Selecting

- Selecting of data or information is a critical function in digital systems and computers
- Circuits that perform selecting have:
  - A set of information inputs from which the selection is made
  - A single output
  - A set of control lines for making the selection
- Logic circuits that perform selecting are called *multiplexers*

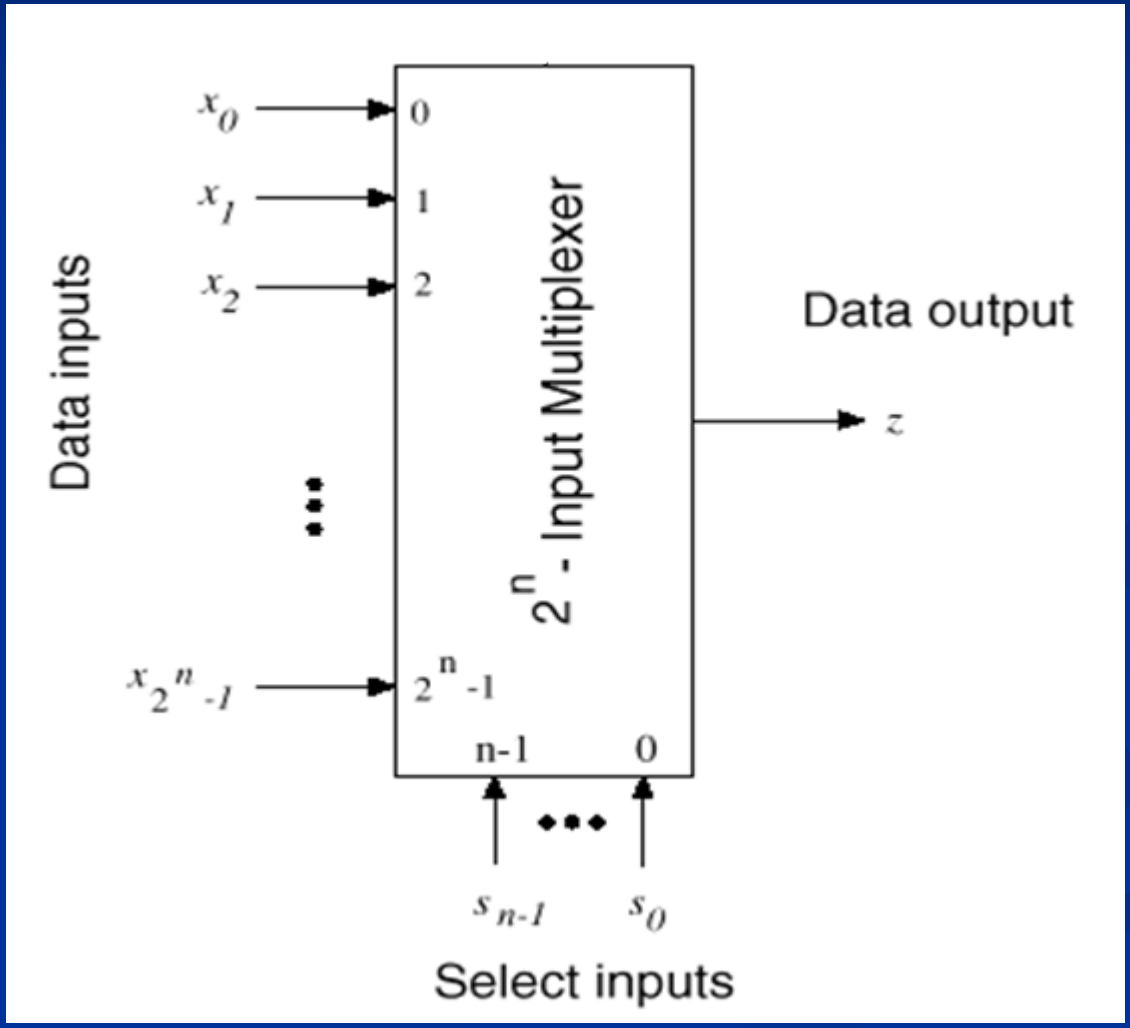
Multiplexers

- A multiplexer selects information from an input line and directs the information to an output line
- A typical multiplexer has n control inputs (S_{n-1}, … S_0) called *selection inputs*, 2^n information inputs (I_{2^n-1}, … , I_0), and one output Y
- A multiplexer can be designed to have m information inputs with $m < 2^n$ as well as n selection inputs

Multiplexer (cont.)

