
1	1	0	0	$D_3 = c$
1	1	1	1	

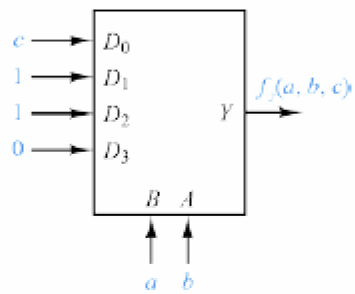


(b) $f_2(a,b,c) = \prod M(0,6,7) = \sum m(1,2,3,4,5)$

$$= \bar{a}\bar{b}c + \bar{a}b\bar{c} + \bar{a}bc + a\bar{b}\bar{c} + a\bar{b}c$$

$$= (\bar{a}\bar{b})c + (\bar{a}b)\cdot 1 + (a\bar{b})\cdot 1 + (ab)\cdot 0$$

a	b	c	f_i	
0	0	0	0	$D_0 = c$
0	0	1	0	
0	1	0	1	$D_1 = 1$
0	1	1	0	
1	0	0	1	$D_2 = 1$
1	0	1	1	
1	1	0	0	$D_3 = 0$
1	1	1	1	



(c) $f_3(a,b,c) = (a+\bar{b})(\bar{b}+c)$

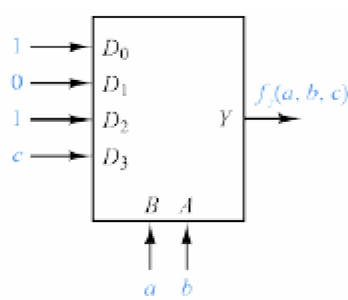
$$= (a+\bar{b}+\bar{c})(a+\bar{b}+c)(\bar{a}+\bar{b}+c)(a+\bar{b}+c)$$

$$= \prod M(2,3,6,) = \sum m(0,1,4,5,7)$$

$$= \bar{a}\bar{b}\bar{c} + \bar{a}\bar{b}c + a\bar{b}\bar{c} + a\bar{b}c + abc$$

$$= (\bar{a}\bar{b})\cdot 1 + (\bar{a}b)\cdot 0 + (a\bar{b})\cdot 1 + (ab)c$$

a	b	c	f_i	
0	0	0	0	$D_0 = 1$
0	0	1	0	
0	1	0	1	$D_1 = 0$
0	1	1	0	
1	0	0	1	$D_2 = 1$
1	0	1	1	
1	1	0	0	$D_3 = c$
1	1	1	1	

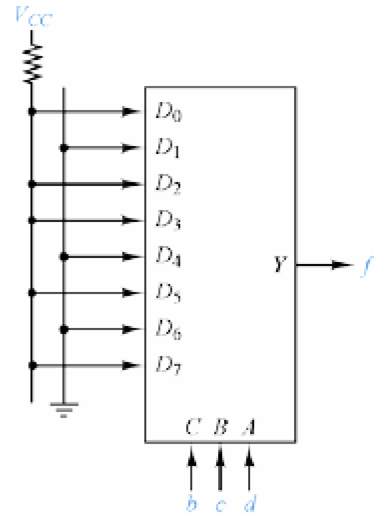


<u>Prob 4</u>: Textbook 3.62

3.62 Realize each of the following functions with an 8-to-1 multiplexer module.

(a) $f(b,c,d) = \sum m(0,2,3,5,7)$

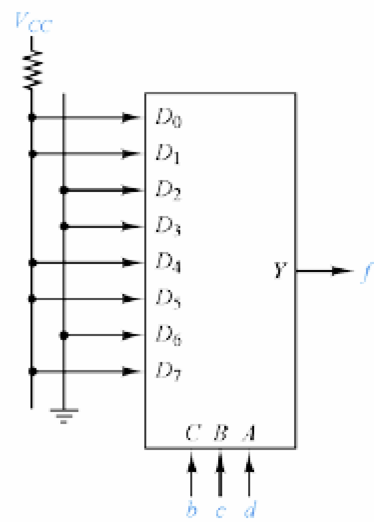
i	C	B	A	Y	
	b	c	d	f	
0	0	0	0	1	$D_0 = 1$
1	0	0	1	0	$D_1 = 0$
2	0	1	0	1	$D_2 = 1$
3	0	1	1	1	$D_3 = 1$
4	1	0	0	0	$D_4 = 0$
5	1	0	1	1	$D_5 = 1$
6	1	1	0	0	$D_6 = 0$
7	1	1	1	1	$D_7 = 1$



(b) $f(b,c,d) = \bar{c} + b = (b + \bar{c} + \bar{d})(b + \bar{c} + d)$

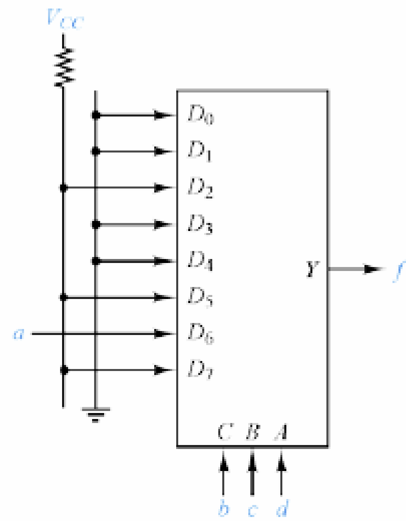
$= \prod M(2,3) = \sum m(0,1,4,5,7)$

i	C	B	A	Y	
	b	c	d	f	
0	0	0	0	1	$D_0 = 1$
1	0	0	1	1	$D_1 = 0$
2	0	1	0	0	$D_2 = 1$
3	0	1	1	0	$D_3 = 1$
4	1	0	0	1	$D_4 = 0$
5	1	0	1	1	$D_5 = 1$
6	1	1	0	0	$D_6 = 0$
7	1	1	1	1	$D_7 = 1$



(c) $f(a,b,c,d) = \prod M(0,1,2,3,6,7,8,9,12,14,15)$

i		C	B	A	Y	
	a	b	c	d	f	
0	0	0	0	0	0	$D_0 = 0$
1	0	0	0	1	0	
2	0	0	1	0	0	$D_1 = 0$
3	0	0	1	1	0	
4	0	1	0	0	1	$D_2 = 1$
5	0	1	0	1	1	
6	0	1	1	0	0	$D_3 = 0$
7	0	1	1	1	0	
8	1	0	0	0	0	$D_4 = 0$
9	1	0	0	1	0	
10	1	0	1	0	1	$D_5 = 1$
11	1	0	1	1	1	
12	1	1	0	0	0	$D_6 = a$
13	1	1	0	1	1	
14	1	1	1	0	0	$D_7 = 0$
15	1	1	1	1	0	



Prob 5: Texttbook 3.68

3.68 Design a full adder module with data inputs A and B, carry input C_{in}, sum output S, and carry output C_{out}.

$A\,B\,C_{in}$	C_{out} S
000	0 0
001	0 1
010	0 1
011	1 0
100	0 1
101	1 0
110	1 0
111	1 1

(a) Use a 3-to-8 decoder and NAND gates (b) Use a four-input, 2-bit multiplexer