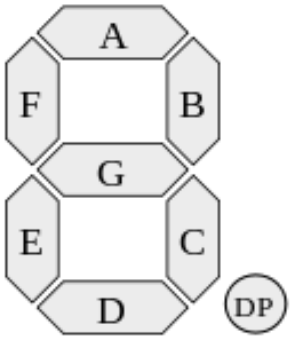
Computer Mathematics

Week 10 Examples

1. A 4-bit *shift register* has one input D and four outputs $Q_0 \ldots q_3$. When the clock ticks, the outputs are shifted left and the input is shifted into the register. In other words, following changes occur: $Q_3 \leftarrow Q_2$, $Q_2 \leftarrow Q_1$, $Q_1 \leftarrow Q_0$, $Q_0 \leftarrow D$. Draw a logic circuit that implements a 4-bit shif register.

2. A bi-directional shift register can shift either left or right, copying D into either Q_3 or Q_0 respectively, depending on another input called 'direction'. Draw a logic circuit that implements a bi-directional shift register.

3. Seven-segment LED displays are common (e.g., in elevators). They can display the digits 0 to 9 and often the letters A to F (hexadecimal digits). A controller for seven-segment displays converts a binary number (in the range 0 to 15) into seven signals that control whether each of the seven segments a through g is on or off.



Segments (✓ = ON)							Display	Segments (✓ = ON)							Display
a	b	c	d	e	f	g		a	b	c	d	e	f	g	
✓	✓	✓	✓	✓	✓		0	✓	✓	✓	✓	✓	✓	✓	8
	✓	✓					1	✓	✓	✓			✓	✓	9
✓	✓		✓	✓		✓	2	✓	✓	✓		✓	✓	✓	A
✓	✓	✓	✓			✓	3			✓	✓	✓	✓	✓	b
	✓	✓			✓	✓	4	✓			✓	✓	✓		C
✓		✓	✓		✓	✓	5		✓	✓	✓	✓		✓	d
✓		✓	✓	✓	✓	✓	6	✓			✓	✓	✓	✓	E
✓	✓	✓					7	✓				✓	✓	✓	F

Draw a logic circuit that converts a 4-bit binary input number into a signal that controls whether segment d is on or off.

Add a four-bit shift register to the inputs of your circuit, so that the display can be programmed using just two signals (serial data and a clock). Represent your seven-segment driver as a single box with four inputs (the digit to display) and seven outputs (driving each LED segment), and your shift register as a single box with five inputs (four data inputs plus clock) and four outputs.