- "Selects" binary information from one of many input lines and directs it to a single output line.
- Also know as the "selector" circuit,
- Selection is controlled by a particular set of inputs lines whose # depends on the # of the data input lines.
- For a 2^n-to-1 multiplexer, there are 2^n data input lines and n selection lines whose bit combination determines which input is selected.

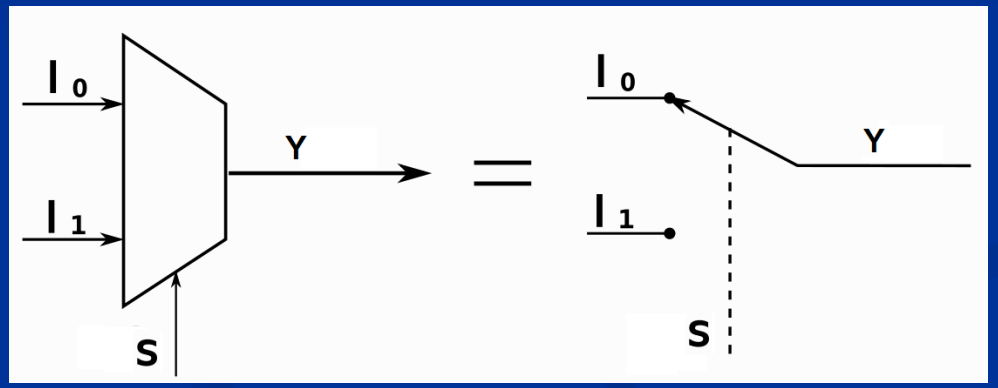
Multiplexer (cont.)

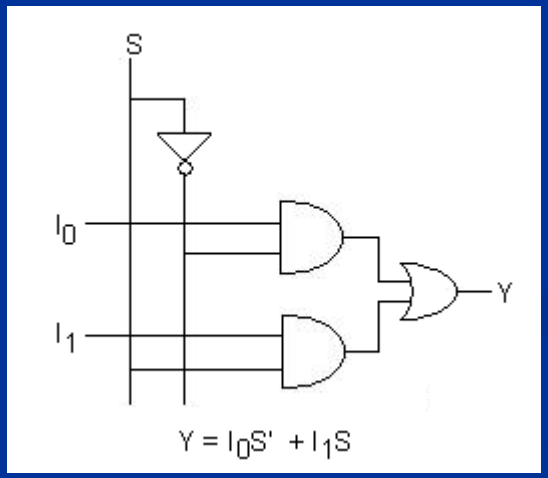


2-to-1 MUX Design

- Since $2 = 2^1$, n = 1
- The single selection variable S has two values:
  - S = 0 selects input I_0
  - S = 1 selects input I_1
- The equation:

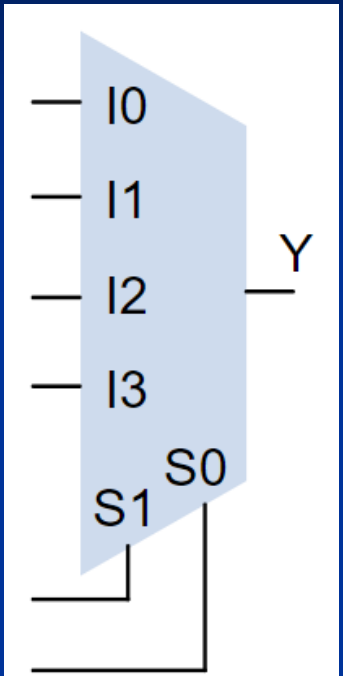
  $Y = S'I_0 + SI_1$
- The circuit:



