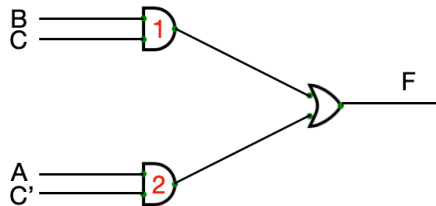


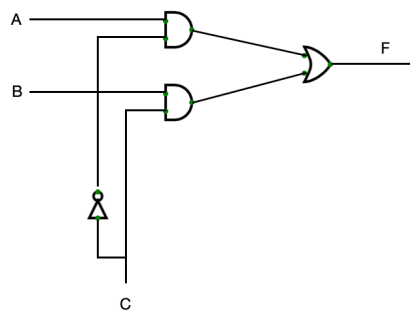
Circuits (IV)

Useful Combinational Circuits (cont.)

- In addition to the decoder, other combinational circuits are frequently used in a computer.
- Each of these circuits fulfills some function, just like an encoder uses N input signals to decide 2^N output values.
- Let's take a look at this circuit.



- Since C and C' are used in both AND gate 1 and AND gate 2, we can draw the circuit as following.



- What does this circuit do?
- Use input C to decide whether the output F has A or B 's value.
- We can also simplify the truth table to

C	F
0	A
1	B

- C is a control bit, deciding which input is F 's value.
- We call this type of combinational circuits **Multiplexer (MUX)**
 - A **data selector**
 - *Routs one of 2^N inputs to one output using N control bits.*

- The black box representation of the above 2:1 MUX is

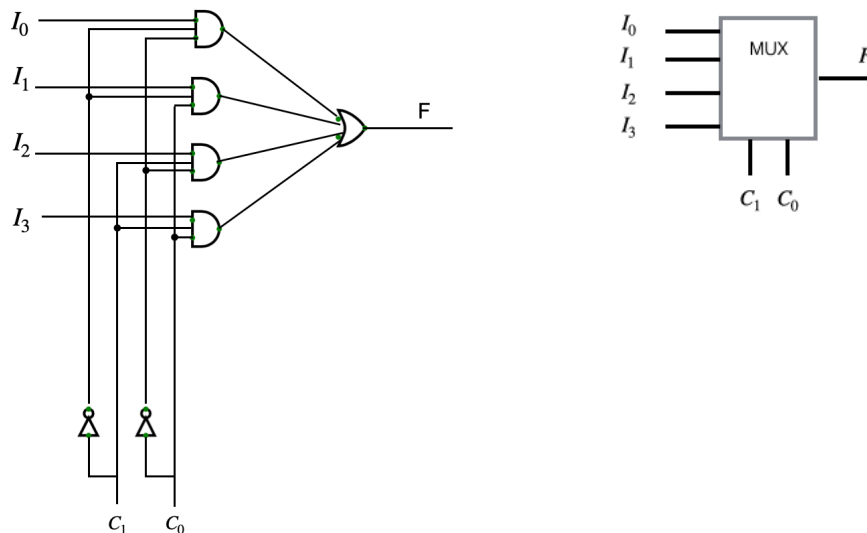


- There are also 4:1 MUX, 8:1 MUX, 16:1 MUX, and 32:1 MUX.
 - What are the corresponding number of control bits those MUX need?
 - 4:1 MUX needs 2, 8:1 MUX needs 3, 16:1 MUX needs 4, and 32:1 MUX needs 5.

- The truth table describe the 4:1 MUX is

C_1	C_0	F
0	0	I_0
0	1	I_1
1	0	I_2
1	1	I_3

- The 4:1 MUX looks like below.

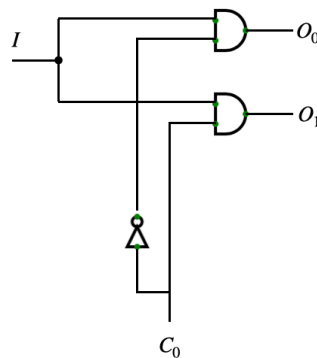


- Can you give me a Sum Of Products for the 4:1 MUX?

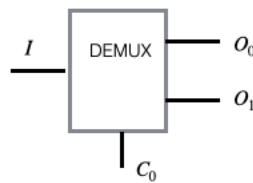
$$F = C_1' C_0' I_0 + C_1' C_0 I_1 + C_1 C_0' I_2 + C_1 C_0 I_3$$

- An example of using MUX in our daily life is the remote controller of home stereo unit that allows us to choose the audio from a cellphone, a tablet, or a TV.
- It is also used in ALU of computers.

- Another useful combinational circuit is **Demultiplexer (DEMUX)**.
 - As the name indicates, it's the inverse of MUX.
 - It is a data distributor.
 - *Routs one input to one of the 2^N outputs using N control bits.*
- The circuit for a 1:2 DEMUX looks like



- A black box representation of a 1:2 DEMUX is



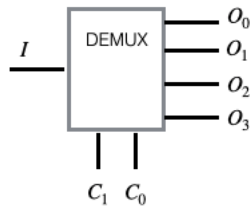
- The truth table for a 1:2 DEMUX is

C_0	O_0	O_1
0	I	0
1	0	I

- It can be used in ALU of computers to decide where the result of ALU should be stored.
- It can also be used to connected a computer and multiple destinations such as B/W laser printer, fax machine, color inject printer, and pen plotter to decide how you want to print.

- **Exercise:** Given the truth table for a 1:4 DEMUX and the black box representation below,
What is the output value if $I = 1$ and $C_1C_0 = 01$? What if $I = 0$ and $C_1C_0 = 11$?

C_1	C_0	O_0	O_1	O_2	O_3
0	0	I	0	0	0
0	1	0	I	0	0
1	0	0	0	I	0
1	1	0	0	0	I



When $I = 1$ and $C_1C_0 = 01$, $O_0 \sim O_3$ is 0100

When $I = 0$ and $C_1C_0 = 11$, $O_0 \sim O_3$ is 0000