MAGNITUDE COMPARATOR Problem 3.47

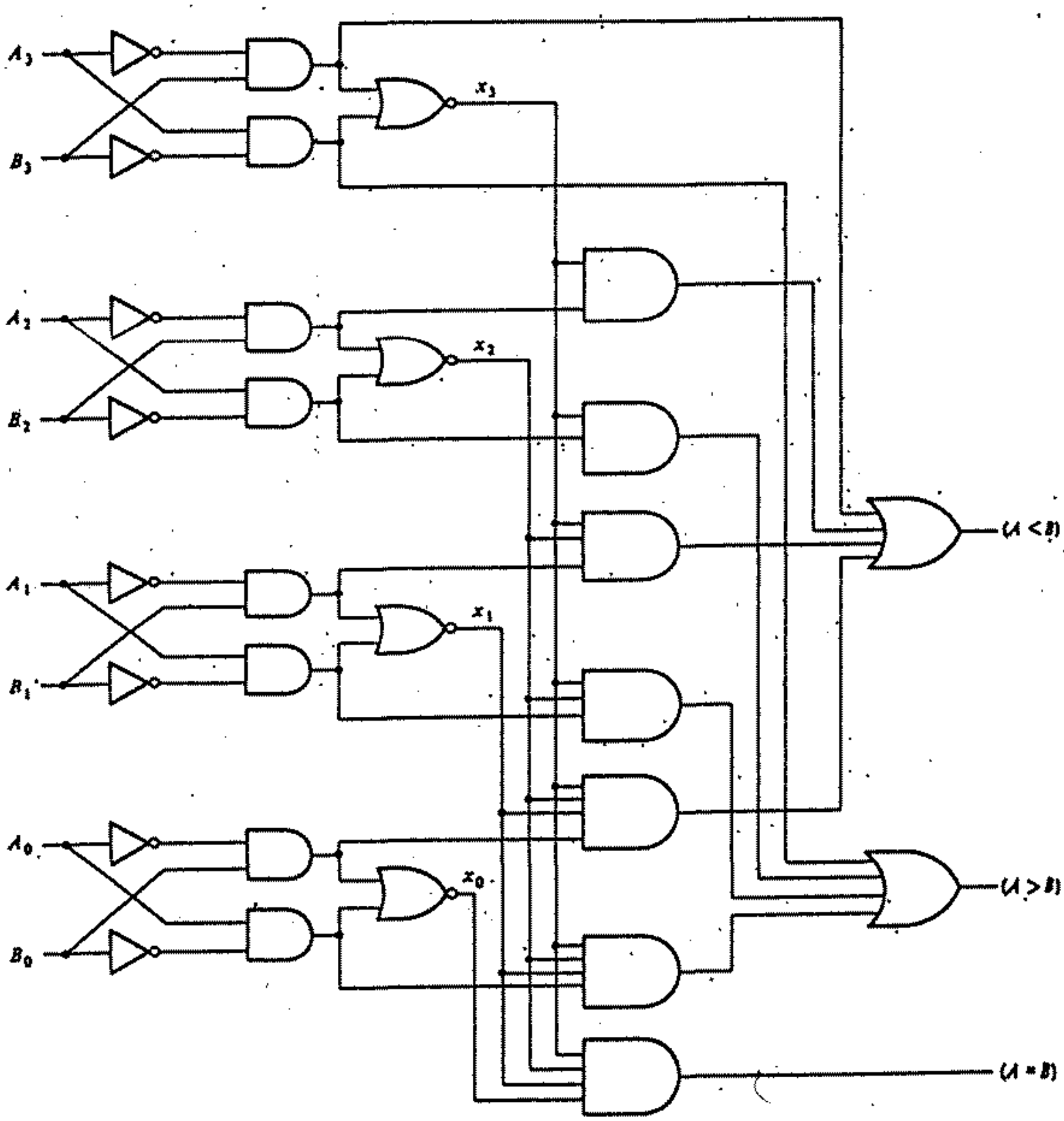
$\odot$ exclusive nor

$A = A_3 A_2 A_1 A_0$
$B = B_3 B_2 B_1 B_0$
Let $X_i = A_i B_i + A_i' B_i' = A_i \odot B_i$, i.e. $X_i = 1$ if $A_i = B_i$

