ECE 2300
Digital Logic Design

Homework 5

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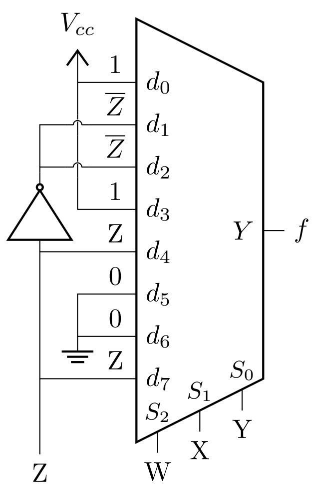
1 Using an 8:1 mux, create a circuit to generate

$$f(WXYZ) = \overline{W} \cdot \overline{Z} + \overline{X} \cdot \overline{Y} \cdot Z + X \cdot Y \cdot Z$$

W	X	Y	Z	f
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1

W	X	Y	Z	f
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1



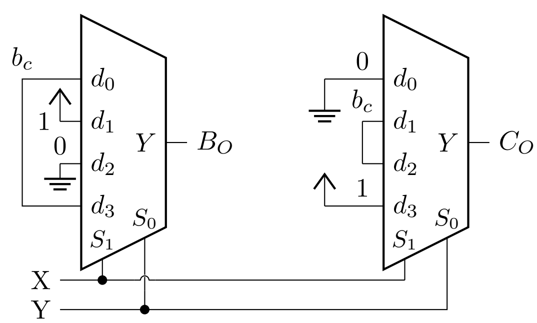
2 Using two 4:1 muxes, generate the B_O (Borrow-Out) and C_O (Carry-Out) outputs for a 1-bit full subtractor and 1-bit full adder respectively where X is the minuend, Y is the subtrahend or Y and Y are the addends and bc is the borrow-in or carry-in.

$$B_O = \overline{X} \cdot b_c + \overline{X} \cdot Y + Y \cdot b_c$$

$$C_O = X \cdot Y + X \cdot b_c + Y \cdot b_c$$

X	Y	b_c	B_O	C_O
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	1	1

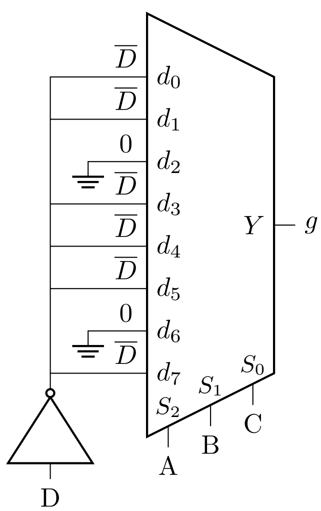
X	Y	b_c	B_O	C_O
1	0	0	0	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1



3 Using an 8:1 mux, create a circuit to generate the segment g outputs for a 7-segment display where $g = \overline{B} \cdot \overline{D} + C \cdot \overline{D}$.

A	B	C	D	g
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	0

A	B	C	D	g
1	0	0	0	1
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	1	0
1	1	0	0	0
1	1	1	0	1
1	1	1	1	0

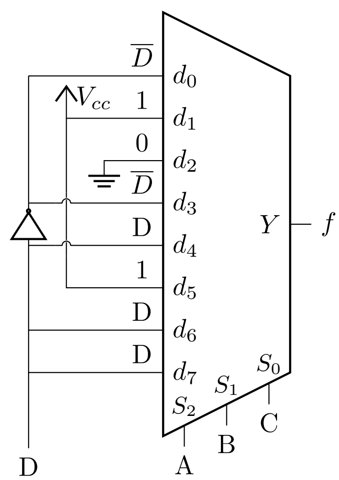


4 Using an 8:1 mux, create a circuit to generate

$$f(ABCD) = A \cdot D + \overline{A} \cdot \overline{B} \cdot \overline{D} + \overline{B} \cdot C + \overline{A} \cdot C \cdot \overline{D}$$

A	B	C	D	f
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	0

A	B	C	D	f
1	0	0	0	0
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1



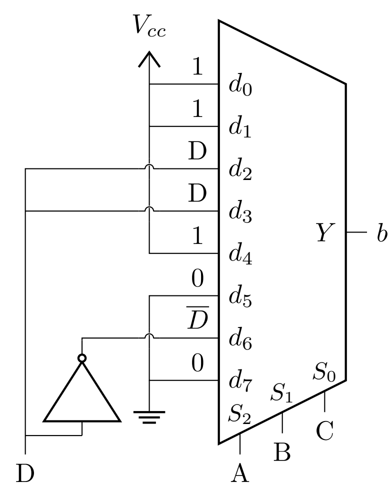
5 Using an 8:1 mux, create a circuit to generate the segment b outputs for a 7-segment display.

