

COL215L: Digital Logic & System Design

Lecture 9: Combinational Circuits (Cont.)



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Incompletely Specified Functions

- Don't-care conditions
 - Outputs actually do not matter for certain subset of inputs
 - A subset of inputs do not (or cannot) occur
- K-Map
 - Include *don't care* minterms
- QM Method
 - Use *don't care* minterms for generation of the implicants
 - Ignore *don't care* minterms during the covering process

Incompletely Specified Functions (Cont.)

$$\Sigma m(\text{---})$$

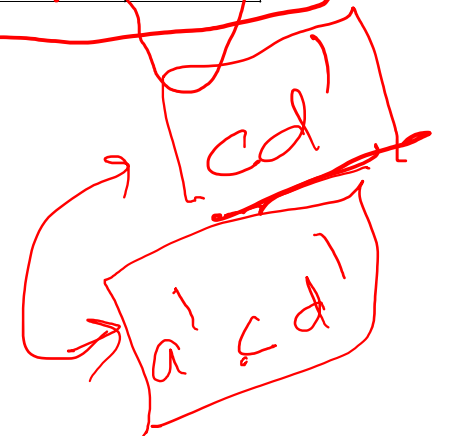
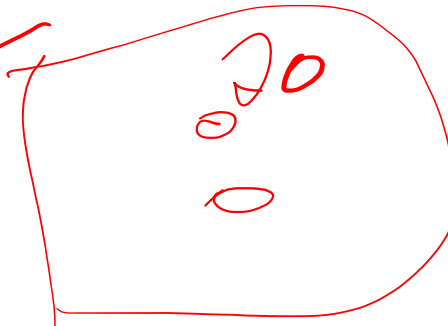
$$+ \Sigma d(\text{---} - r3)$$

$a \rightarrow 0/1$
 $b \rightarrow 0/1$

a	b	y
0	0	0
0	1	1
1	0	1
1	1	X

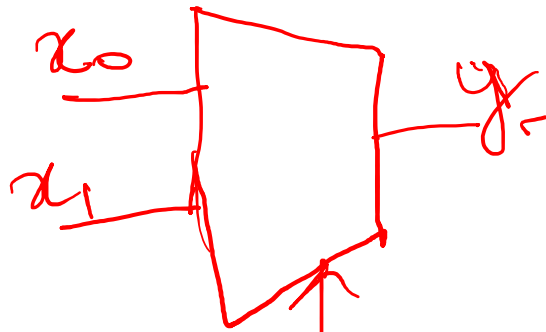
ab \ cd	00	01	11	10
00			1	1
01	1	1		
11	X	X	X	X
10	1	1	X	X

Map term



Multiplexer

- 2-to-1 Multiplexer



S selector

~~2 inputs~~

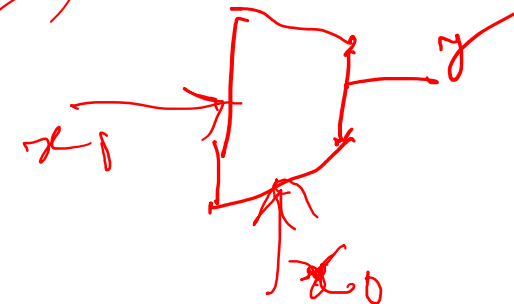
S	y
0	x_0
1	x_1

x_0	x_1	y
0	0	0
0	1	1
1	0	0
1	1	1

$4-1$ $2^n \rightarrow 1$

$$y = \bar{S}x_0 + Sx_1$$

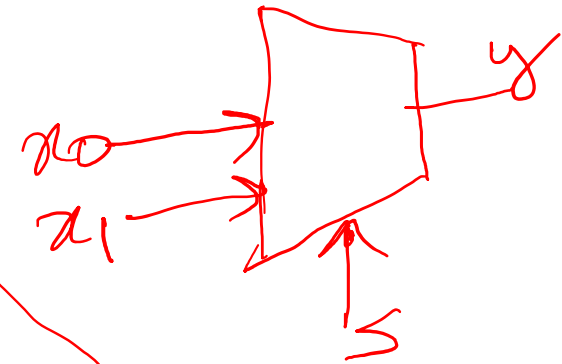
$$y = \bar{x}_0 x_1 + x_0 \bar{x}_1$$



Multiplexer (Cont.)