$(A=B) = X_3 \cdot X_2 \cdot X_1 \cdot X_0$

$(A>B) = A_3 B_3' + X_3 A_2 B_2' + X_3 X_2 A_1 B_1' + X_3 X_2 X_1 A_0 B_0'$

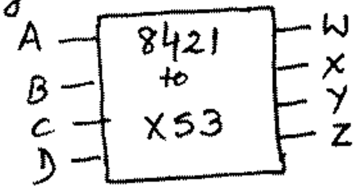
$(A<B) = A_3' B_3 + X_3 A_2' B_2 + X_3 X_2 A_1' B_1 + X_3 X_2 X_1 A_0' B_0$



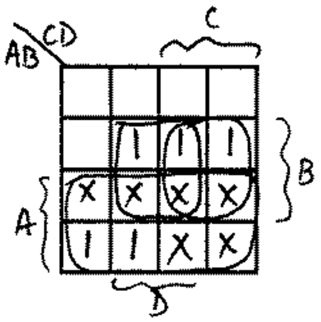
4-bit magnitude comparator

CODE CONVERTER

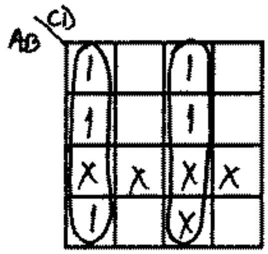
e.g.



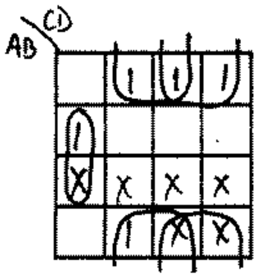
Decimal Digit	Input BCD A	B	C	D	Output Excess-3 W	X	Y	Z
0	0	0	0	0	0	0	1	1
1	0	0	0	1	0	1	0	0
2	0	0	1	0	0	1	0	1
3	0	0	1	1	0	1	1	0
4	0	1	0	0	0	1	1	1
5	0	1	0	1	1	0	0	0
6	0	1	1	0	1	0	0	1
7	0	1	1	1	1	0	1	0
8	1	0	0	0	1	0	1	1
9	1	0	0	1	1	1	0	0
10	1	0	1	0	X	X	X	X
⋮		⋮				⋮		
15	1	1	1	1	X	X	X	X



