ECE 2300 Digital Logic and Computer Organization Fall 2025

Topic 4: Combinational Building Blocks

School of Electrical and Computer Engineering
Cornell University

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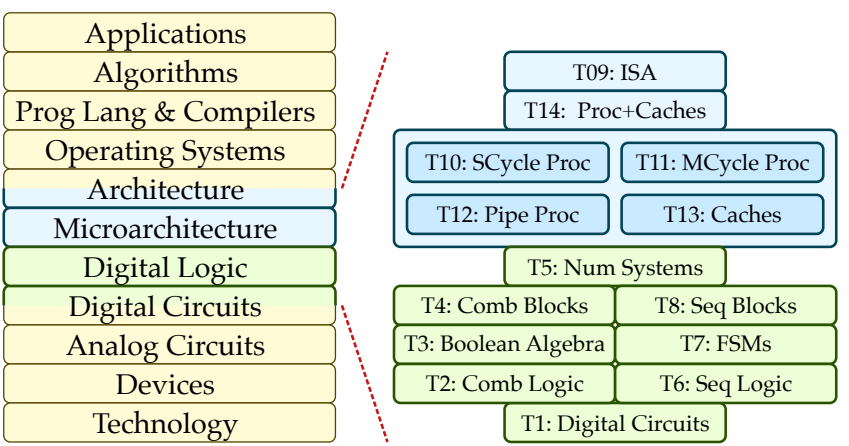
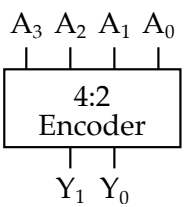


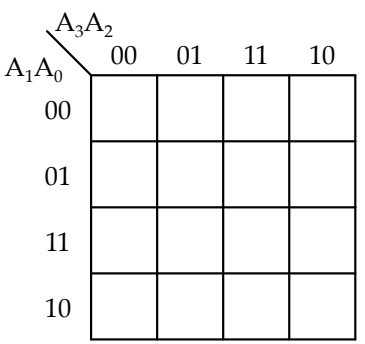
1. Encoders and Decoders

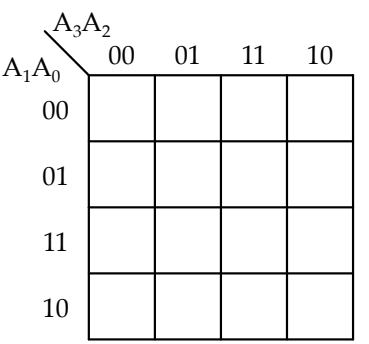
- *Binary encoder* has 2^N inputs and N outputs; sets the output value to reflect which input is one assuming exactly one input is one (encodes a one-value as a binary value)
- *Binary decoder* has N inputs and 2^N outputs and asserts exactly one output depending on the input value (decodes a binary value into a one-hot value)

