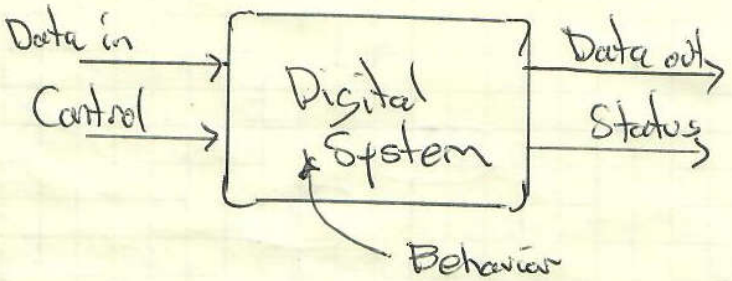
Combinational logic building blocks

Refine our view of the input & output: The transformation of input to output data is determined by control inputs. Exceptional processing events are reported by status outputs.



N:M Decoder

Data input : 1-bit D
Data output : M bits $Y = y_{M-1} \cdots y_1 y_0$
Control : N-bit $S = S_{N-1} \cdots S_1 S_0$
Status : None
Behavior : $y_S = D$, all other $y_i = 0$

Truth Table for 2:4 decoder

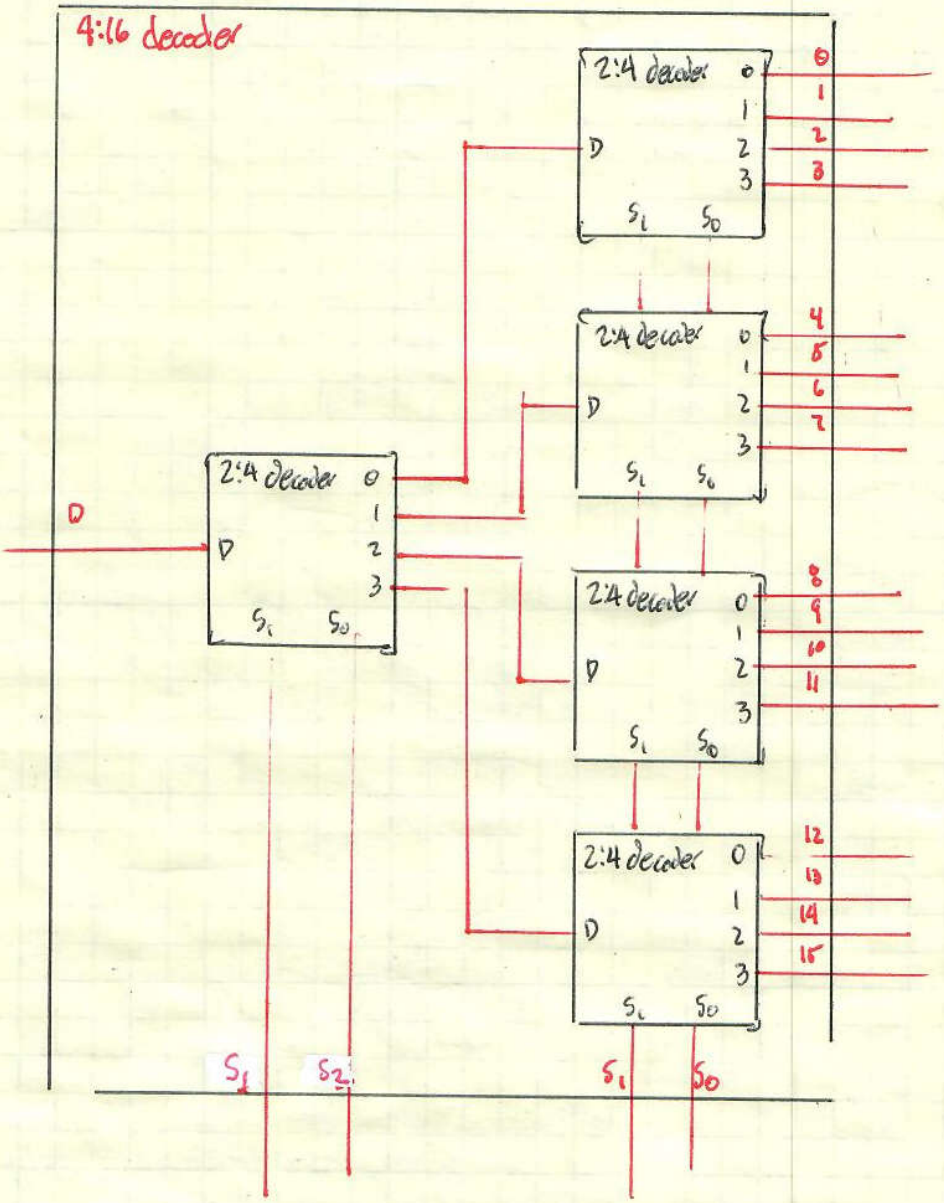
S_1	S_0	D	y_3	y_2	y_1	y_0
0	0	0				
0	0	1				1
0	1	0				
0	1	1			1	
1	0	0				
1	0	1		1		
1	1	0				
1	1	1	1			