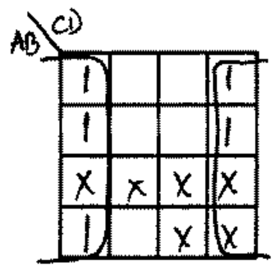
$W = A + BC + BD$



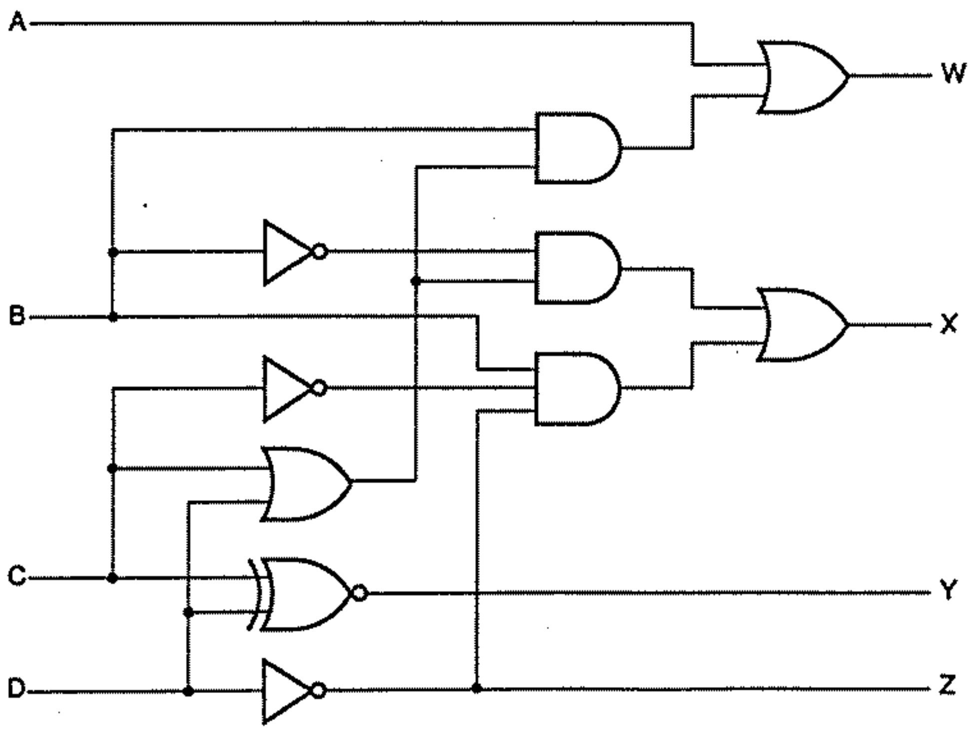
$Y = CD + C'D'$



$X = B'C + B'D + BC'D'$



$Z = D'$



$W = A + BC + BD$

$X = B'C + B'D + BC'D'$

$Y = CD + C'D'$

$Z = D'$

DECODER

DECODES A GIVEN BINARY CODE WORD

n INPUTS

$m \leq 2^n$ OUTPUTS

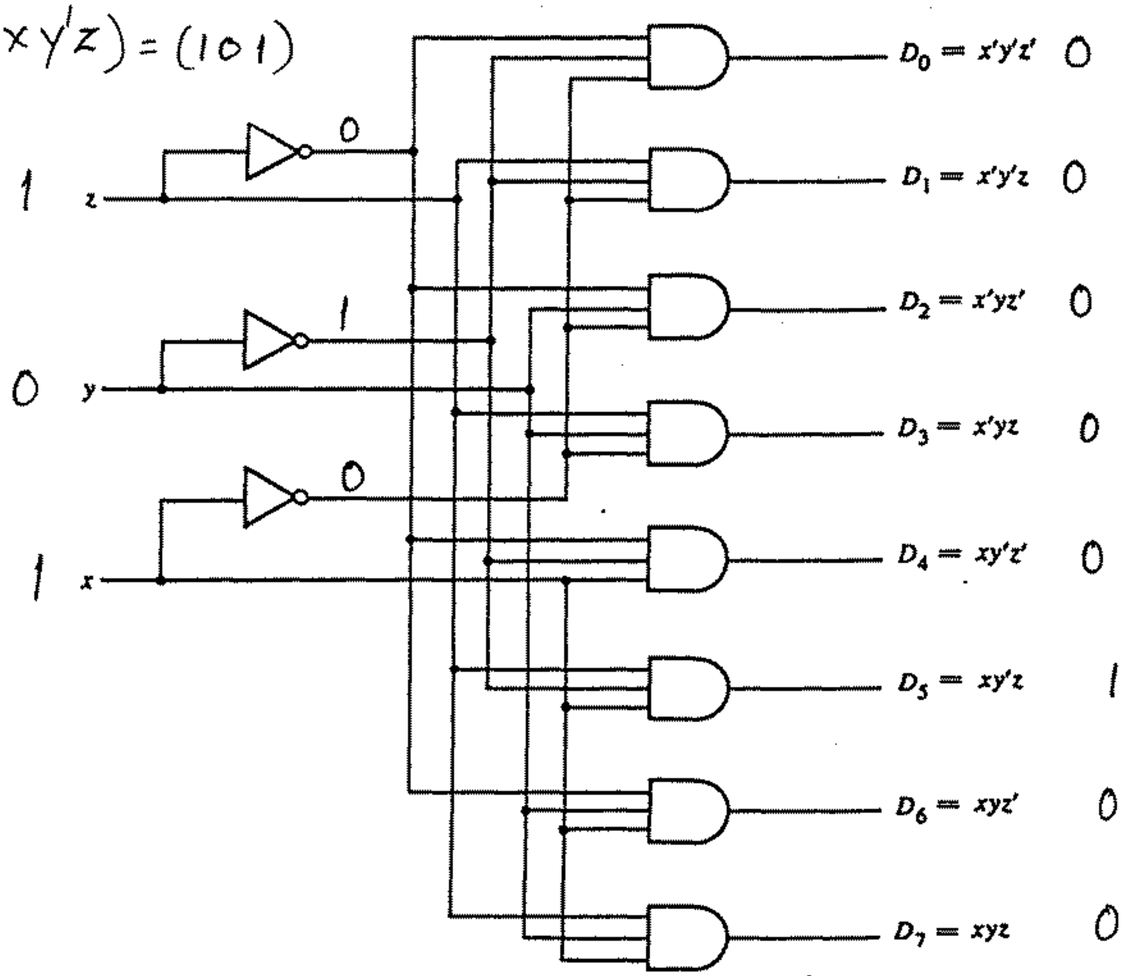
The output is 2^n possible minterms.