Given ABCD = 0, 1, 2, …, F, the segment b outputs are $(F9C8)_{16}$ (e.g. the MSB of $(F)_{16}$ = output for ABCD = $(0000)_2$ and the LSB of $(8)_{16}$ = output for ABCD = $(1111)_2$).

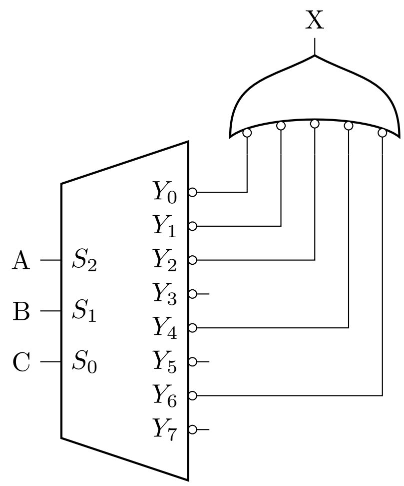
$$(F9C8)_{16} = (1111\,0101\,1100\,1000)_2$$

A	B	C	D	b
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1

A	B	C	D	b
1	0	0	0	1
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0



6 Given inputs A, B, and C where A is the MSB, use a 3:8 demux to generate $X = \sum(m_0, m_1, m_2, m_4, m_6)$



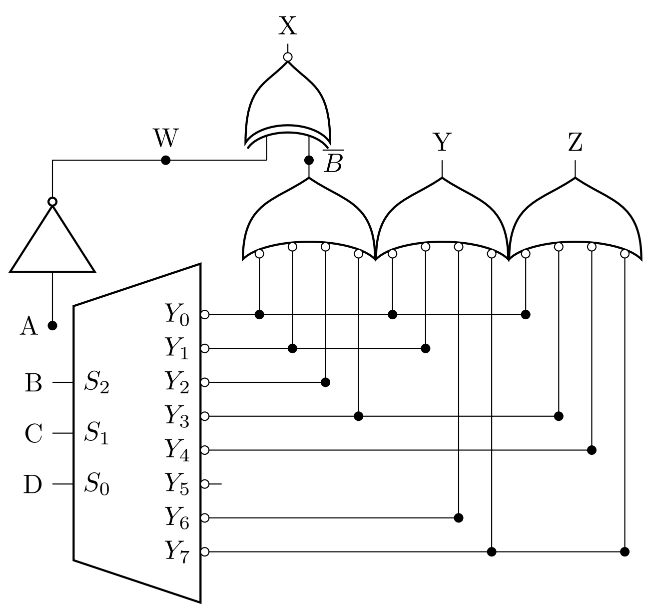
7 Using a 3:8 demux, generate a complemented Gray code

A	B	C	D	W	X	Y	Z
0	0	0	0	1	1	1	1
0	0	0	1	1	1	1	0
0	0	1	0	1	1	0	0
0	0	1	1	1	1	0	1
0	1	0	0	1	0	0	1
0	1	0	1	1	0	0	0
0	1	1	0	1	0	1	0
0	1	1	1	1	0	1	1

A	B	C	D	W	X	Y	Z
1	0	0	0	0	0	1	1
1	0	0	1	0	0	1	0
1	0	1	0	0	0	0	0
1	0	1	1	0	0	0	1
1	1	0	0	0	1	0	1
1	1	0	1	0	1	0	0
1	1	1	0	0	1	1	0
1	1	1	1	0	1	1	1

Observe that $\sum(m_0, m_1, m_2, m_3) = \overline{B}$, it can be decuced that $X = \overline{B} \otimes W$

