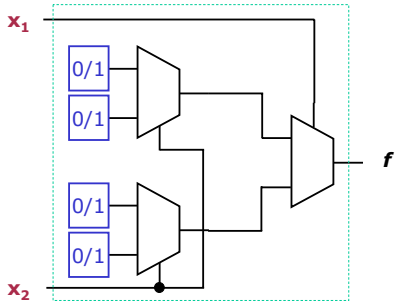
ECE380 Digital Logic

Implementation Technology:
Look-up Tables, XOR and XNOR gates

Look-up tables

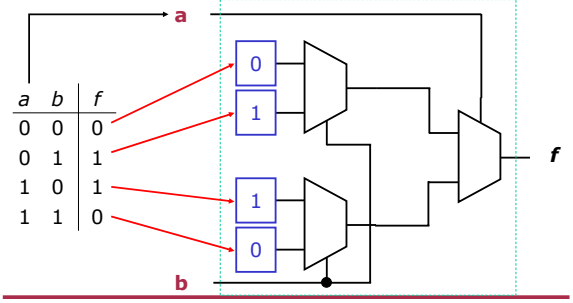
- A logic block commonly used in FPGA devices is the ***look-up table*** (LUT)
- An LUT contains ***storage cells*** that are used to implement small logic functions
- Each cell is capable of storing a single logic value (0 or 1)
- Multiplexers are used to select one of the storage cells for output
- Essentially, the cells store the truth table for a function and the multiplexers select a particular cell for output based on a set of select (control) inputs

Two-input LUT structure



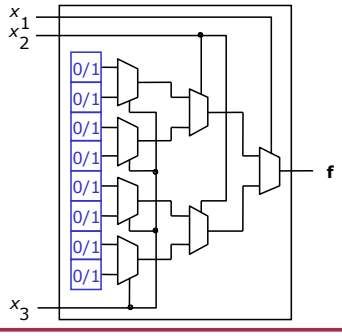
Programmed LUT (f=a'b+ab')

most significant variable controls last multiplexer



a	b	f
0	0	0
0	1	1
1	0	1
1	1	0

Three-input LUT structure



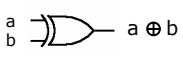
Three-input LUT example

- Show the diagram for a programmed LUT that implements the function
- f(a,b,c)=a'bc+abc'+ac

Exclusive OR (XOR) gate

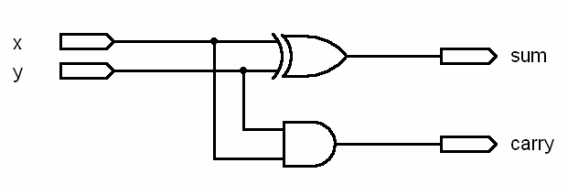
- Another basic element, very useful in building circuits that perform arithmetic operations, is the exclusive OR (XOR) gate
- XOR function is denoted with the $\oplus$ symbol
- In SOP form, $a \oplus b = ab'+a'b$
- Output is '1' only if the inputs are different

a	*b*	$a \oplus b$
0	0	0
0	1	1
1	0	1
1	1	0



Example XOR usage

- Recall the adder circuit
  - sum=xy'+x'y
  - carry=xy



XOR of three variables

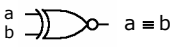
- What is the canonical SOP form for the following expression?

  $f(a,b,c) = a \oplus b \oplus c$

Exclusive NOR (XNOR) gate

- Derived from the XOR function, XNOR is the complement of XOR
- XNOR function is denoted with the $\equiv$ symbol
- In SOP form, $a \equiv b = (a \oplus b)' = ab+a'b'$
- Output is '1' only if the inputs are the same
- Also called an equivalence function

a	*b*	$a \equiv b$
0	0	1
0	1	0
1	0	0
1	1	1



XNOR of three variables

- What is the canonical SOP form for the following expression?

  $f(a,b,c) = a \equiv b \equiv c$