Example: 3-to-8 Decoder (3 × 8 Decoder)

Truth Table of a 3-to-8-Line Decoder

Inputs			Outputs							
x	y	z	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7
0	0	0	1	0	0	0	0	0	0	0
0	1	1	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1

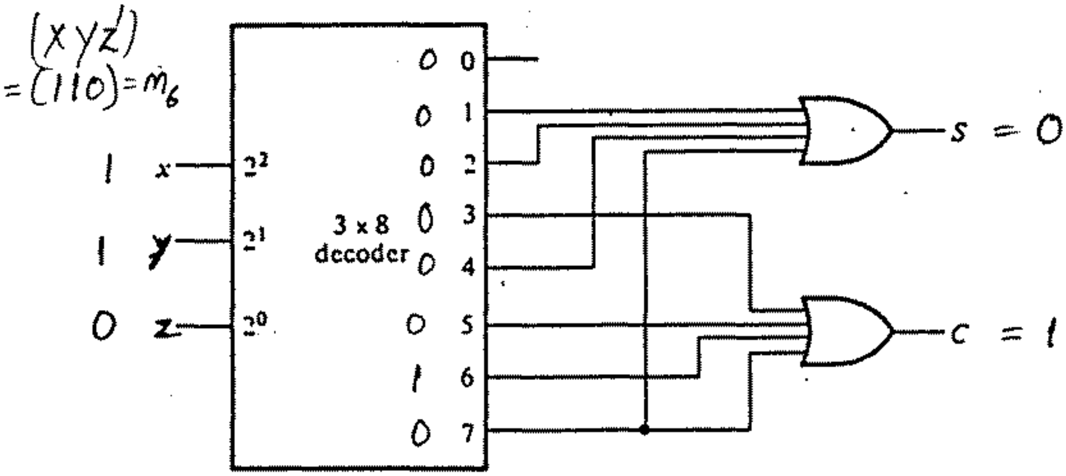
: $(xy'z) = (101)$



A 3-to-8 line decoder

Any boolean function $f(x_1, \ldots, x_n)$ can be implemented by an $n\text{x}2^n$ DECODER & an OR gate.

e.g., FULL ADDER
$S(x,y,z) = \sum (1,2,4,7)$
$C(x,y,z) = \sum (3,5,6,7)$
Two boolean functions defined over 3 variables need a 3x8 decoder and two OR gates



Implementation of a full-adder with a decoder

VARIOUS DECODERS

<table>
<tr><th>n</th><th>nx2^n</th><th>Function Table</th><th>Block Diagram</th><th>Reduced Block Diagram</th></tr>
<tr><td>1</td><td>1x2</td><td>
<table>
<tr><th>x</th><th>D_0</th><th>D_1</th></tr>
<tr><td>0</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>1</td></tr>
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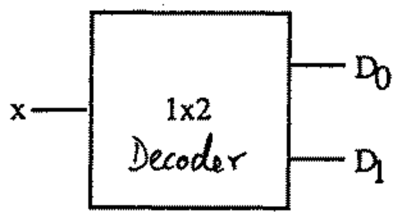
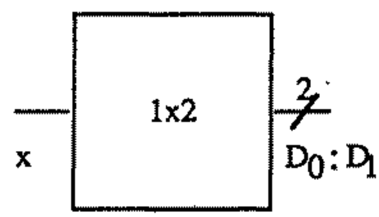
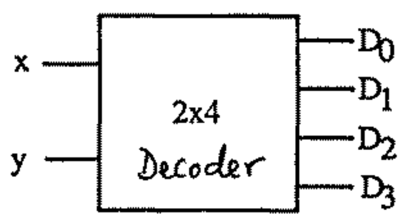
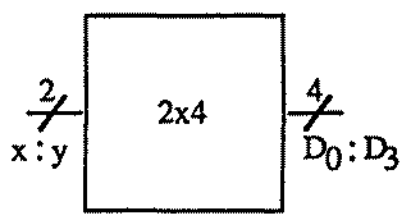
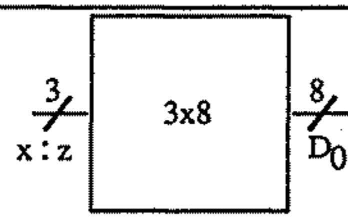
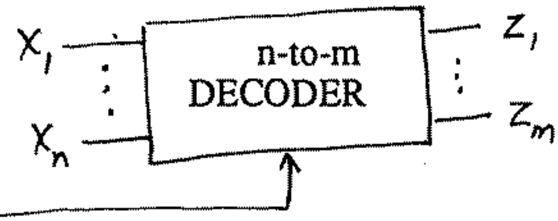
</td><td>
</td><td>
</td></tr>
<tr><td>2</td><td>2x4</td><td>
<table>
<tr><th>x</th><th>y</th><th>D_0</th><th>D_1</th><th>D_2</th><th>D_3</th></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
</table>
</td><td>
</td><td>
</td></tr>
<tr><td>3</td><td>3x8</td><td>Already given</td><td>Already shown</td><td>
</td></tr>
</table>