$\overline{B}$	W	X
0	0	1
0	1	0
1	0	0
1	1	1

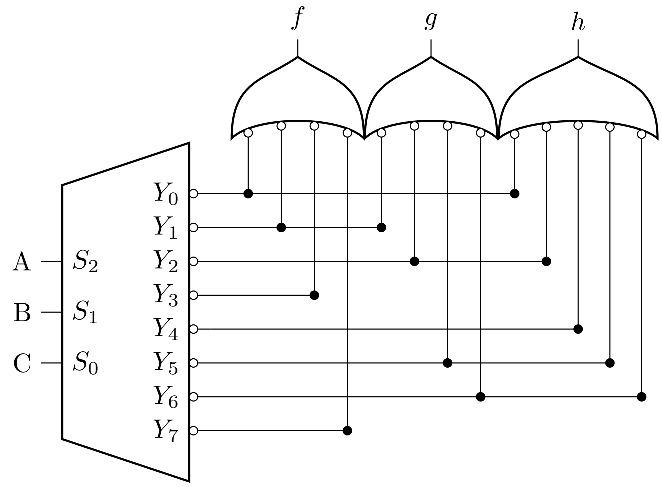


8 Using a 3:8 demux, generate these functions of A, B and C:

$$f = \sum(m_0, m_1, m_3, m_7)$$

$$g = \sum(m_1, m_2, m_5, m_6)$$

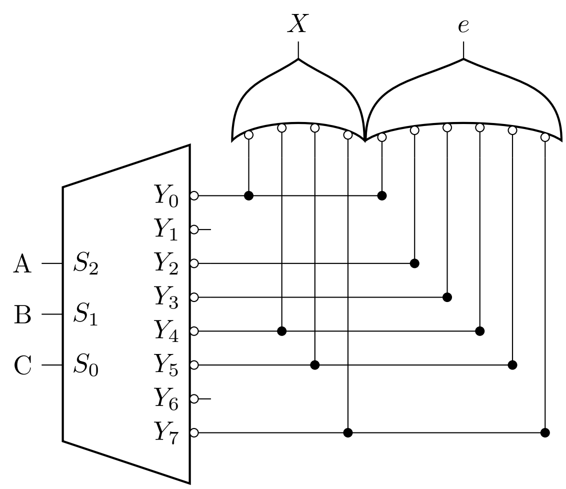
$$h = \sum(m_0, m_2, m_4, m_5, m_6)$$



9 Using a 3:8 demux generate the following truth table:

A	B	C	X	e
0	0	0	1	1
0	0	1	0	0
0	1	0	0	1
0	1	1	0	1

A	B	C	X	e
1	0	0	1	1
1	0	1	1	1
1	1	0	0	0
1	1	1	1	1



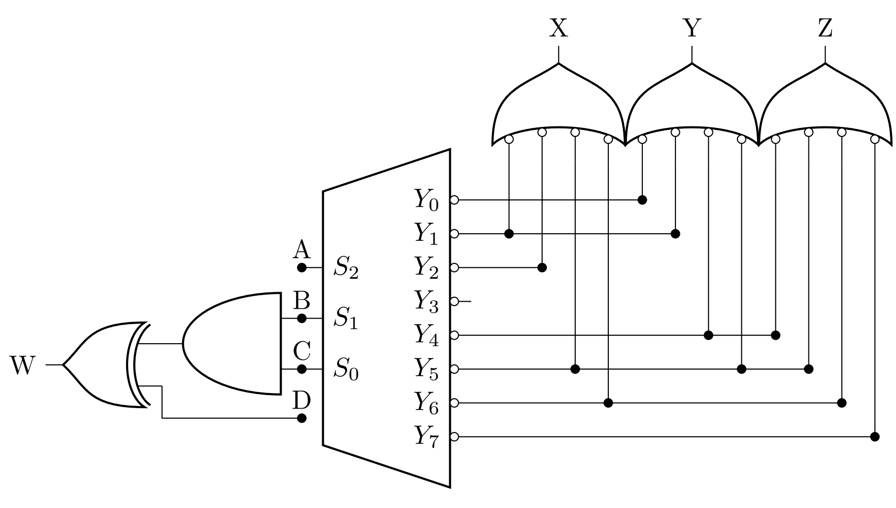
10.a Using a 3:8 demux, transpose input ABCD then add two, modulo 16 to created output WXYZ. (i.e. WXYZ = (DCBA + 2)mod 16).

A	B	C	D	W	X	Y	Z
0	0	0	0	0	0	1	0
0	0	0	1	1	0	1	0
0	0	1	0	0	1	1	0
0	0	1	1	1	1	1	0
0	1	0	0	0	1	0	0
0	1	0	1	1	1	0	0
0	1	1	0	1	0	0	0
0	1	1	1	0	0	0	0

A	B	C	D	W	X	Y	Z
1	0	0	0	0	0	1	1
1	0	0	1	1	0	1	1
1	0	1	0	0	1	1	1
1	0	1	1	1	1	1	1
1	1	0	0	0	1	0	1
1	1	0	1	1	1	0	1
1	1	1	0	1	0	0	1
1	1	1	1	0	0	0	1

Observing the truth table:

$$W = (B \cdot C) \oplus D$$



10.b This circuit can be simplified to remove the 3:8 demux. Draw the schematic for each output (W, X, Y and Z) using only the six basic Gates:

A	B	C	D	W	X	Y	Z
0	0	0	0	0	0	1	0
0	0	0	1	1	0	1	0
0	0	1	0	0	1	1	0
0	0	1	1	1	1	1	0
0	1	0	0	0	1	0	0
0	1	0	1	1	1	0	0
0	1	1	0	1	0	0	0
0	1	1	1	0	0	0	0

A	B	C	D	W	X	Y	Z
1	0	0	0	0	0	1	1
1	0	0	1	1	0	1	1
1	0	1	0	0	1	1	1
1	0	1	1	1	1	1	1
1	1	0	0	0	1	0	1
1	1	0	1	1	1	0	1
1	1	1	0	1	0	0	1
1	1	1	1	0	0	0	1

Observing the truth table:

$$W = (B \cdot C) \oplus D$$

$$X = B \oplus C$$

$$Y = \overline{B}$$

$$Z = A$$