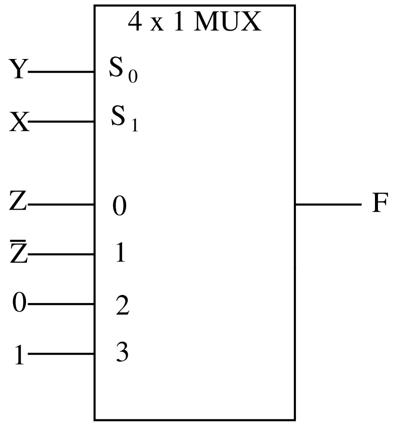
Combinational Circuit Implemented with Multiplexers

- Can implement any Boolean function of n variables with an n selection input, 2^n data input multiplexer.
  - Simply tie each input to the "0" or "1" line.

- Also possible to implement any $(n+1)$-variable function with a 2^n-to-1 multiplexer.
  - Use the $(n+1)$-st variable in true or complement form, depending on what the truth table requires.

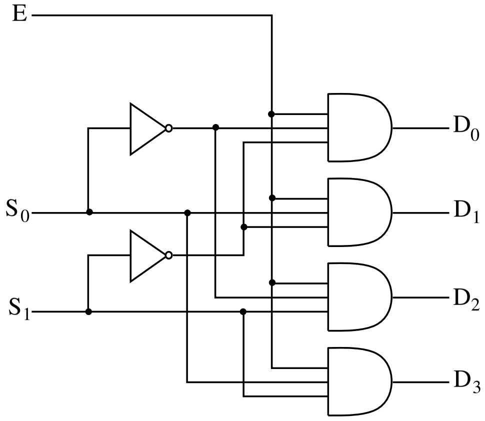
X	Y	Z	F	
0	0	0	0	F = Z
0	0	1	1	
0	1	0	1	F = $\overline{Z}$
0	1	1	0	
1	0	0	0	F = 0
1	0	1	0	
1	1	0	1	F = 1
1	1	1	1	



Demultiplexer

- A **demultiplexer** is a digital function that performs the inverse of the multiplexing operation.
  - Receives info from a single line and transmits it to one of 2^n possible ouput lines.

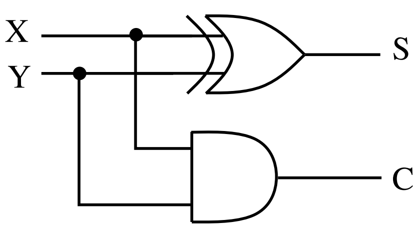
- A 1-to-2^n demultiplexer is identical to an n-to-2^n decoder with enable input.
  - Exp: Decoder: S_0, S_1 are data inputs, E is the enable; Demultiplexer: E is the data input, the other inputs accept the selection variables.



Half Adder

- A **half adder** adds two bits, X and Y, to produce a 1-bit **sum**, S, and a 1-bit **carry**, C.
- $S = (\bar{X}Y + X\bar{Y}) = X \oplus Y$;
  $C = XY$.

Inputs		Outputs	
X	Y	C	S
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0



Full Adder

- A **full adder** adds two bits, X and Y, and one **carry input**, Z, to produce a 1-bit **sum**, S, and a 1-bit **carry**, C.
- $S = (\bar{X}\bar{Y}Z + \bar{X}Y\bar{Z} + X\bar{Y}\bar{Z} + XYZ) = X \oplus Y \oplus Z$;
  $C = XY + XZ + YZ = XY + Z(X \oplus Y)$.

Inputs			Outputs	
X	Y	Z	C	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1