Faculty of Engineering

CSE115: Digital Design

Lecture 18:
Multiplexers and Demultiplexers

Suggested Reading

- Section 5.7

Multiplexers

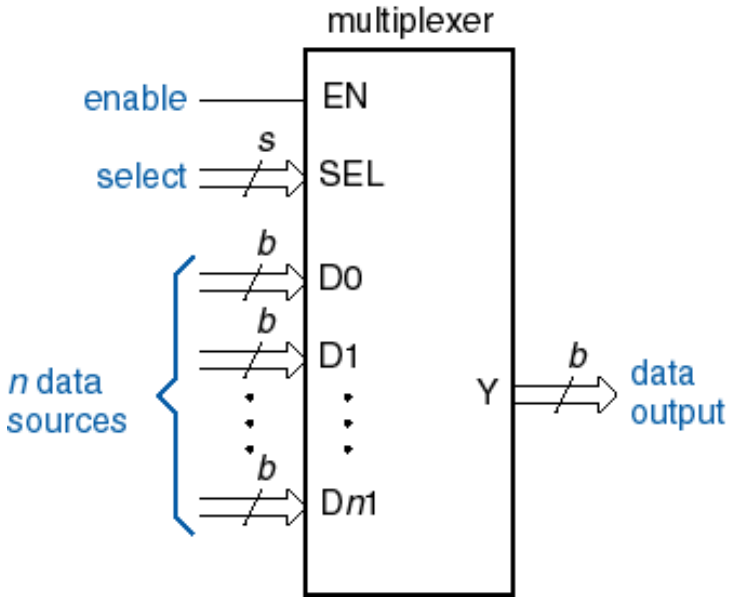
Multiplexing: transmitting large number of signals over a small number of channels or lines

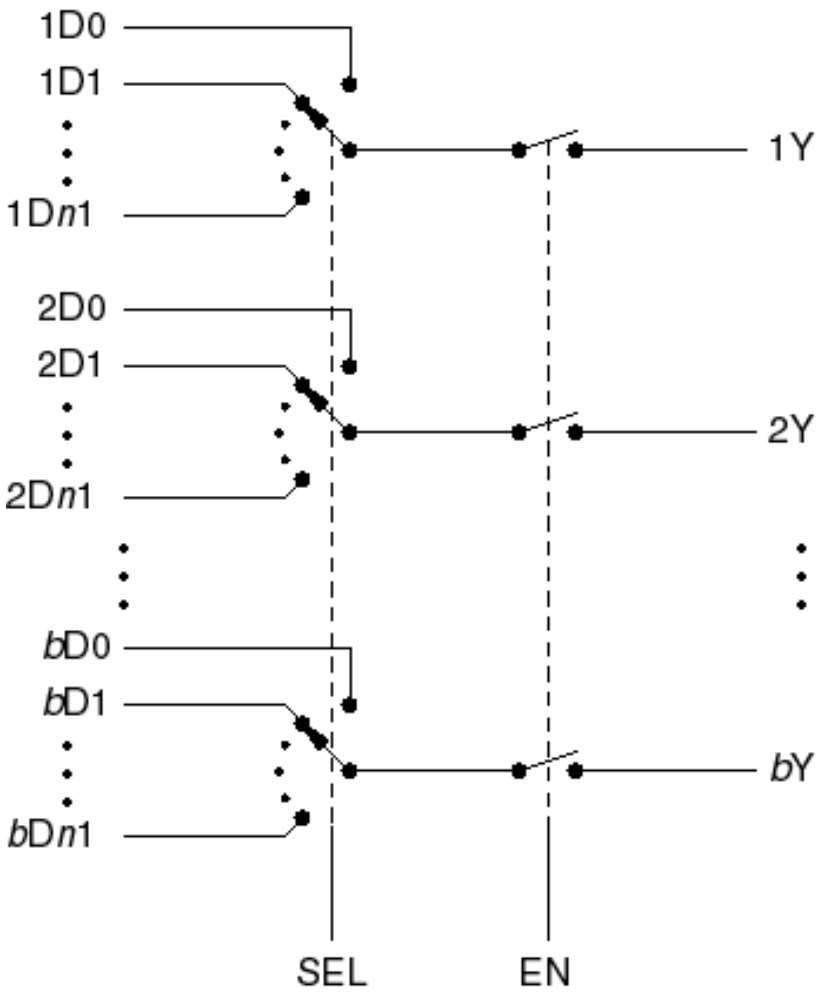
Digital multiplexer (**MUX**): selects one of many input lines and directs it to a single output.