a	b	y
0	0	0
0	1	1
1	0	1
1	1	0

$$y = \bar{a} \bar{b} + a \bar{b}$$

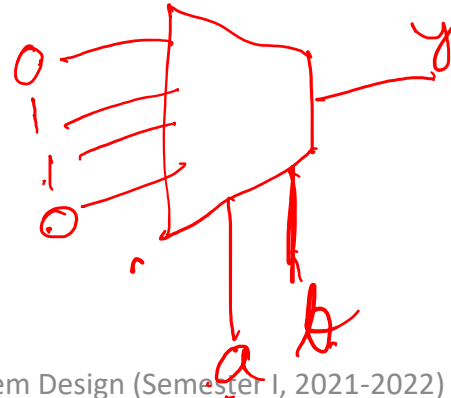


$$y = \bar{S} x_0 + S x_1$$

$$S = a$$

$$x_0 = b$$

$$x_1 = \bar{b}$$



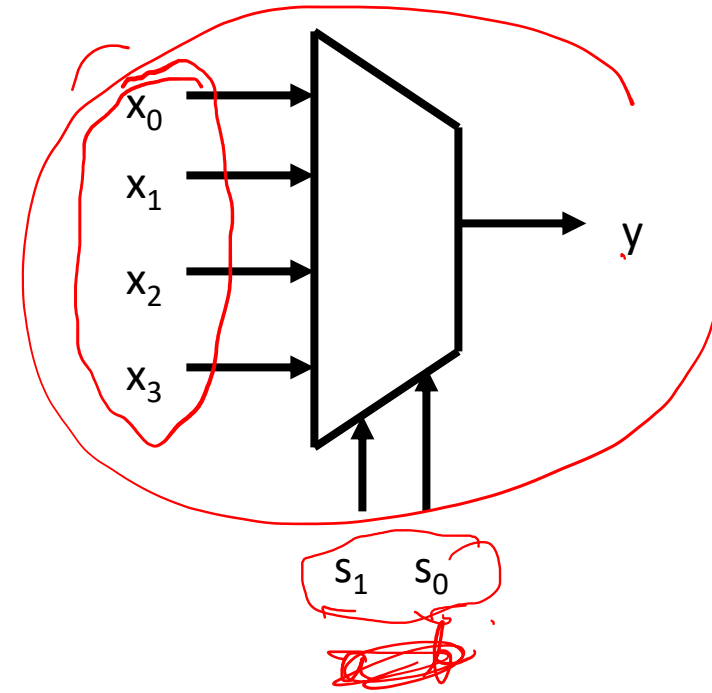
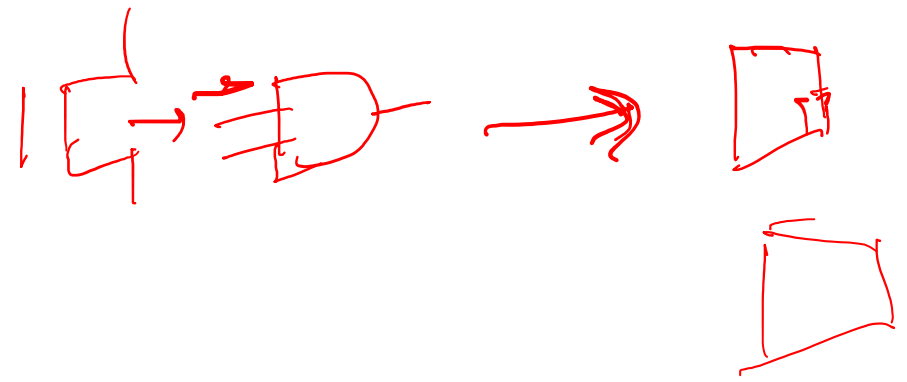
Multiplexer (Cont.)

