Homework 1 - ECE Review

Problem 1

Perform the following arithmetic using **6 bit 2's complement** numbers. Provide the answer in binary and hexadecimal form.

$$\begin{array}{r} 30 \\ -\ 8 \\ \hline \end{array}$$

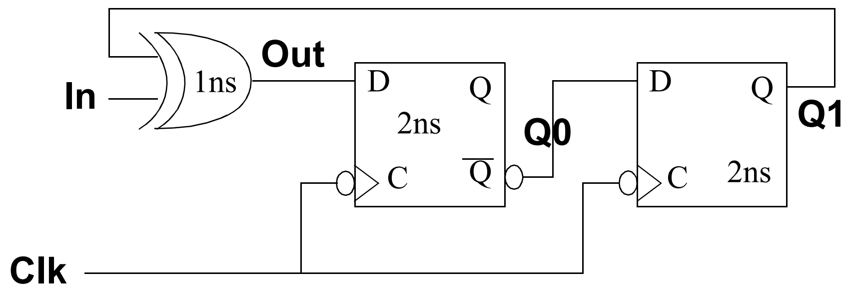
Problem 2

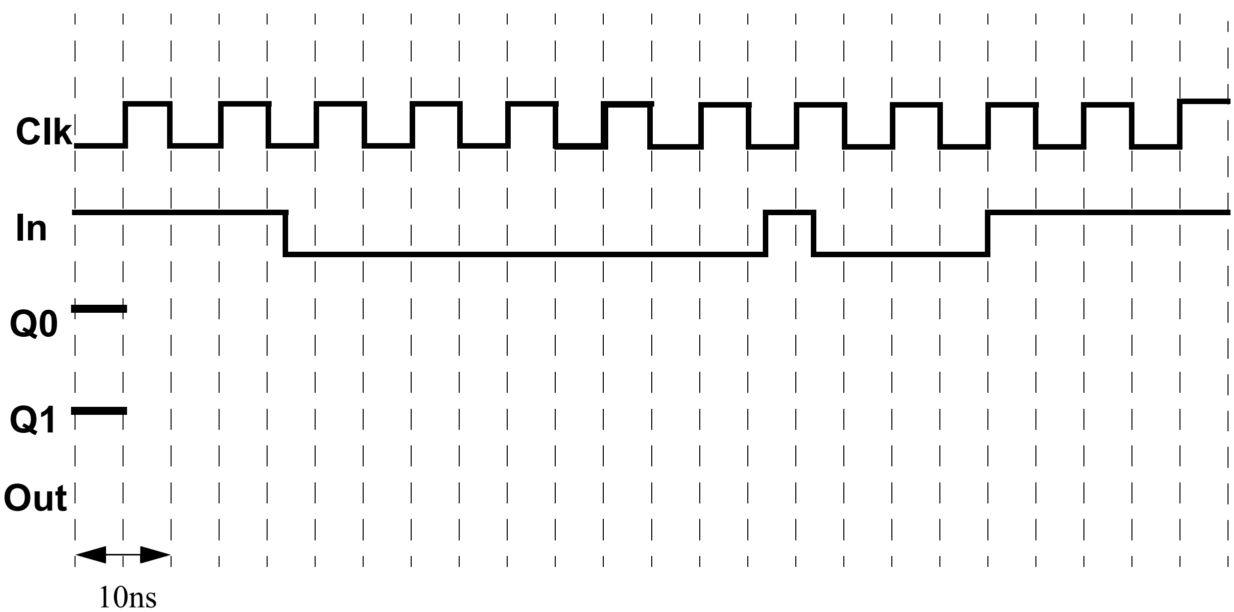
Design a 4-bit arithmetic block that performs the following functions. You may only use muxes, NOR gates, and 4 full adders. Assme all inputs are 4-bit binary numbers in 2's complement form.

S_1 S_0	function
0 0	A+B
0 1	A-B
1 0	A+1
1 1	A-1

Problem 3

Complete the timing diagram for the following circuit. Assume that the flip-flops have a 2ns delay each and that the XOR gate has a 1ns delay. Both flip-flops are negative edge triggered. Q0 and Q1 are initially high.Assume there are no set-up or hold violations.





Problem 4

An electronic lock is controlled by a keypad that has three buttons labelled **A**, **B**, and **R**. The keypad is restricted such that, at most, one key can be pressed at a time, and that each keypress generates an input signal that lasts for only one clock cycle. A state machine takes the keypresses as input, and its output is either lock (**L**) or unlock (**U**). If the correct sequence of keys is typed and followed by an **R**, the state machine generates an unlock (**U**) signal and then resets. At any other time the output should be locked (**L**). If an incorrect sequence of keys is pressed the lock becomes inactive until the reset (**R**) key is pressed, at which point the lock resets (with no unlock signal).

(a) Create state diagram for a MOORE machine that will test for the correct key sequence is BBA. Label your inputs A, B, R, and O (for no key pressed). Label your output L or U. Label your states with words such as “reset” and “inactive,” or with partial key sequences such as “BBA.” Make sure that all possible transistions exist.

(b) How many flip-flops are necessary to implement this state machine if the outputs are one-hot encoded? Explain your answer.

(c) How many flip-flops are necessary to implement this state machine if the states are binary encoded? Explain your answer.

(d) Show how the state diagram would change for a Meely implementation?

(e) How many flip-flops are necessary to implement the Meely state machine if the states are one-hot encoded? Explain your answer.

(f) How many flip-flops are necessary to implement the Meely state machine if the states are binary encoded? Explain your answer.

(g) Under what circumstances would a designer choose the Moore implementation? The Meely implementation?