Selection lines controls the selection of a particular input

n selection lines, 2^n inputs, single output

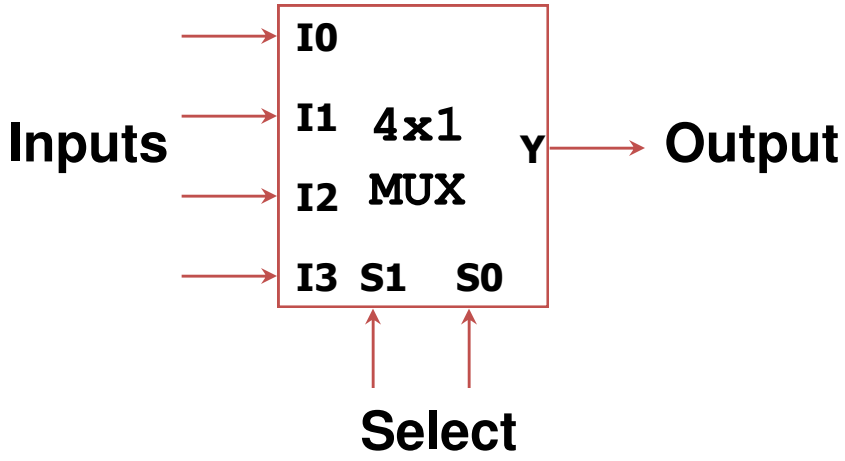
Multiplexers



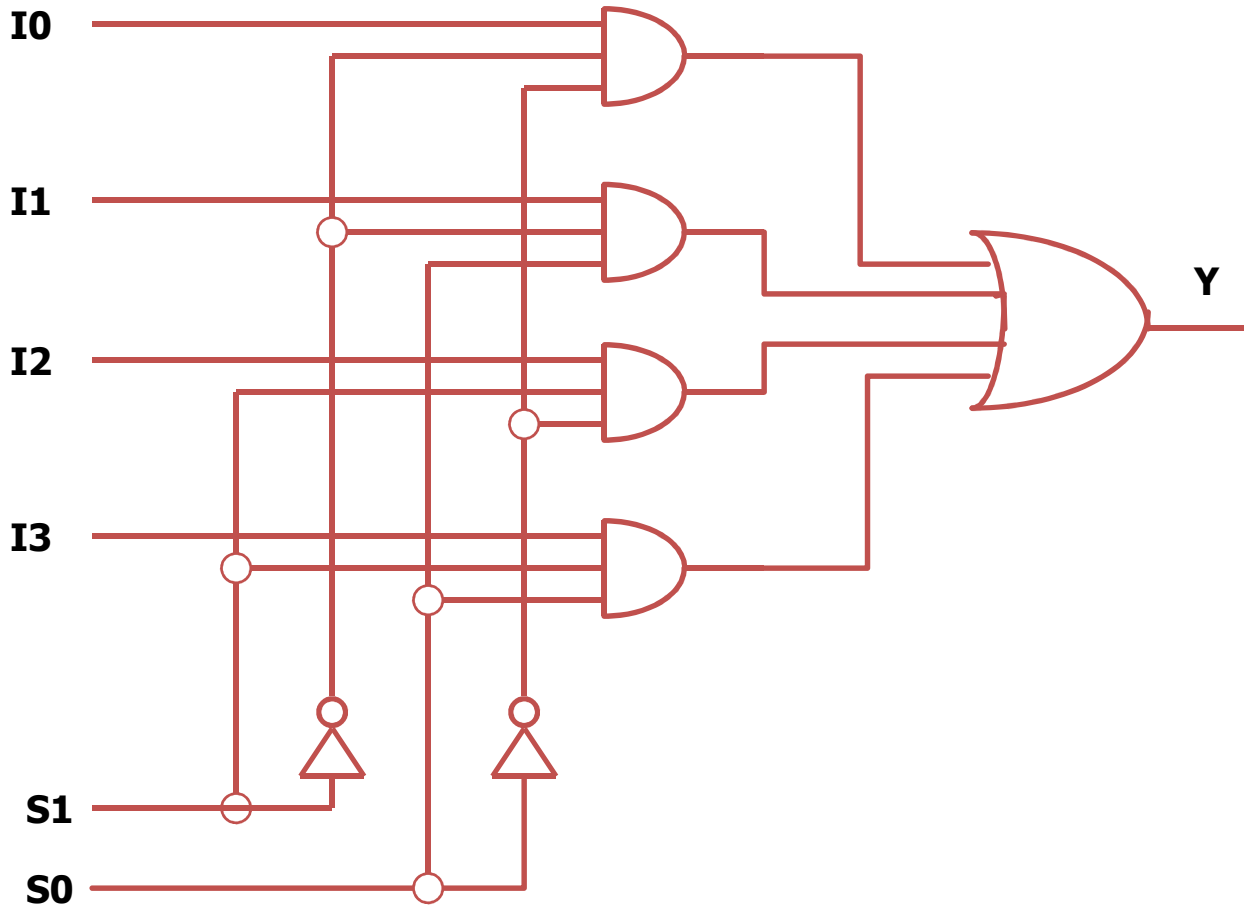


4-to-1 Line Multiplexer

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



Logic Diagram of 4-to-1 Multiplexer



