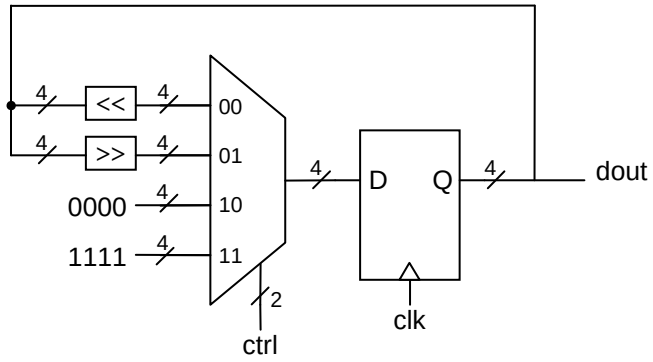
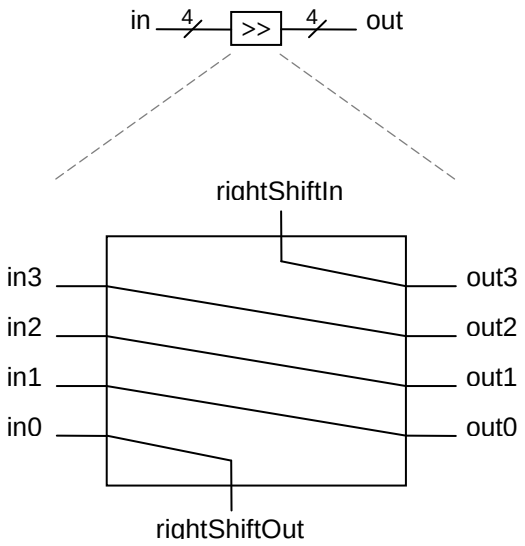
ECEn/CS 224
Chapter 12 Homework Solutions

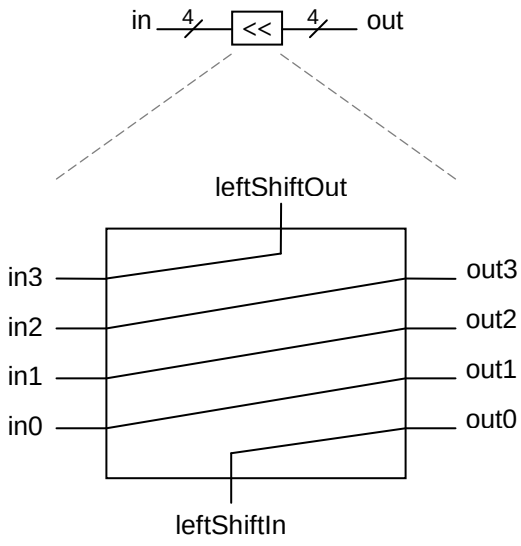
12.1 Design a 4-bit shift register with the following functionality: shift-left, shift-right, clear, load-all-1's. Use a 2-bit control input to select between these options (00=shift-left, 01=shift-right, 10=clear, 11=load-all-1's).

A schematic drawing of the circuit is shown below.



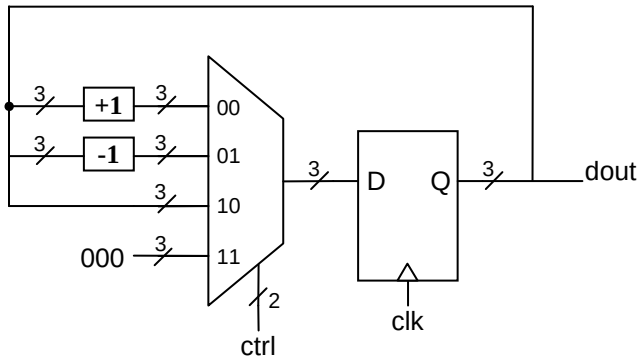
The 1-bit shifters are implemented simply by changing the way the output of the flip flop is connected to the input of the mux, as shown below. Optional shiftIn inputs and shiftOut outputs are also shown. For this problem, it's alright to assume that the value 0 is shifted in and the value that is shifted out is ignored.





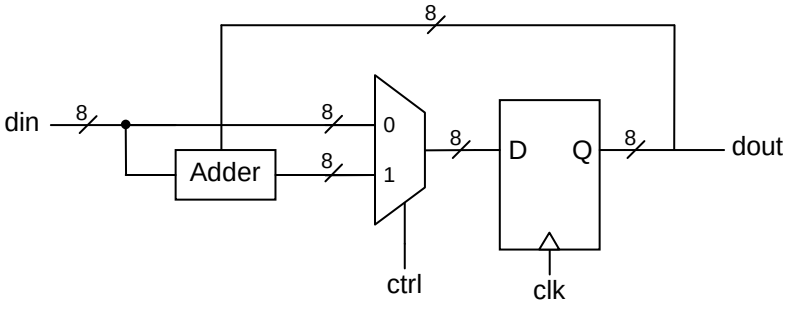
12.2 Design a 3-bit up/down counter with the following functions: increment, decrement, no change, reset. Use a 2-bit control input to select between these options (00=increment, 01=decrement, 10=no change, 11=reset). You may assume you have an already-designed '+1' block available for your use as well as an already-designed '-1' block available for your use.