1.1. Encoders

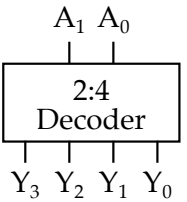


A_3	A_2	A_1	A_0	Y_1	Y_0
0	0	0	1		
0	0	1	0		
0	1	0	0		
1	0	0	0		

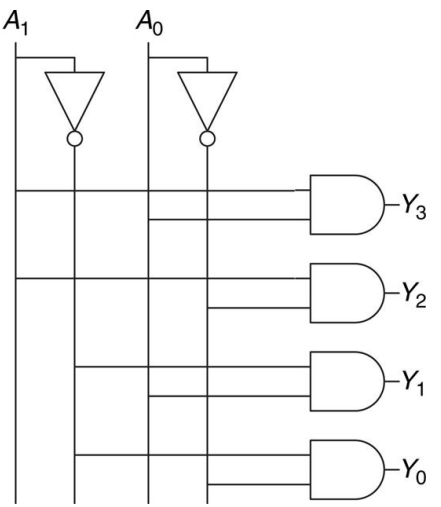




1.2. Decoders

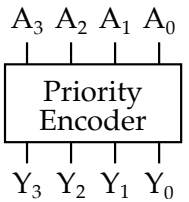


A_1	A_0	Y_3	Y_2	Y_1	Y_0
0	0				
0	1				
1	0				
1	1				



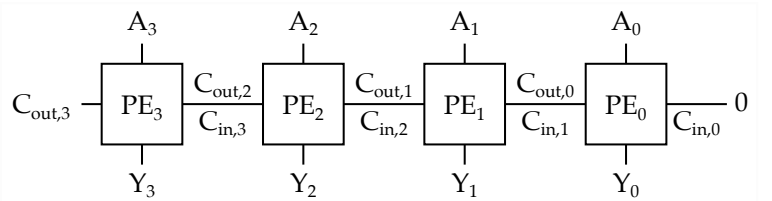
2. Priority Encoders

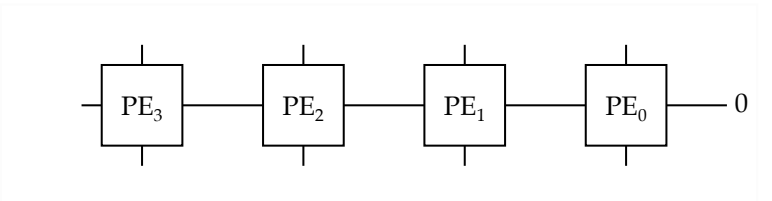
- *Priority encoder* indicates the first input that is one (i.e., the highest priority input) using a one-hot output



A_3	A_2	A_1	A_0	Y_3	Y_2	Y_1	Y_0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	0	0	0	1	0
0	0	1	1	0	0	0	1
0	1	0	0	0	1	0	0
0	1	0	1	0	0	0	1
0	1	1	0	0	0	1	0
0	1	1	1	0	0	0	1
1	0	0	0	1	0	0	0
1	0	0	1	0	0	0	1
1	0	1	0	0	0	1	0
1	0	1	1	0	0	0	1
1	1	0	0	0	1	0	0
1	1	0	1	0	0	0	1
1	1	1	0	0	0	1	0
1	1	1	1	0	0	0	1

- We can leverage modularity and regularity to manage complexity
- One-bit priority encoder (PE) takes a *continue* signal from the right and passes it to the left
  - *continue* = 1 means have not found first one, continue searching
  - *continue* = 0 means have found first one



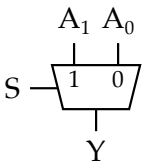


A	C_{in}	C_{out}	Y
0	0		
0	1		
1	0		
1	1		

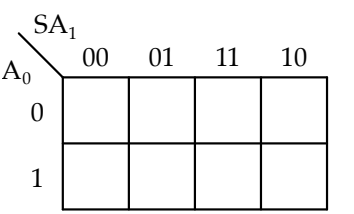
3. Multiplexors and Demultiplexors

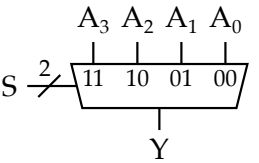
- *Multiplexor* chooses among several possible inputs based on the value of a *select* signal
- *Demultiplexor* "routes" an input to one of many several possible outputs based on a *select* signal

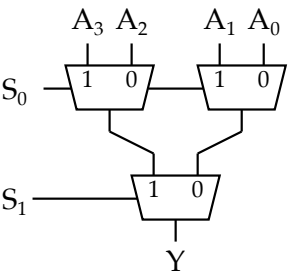
3.1. Multiplexors

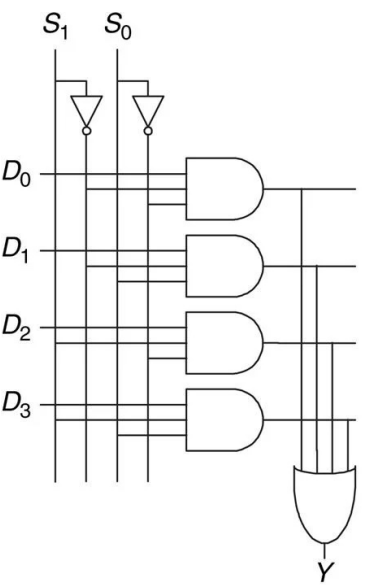


S	A_1	A_0	Y
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

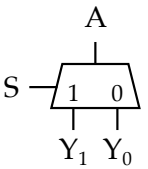



A3 A2 A1 A0
S
2
11 10 01 00
Y


A3 A2
A1 A0
S0
1 0
1 0
S1
1 0
Y


S1 S0
D0
D1
D2
D3
Y

3.2. Demultiplexors



S	A	Y_1	Y_0
0	0		
0	1		
1	0		
1	1		

4. Shifters and Rotators

- *Shifter* shifts the input value either left or right by a variable amount specified with a *shift amount* signal; zeros are shifted in
- *Rotator* rotates the input value either left or right by a variable amount specified with a *rotate amount* signal