Properties of Different Approaches

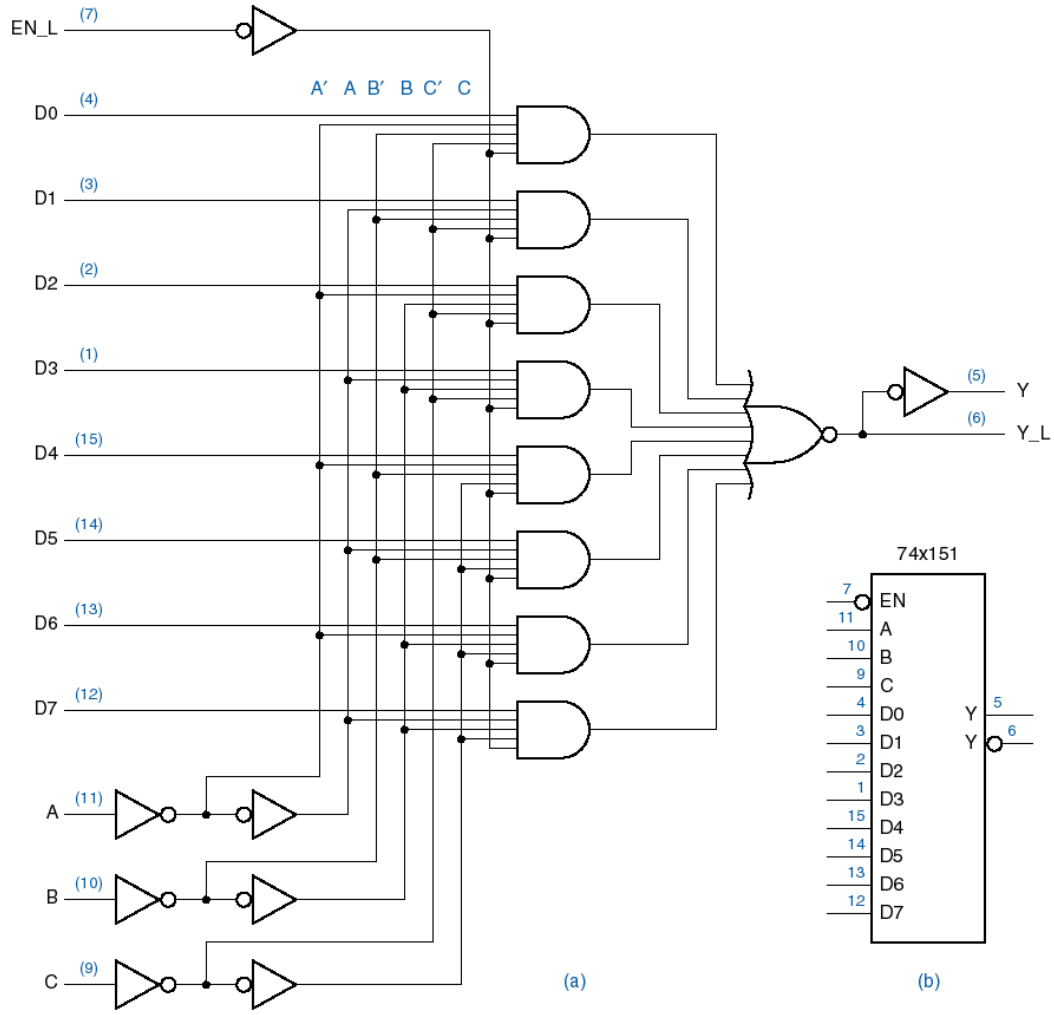
74x151: 8-to-1 MUX

74x251: 8-to-1 MUX with three-state output

74x153: 4-to-1 2 bit MUX

74x157: 2-to-1 4 bit MUX

74x151 8-Input Multiplexer



74x151 Truth Table

Inputs				*Outputs*	
EN_L	C	B	A	Y	Y_L
1	x	x	x	0	1