DECODERS WITH ENABLE INPUT

n INPUTS

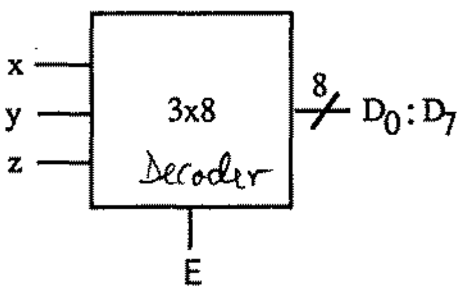


$m \leq 2^n$ OUTPUTS

(E) ENABLE

If E = 0, ALL OUTPUTS ARE 0
If E = 1, ONLY ONE OUT OF m OUTPUTS IS 1, REMAINING OUTPUTS ARE 0
(THAT OUTPUT IS DETERMINED BY THE COMBINATION OF VALUES OF n INPUTS)

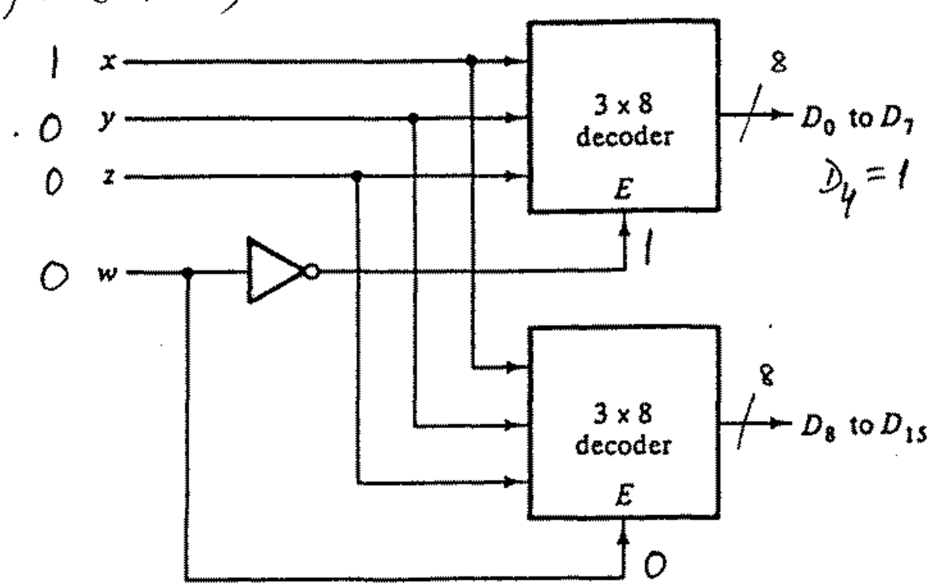
e.g., 3x8 DECODER WITH ENABLE INPUT



DECODERS CONSTRUCTED USING OTHER DECODERS

e.g., 4x16 DECODER CONSTRUCTED USING TWO 3x8 DECODERS WITH ENABLE INPUTS

(wxyz) = (0100)