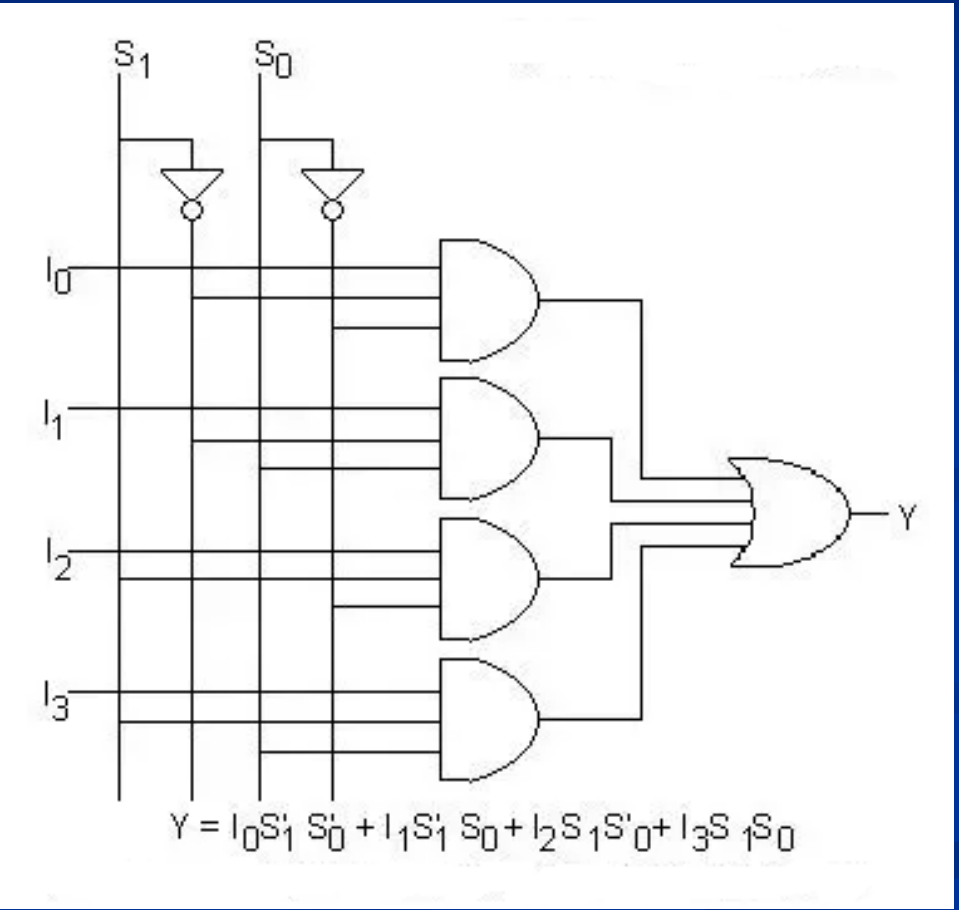


S	Y
0	I0
1	I1

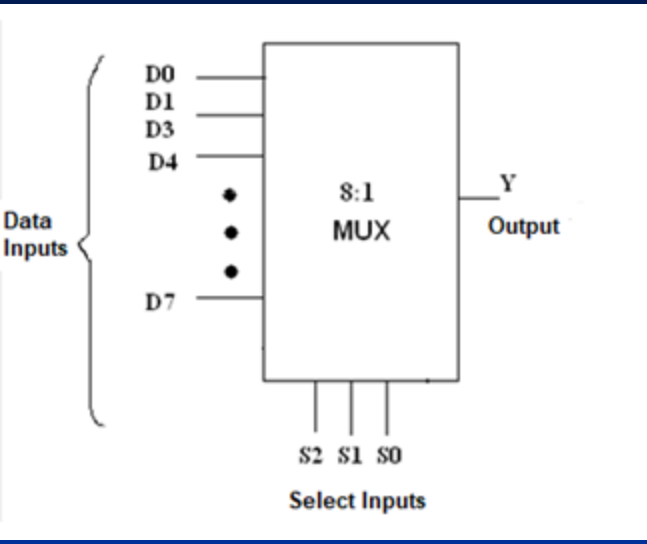
4-to-1 MUX Design



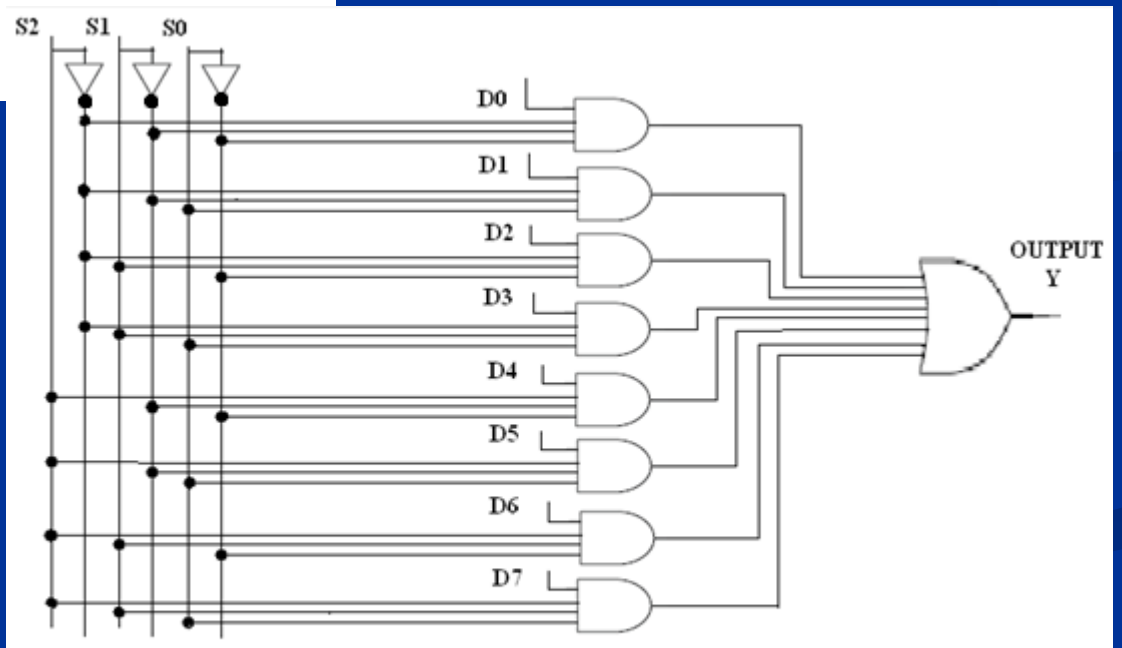
S1	S0	Y
0	0	I0
0	1	I1
1	0	I2
1	1	I3



8-to-1 MUX Design



Select Inputs			Output
S2	S1	S0	Y
0	0	0	D0
0	0	1	D1
0	1	0	D2
0	1	1	D3
1	0	0	D4
1	0	1	D5
1	1	0	D6
1	1	1	D7

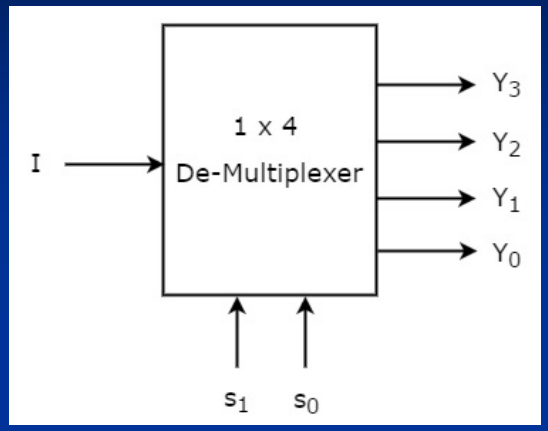


$$Y = \overline{S2}\,\overline{S1}\,\overline{S0}\,D0 + \overline{S2}\,\overline{S1}\,S0\,D1 + \overline{S2}\,S1\,\overline{S0}\,D2 + \overline{S2}\,S1\,S0\,D3 + S2\,\overline{S1}\,\overline{S0}\,D4 + S2\,\overline{S1}\,S0\,D5 + S2\,S1\,\overline{S0}\,D6 + S2\,S1\,S0\,D7$$

De-Multiplexers

- **De-Multiplexer** is a combinational circuit that performs the reverse operation of Multiplexer.
- It has single input, 'n' selection lines and maximum of 2^n outputs. The input will be connected to one of these outputs based on the values of selection lines.
- Since there are 'n' selection lines, there will be 2^n possible combinations of zeros and ones. So, each combination can select only one output.

1-to-4 De-MUX Design



Selection Inputs		Outputs			
S_1	S_0	Y_3	Y_2	Y_1	Y_0
0	0	0	0	0	**I**
0	1	0	0	**I**	0
1	0	0	**I**	0	0
1	1	**I**	0	0	0

$$Y_3 = s_1 s_0 I$$

$$Y_2 = s_1 s_0' I$$

$$Y_1 = s_1' s_0 I$$

$$Y_0 = s_1' s_0' I$$