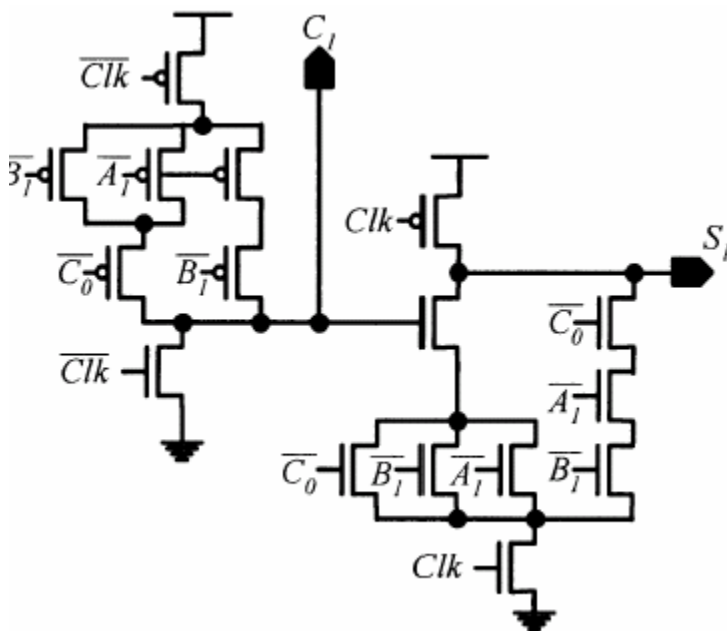


**ECE 733**  
**Midterm**  
**Spring 2005**  
P. Franzon

This test is open book, open notes. Computers are NOT allowed (calculators are). You have 75 minutes. Answer in the space provided.

**Question 1**

Consider the following gate:



Please answer the following questions:

(a) To what class of logic does this gate type belong (e.g. “DCVS”)? (1 point)

Dynamic.

(b) When are C1 and S1 pre-charged and when are they evaluated? (2 points)

Precharged when clock is Low, and evaluated when clock is high.

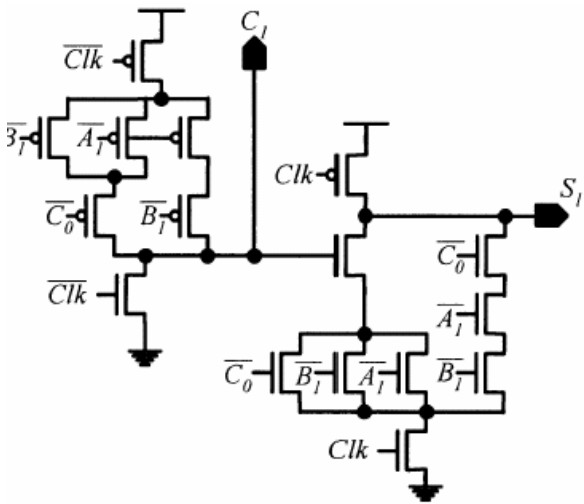
(c) Write the logic expression for C1. What is its function (in words)? (3 points)

$C1 = A1.B1 + A1.C0 + B1.C0$  . Carry out of a full adder.

(d) What is the DC noise margin HI and LO on input A1? Ignore the body effect. (2 points)

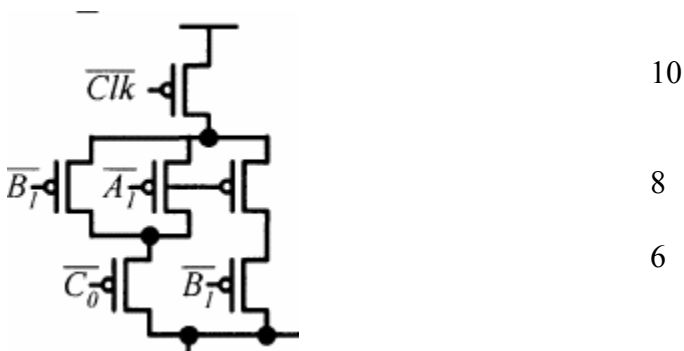
$|V_{tp}|$  and  $V_{tn}$

(e) If the transistors are all the same size, what is the critical path to S1 from the inputs? Use the figure in your answer. Clearly identify which transistors are in this path, and the order in which they might turn on. (4 points)



Thru the pFETs on LHS to the nFET connected to C1. Note, the nFETs beneath this transistor matter but turn on before the upper nFET.

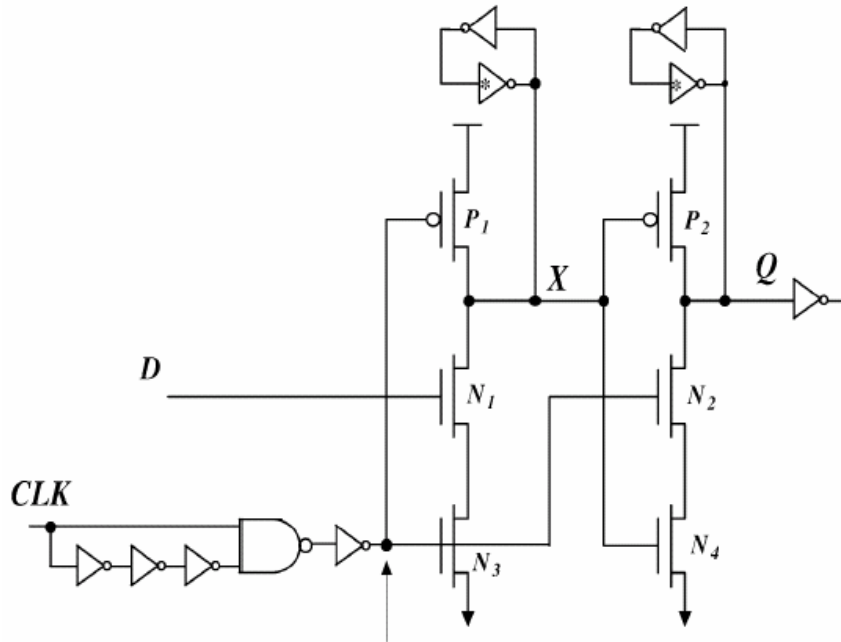
(f) Let's speed up this circuit. If you had only 3 pFET sizes,  $w=10$ ,  $w=8$ , and  $w=6$ , how would you assign them to the transistor group below?





## Question 2

Consider the following circuit.



(a) Is this a Master Slave or pulsed flip-flop? (1 point)

Pulsed.

(b) Is this single-edge or double-edge sampled? (1 point)

Single.

(c) Explain the operation of this flip-flop, using the example of  $D=1$ . Show a waveform for a complete clock period, including CLK, D, X and Q in your waveform. [5 points]

CLK=0 precharges X.

CLK=1. Pulse samples D to pull X down.

Pulse samples X onto Q.

After pulse over Q isolated from X, X goes high.

(d) If D goes to 0 after CLK goes low, what prevents Q from changing incorrectly? [2 points]

N2 is off preventing pull down. P2 is off because of precharge on first stage.