- 2^n -to-1 Multiplexer (n select lines)

- 4-to-1 Multiplexer (2 select lines)

- Exercise

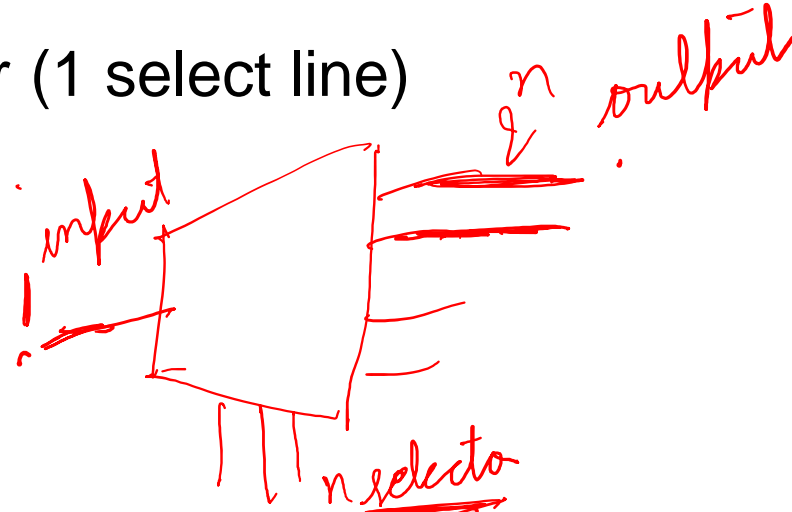
- Complete truth table
- Realize using logic gates



$$y = \bar{s}_1 \bar{s}_0 x_0 + \bar{s}_1 s_0 x_1 + s_1 \bar{s}_0 x_2 + s_1 s_0 x_3$$

De-multiplexer

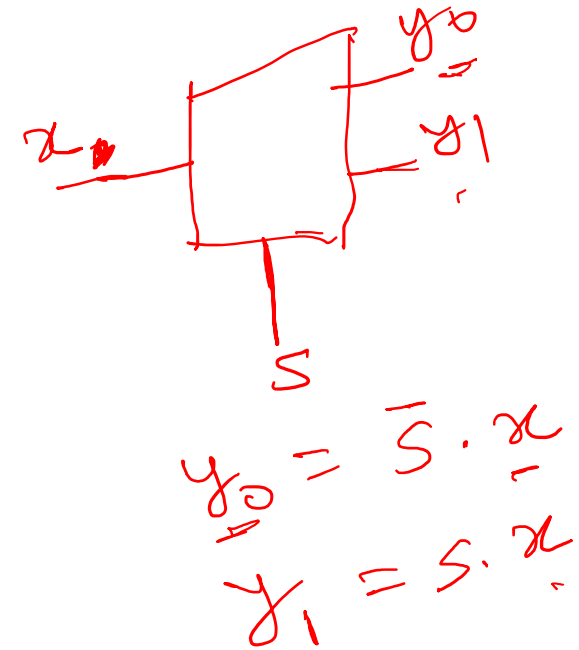
- 1-to-2 Demultiplexer (1 select line)



- 1-to-4 Demultiplexer (2 select lines)