0	0	0	0	D0	D0′
0	0	0	1	D1	D1′
0	0	1	0	D2	D2′
0	0	1	1	D3	D3′
0	1	0	0	D4	D4′
0	1	0	1	D5	D5′
0	1	1	0	D6	D6′
0	1	1	1	D7	D7′

Implementing Logic Functions

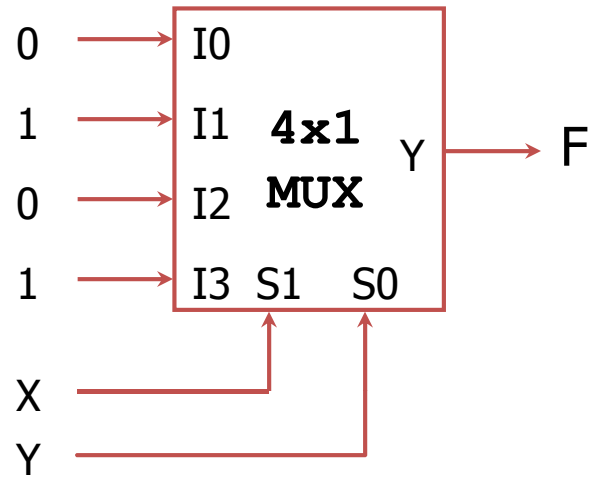
n- variable logic function can be implemented using 2^n-to-1 MUX

The inputs variables are connected to the select input.