$y_0 = S_1' S_0' D$
$y_1 = S_1' S_0 D$
$y_2 = S_1 S_0' D$
$y_3 = S_1 S_0 D$

Build larger decoder from a collection of smaller decoders.

Ex: Build a 4:16 decoder from 2:4 decoders

(4:16 — select, data out; 2:4 — select, data out)



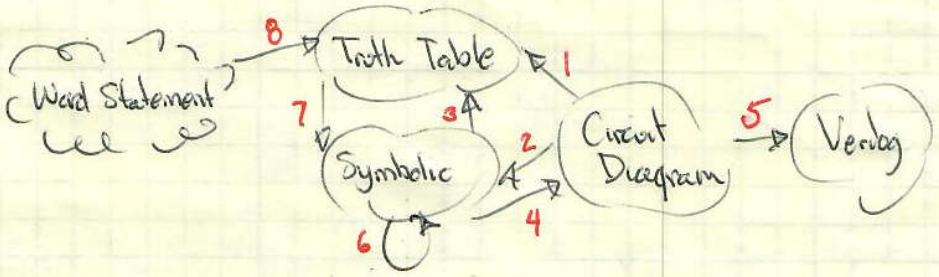
Exam Grand Rules

- Exam is online on Canvas
- Do not have to show up to classroom
- I will be on Zoom to answer any questions
- Held during normal class hours
- Exam opens @ 8:55 w/ 60 minutes
  due @ 10:15

- Once you start you cannot pause exam
- Mostly multi-choice
- 1 3x5 card

Topics

- Numbers — Binary ↔ Hex ↔ Decimal
  N-bits has 2^N representations
- Addition — Word size & overflow
- 5 representations of logic functions



1, 2 Push bits/symbols through circuit
3, 4 Operator precedence
5 CSA, testbench, waveforms
6 Boolean Algebra Bulldozer = convert product to fully populated
7 Minterms Maxterms
8 Multiple input and output

- Kmap — 3, 4, 5 var
  Dont cares
  SOP
  POS
  Σ_m
  Π_M
  → SOP_{min}, POS_{min}

- Determine the truth table for a function with 4 bits of input $a_1a_0b_1b_0$ and 4 bits of output. Let $A = a_1a_0$ and $B = b_1b_0$ each represent 2-bit binary numbers. Let $X = X_3X_2X_1X_0$ represent a 4-bit binary number. The behavior of the circuit is given by the equation

$$X = A * B;$$

a_1	a_0	b_1	b_0	X_3	X_2	X_1	X_0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0
0	0	1	0	0	0	0	0
0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	0
0	1	0	1	0	0	0	1
0	1	1	0	0	0	1	0
0	1	1	1	0	0	1	1

- Determine the POS min expression for $F(A,B,C) = \Pi M(0,1,4,6)$

Step	1	2	3	4	5	6
Function Form	ΠM F	Σm F	Kmap F	Kmap F'	SOPmin F'	POSmin F

① $F(A,B,C) = \Pi M(0,1,4,6)$

② $F(A,B,C) = \Sigma m(2,3,5,7)$

③

A \ BC	00	01	11	10
0			1	1
1	1	1		

F

④

A \ BC	00	01	11	10
0	1	1		
1	1			1

F'

⑤ $F' = A'B' + AC'$

⑥ $F = (A+B)(A'+C)$