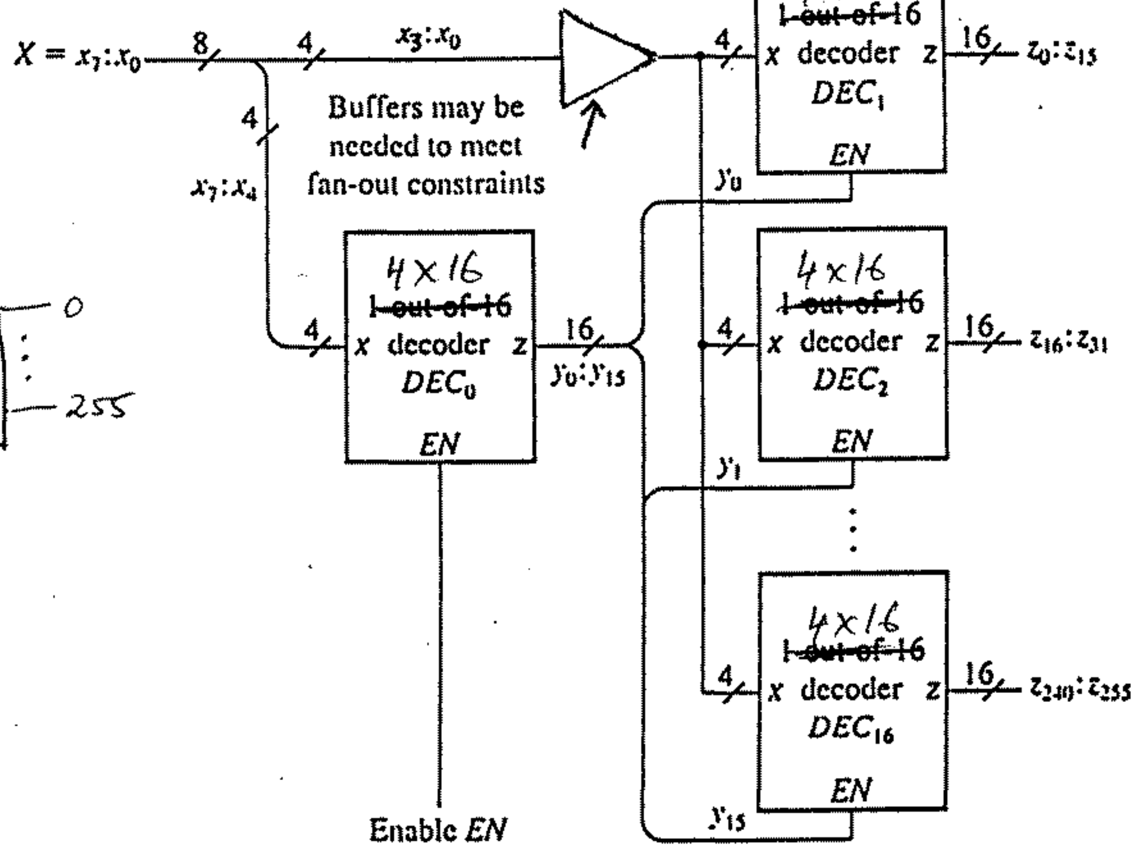
W	X	Y	Z
0	0	0	0
⋮		⋮	
0	1	1	1
1	0	0	0
⋮		⋮	
1	1	1	1

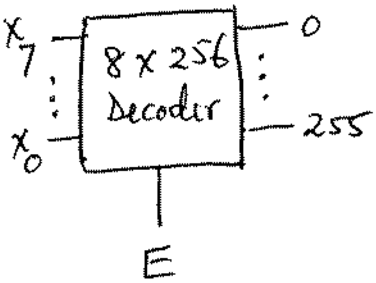
A 4 × 16 decoder constructed with two 3 × 8 decoders

e.g., 8x256 DECODER CONSTRUCTED USING
4x16 DECODERS WITH ENABLE INPUTS

17

16 + 1





$\underbrace{x_7 x_6 x_5 x_4}$ $\underbrace{x_3 x_2 x_1 x_0}$

A ~~1-out-of-256~~ 8 x 256 decoder tree constructed from ~~1-out-of-16~~ 4 x 16 decoders.