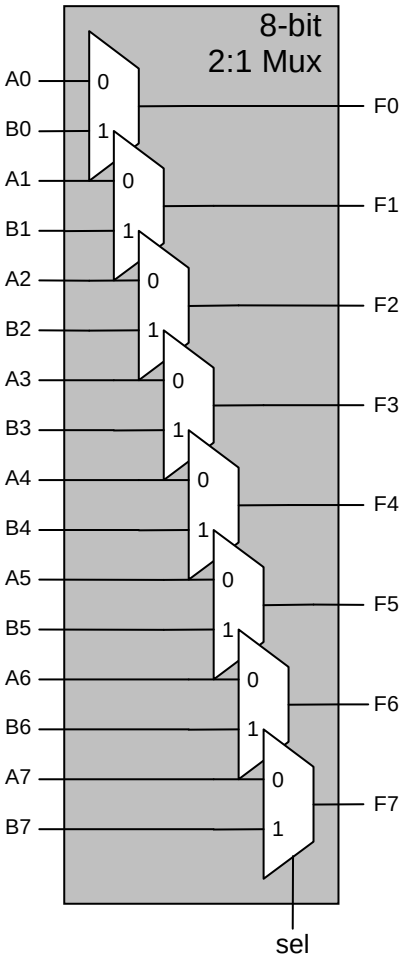
A schematic drawing of the circuit is shown below.

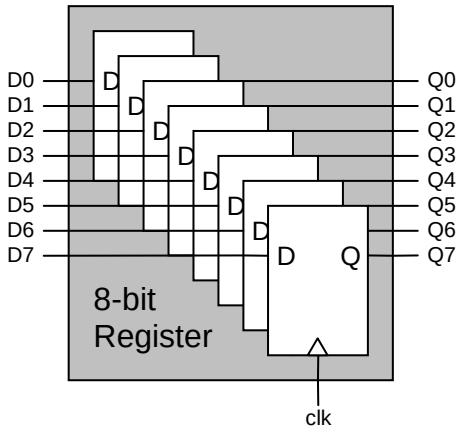


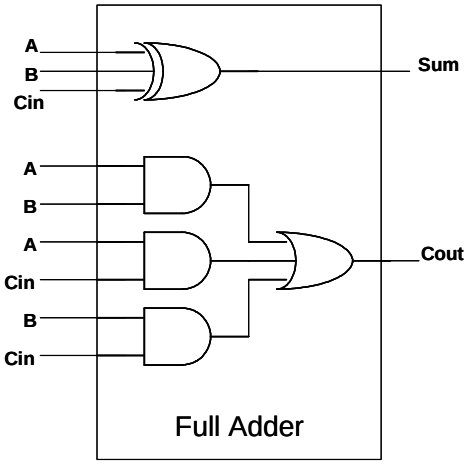
12.3 Design an accumulator. This is a circuit which takes in an 8-bit value and a single control input. When the control input is '0', the accumulator register loads the 8-bit input value. When the control input is '1', the accumulator adds the 8-bit input value to the value already stored in the accumulator register and makes it the new accumulator register value. Design this all the way down to the level of gates and flip-flops.

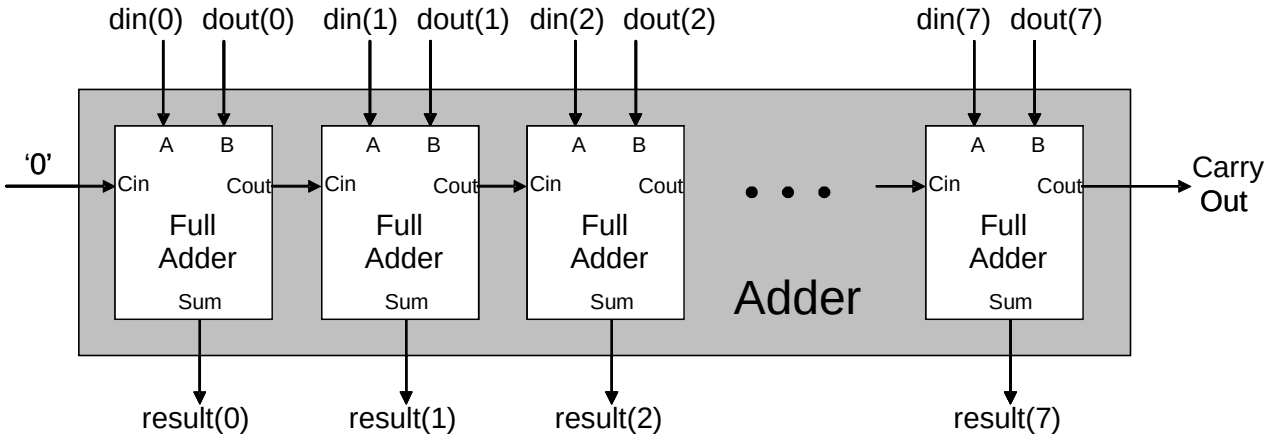
The top level schematic is shown below, followed by the individual blocks. The carry out of the adder would normally be ignored.




8-bit
2:1 Mux
A0
B0
A1
B1
A2
B2
A3
B3
A4
B4
A5
B5
A6
B6
A7
B7
F0
F1
F2
F3
F4
F5
F6
F7
sel


D0
D1
D2
D3
D4
D5
D6
D7
Q0
Q1
Q2
Q3
Q4
Q5
Q6
Q7
D
Q
8-bit
Register
clk


A
B
Cin
Sum
Cout
Full Adder


din(0)
dout(0)
din(1)
dout(1)
din(2)
dout(2)
din(7)
dout(7)
'0'
A
B
Cin
Cout
Full
Adder
Sum
Adder
Carry
Out
result(0)
result(1)
result(2)
result(7)

12.4 Design a 4-bit ring counter. This is a 4-bit shift register. When the control input is high, the register loads the value ’1000’, when the control input is low, the count sequence is:

'1000' → '0100' → '0010' → '0001' → '1000' → …