The function value for each input combination (0 or 1) is connected to the corresponding input of the MUX

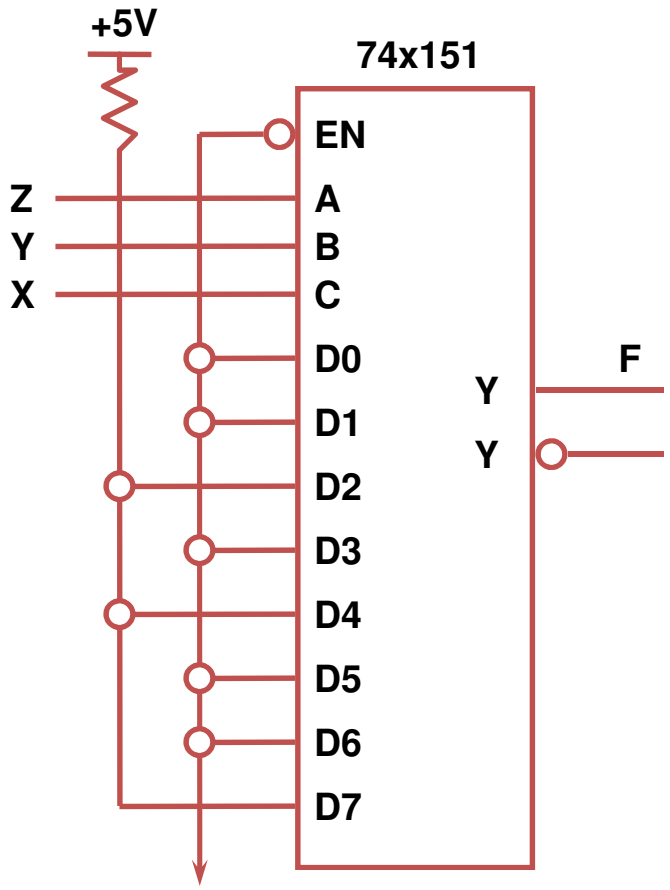
Example: F = $\Sigma_{x,y}$ (1,3)

Row	X	Y	F
0	0	0	0
1	0	1	1
2	1	0	0
3	1	1	1



Example: F = Σx,y,z (2,4,7) using 74x151

Row	X	Y	Z	F
0	0	0	0	0
1	0	0	1	0
2	0	1	0	1
3	0	1	1	0
4	1	0	0	1
5	1	0	1	0
6	1	1	0	0
7	1	1	1	1



Functional Decomposition

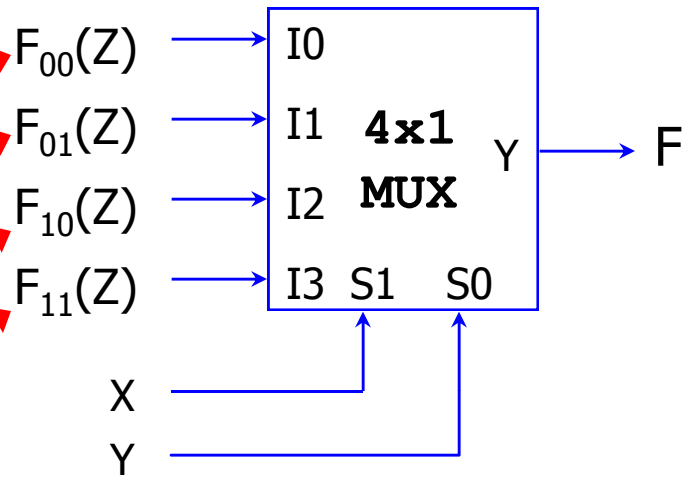
An effective way for using MUX to implement Logic Functions.

n-row truth table can be implemented using **n/2-to-1 MUX:**

- Write the Logic function in terms of the least significant input variable.
- The truth table is reduced by one half.

