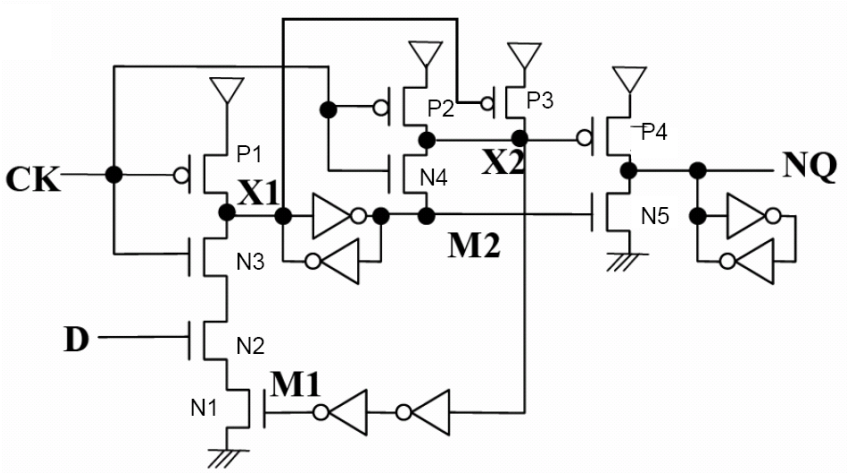
ECE 733
Final Spring 2007

Name:

Student ID:

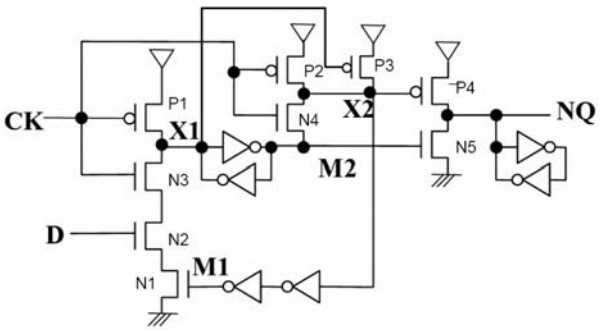
This test is open book, open notes. Computers are NOT allowed (calculators are). You have 75 minutes. Turn in answers on your own paper.

Question 1
Consider the circuit below, the Cross Charge Coupled Flip-flop (XCFF), a variant of the SDFF.

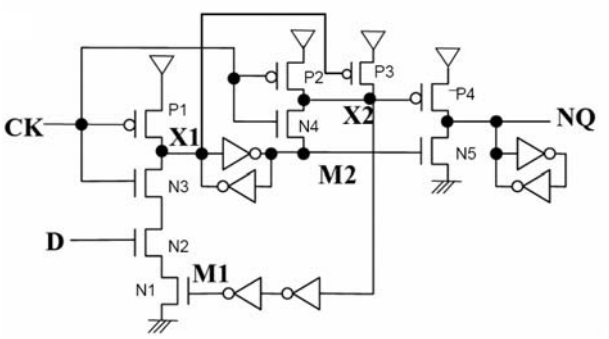


Please answer the following questions:
(a) When CK=0, which nodes are precharged and are they pre-charged high (VDD) or low (GND)? (2 points)

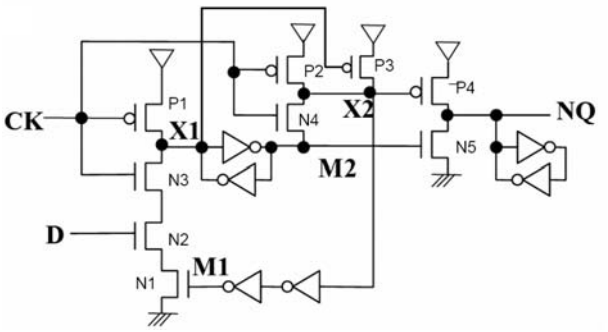
(b) After precharge, what is the basic operation as CK goes from 0 to 1 and if D=1? Clearly label which transistors are on and what the values of nodes X1, X2, M1, M2 and NQ are after CK→1. What is the critical path? Draw it on the diagram. (4 points)



(c) After CK→ 1, what happens if D changes from 1 to 0? I.e. Why does the flip-flop state not change? (2 points)



(d) After precharge, what is the basic operation as CK goes from 0 to 1 and if D=0? Clearly label which transistors are on and what the values of nodes X1, X2, M1, M2 and NQ are after CK→1. What is the critical path? Draw it on the diagram. (4 points)



(e) After the transition in part (d), explain what circuit prevents a false transition if D changes to 1 while clock is high? i.e. What combination of node voltages and transistor states prevent a false transition. [2 points]

(f) What is the purpose of transistor P3? Does it need to be big or small in order to meet this purpose? [2 points]

(g) How does the capacitive load on X1 and X2 each individually compare with that on X in the SDFF? (2 points)

Question 2

Please answer the following short questions.

(a) Of the following loss mechanism, which has the most impact on a 30 cm long 5 Gbps channel built on a standard FR4 PCB? DC resistance, skin effect, dielectric loss, or voltage sharing due to a series termination resistance. [2 points]

(b) Why is a run-length code still desirable in DC-connected channels? [2 points]

(c) For the following data input, which is the expected idealized (0 rise and fall time) waveform after going through a standard two tap (i.e. one flip-flop) pre-emphasis filter? [2 points]