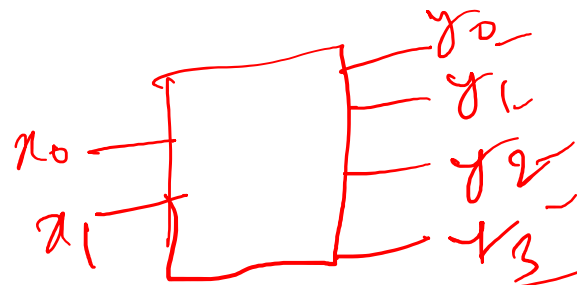
- Exercise

- Complete truth table
- Realize using logic gates



Decoder

- $n \cdot 2^n$
- 2-to-4 decoder with enable



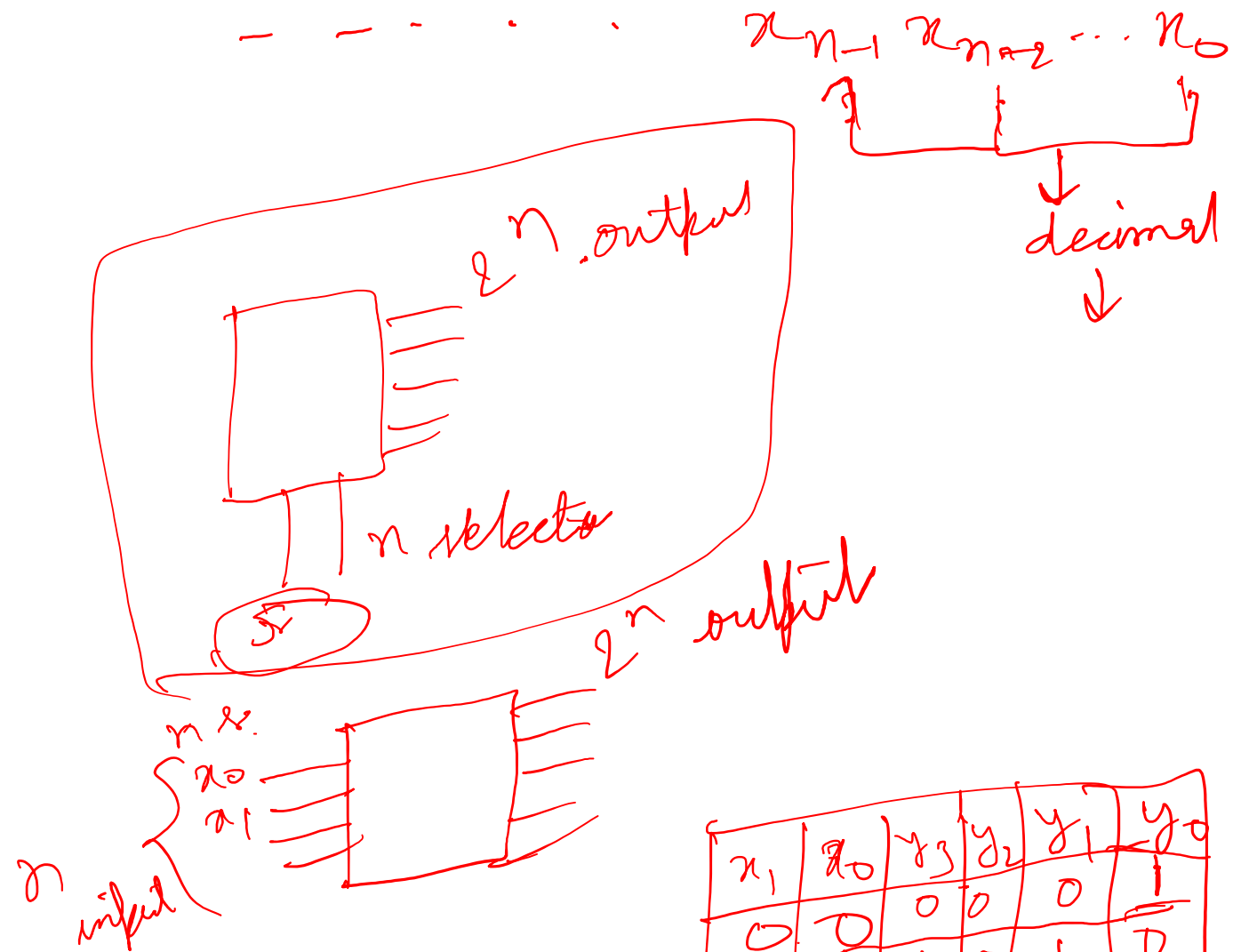
Handwritten equations for the 2-to-4 decoder outputs:

$$y_0 = \bar{x}_1 \bar{x}_0$$

$$y_1 = \bar{x}_1 x_0$$

$$y_2 = x_1 \bar{x}_0$$

$$y_3 = x_1 x_0$$



x_1	x_0	y_3	y_2	y_1	y_0
0	0	0	0	0	1
0	1	0	0	1	0
1	0	0	1	0	0
1	1	1	0	0	0

Read-Only Memory (ROM)