For 3-variable Logic Function, the decomposed truth table is:

Row	X	Y	Z	F
0,1	0	0	X	$F_{00}(Z)$
2,3	0	1	X	$F_{01}(Z)$
4,5	1	0	X	$F_{10}(Z)$
6,7	1	1	X	$F_{11}(Z)$

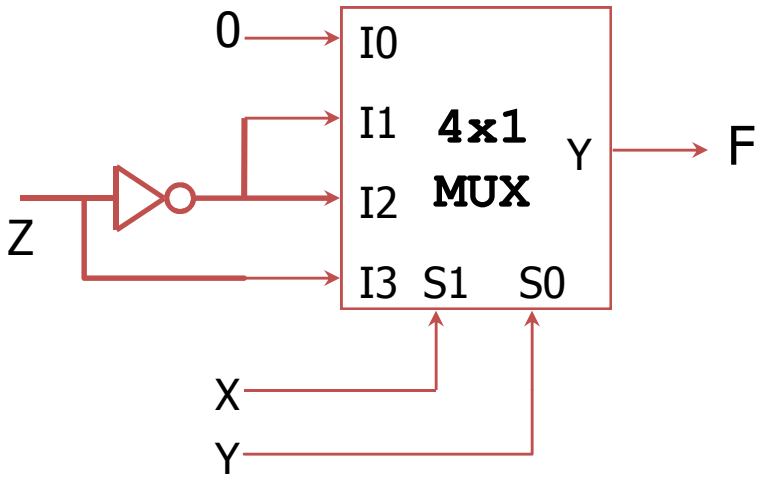


Functional Decomposition Example

Truth Table → Decomposed Truth Table

Row	X	Y	Z	F	
0	0	0	0	0	$F_{00}(Z) = 0$
1	0	0	1	0	
2	0	1	0	1	$F_{01}(Z) = Z'$
3	0	1	1	0	
4	1	0	0	1	$F_{10}(Z) = Z'$
5	1	0	1	0	
6	1	1	0	0	$F_{11}(Z) = Z$
7	1	1	1	1	

Row	X	Y	Z	F
0,1	0	0	0	0
2,3	0	1	X	Z’
4,5	1	0	X	Z’
6,7	1	1	X	Z

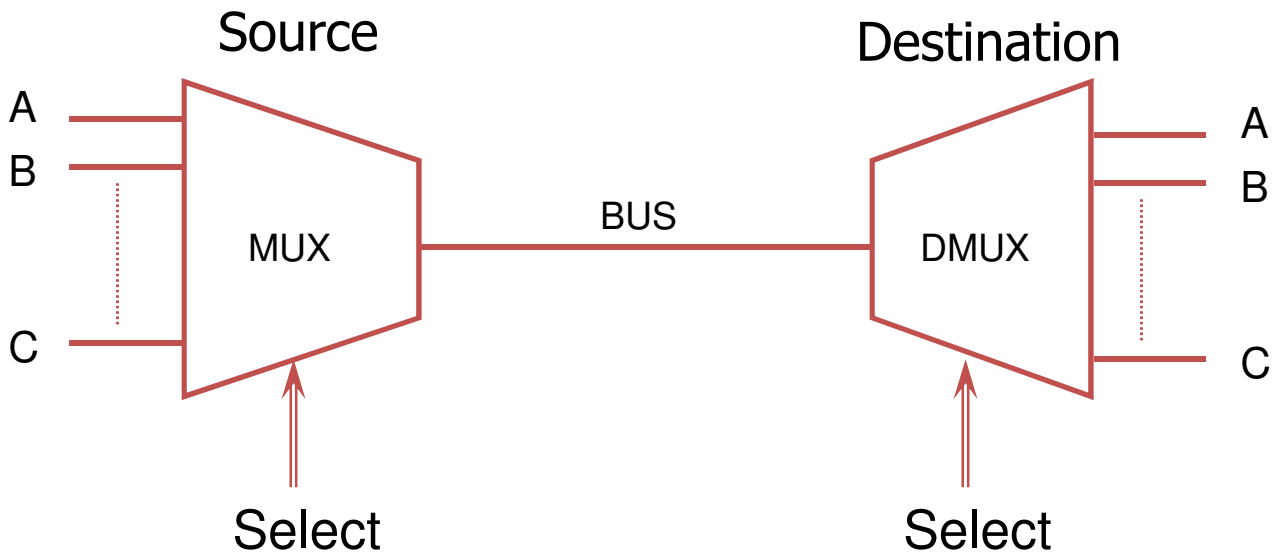


Demultiplexers

Demultiplexer (**DMUX**) performs the opposite function of a MUX.

