

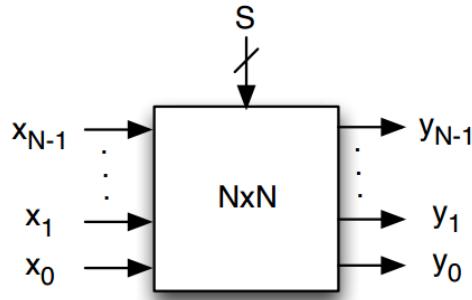
Homework 10: LFSR, Shifters, and Constant Coefficient Multiplication

Due: Friday Nov 21, 5pm

Please include your name, SID and specify either CS150, EE141 or EE241A at the top of your homework handin. Homeworks must be submitted electronically.

1. Design a circuit that can generate both 5 bit and 7 bit pseudo-random numbers. A control signal would switch the circuit between the 5-bit mode and 7-bit mode. When the circuit is used for generating 5 bit numbers, the top two bits of the output should remain low. You will be graded on how well you minimize the amount of hardware used.
2. Design an unsigned combinational multiplier (no flip-flops or controller) for multiplying the unsigned constant value 3900 (decimal) by the 4-bit variable X, which has bits x_3, x_2, x_1 , and x_0 . Using only full-adder cells and inverters, draw a circuit that implements the multiplier, minimizing the total amount of hardware and the delay from input to output. **Hint: think about carry-save addition.** What is the total number of FA cells used?
3. A $N \times N$ crossbar switch is a circuit that can be configured so that each of its N outputs is connected to one of its N inputs:

- (a) Using only 2-input multiplexors, draw the internal circuitry for a 2×2 crossbar switch. Label all inputs and outputs.



- (b) Show how to use the 2×2 switch to design a 4×4 switch.
4. You have 4 flip-flops storing a 4 bit sequence. Using only 2-input MUX's, design a circuit which would allow you to rotate the 4 bits by any shift amount, while minimizing area. You only need to draw the datapath.

5. **EE241A only:** The circuit shown below is used to multiply the 6-bit number X by a 6-bit constant value, C. It is made up of instances of a full-adder cell. The full-adder takes as input 3 1-bit signals and outputs a 1-bit sum and a 1-bit carry. What is the value of C?