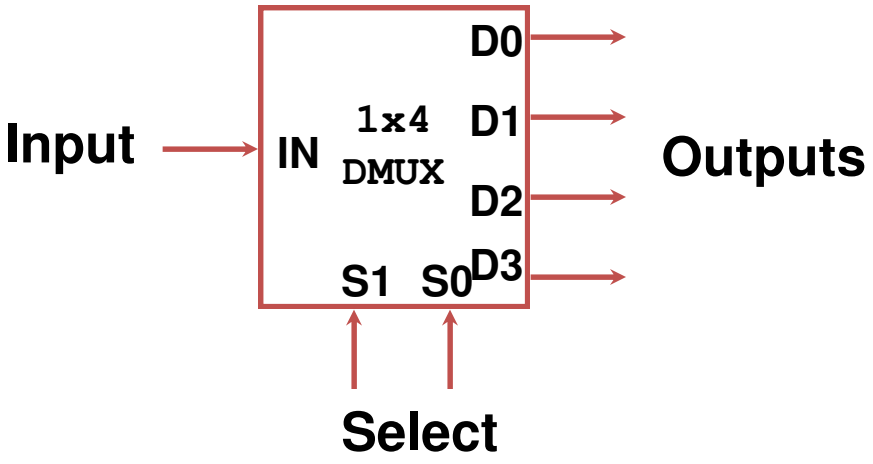
A digital Demultiplexer receives input data on a single input and transmits it on one of 2^n possible outputs according to the value of the n select inputs

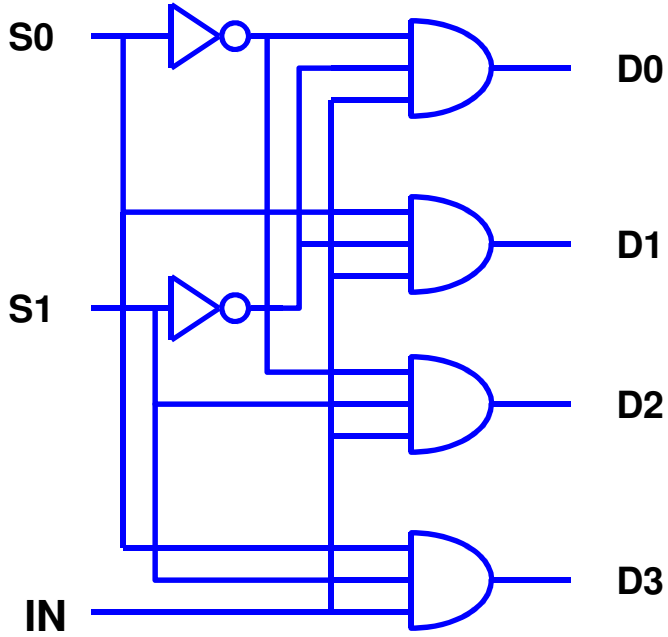
MUX/DMUX are used in data transmission



1-to-4 DMUX

IN	S1	S2	D0	D1	D2	D3
X	0	0	IN	0	0	0
X	0	1	0	IN	0	0
X	1	0	0	0	IN	0
X	1	1	0	0	0	IN





Using Decoders as DMUX

A DMUX has the same structure of a Decoder with enable input.

Decoder can be used as a DMUX by connecting the input data to the enable input.

Example: 2-to-4 Decoder can be used as 1-to-4 DMUX

IN	S1	S2	D0	D1	D2	D3
X	0	0	**IN**	0	0	0
X	0	1	0	**IN**	0	0
X	1	0	0	0	**IN**	0
X	1	1	0	0	0	**IN**