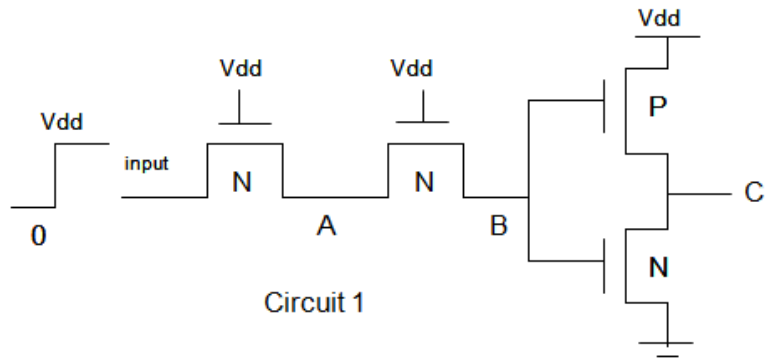


QUESTION #1

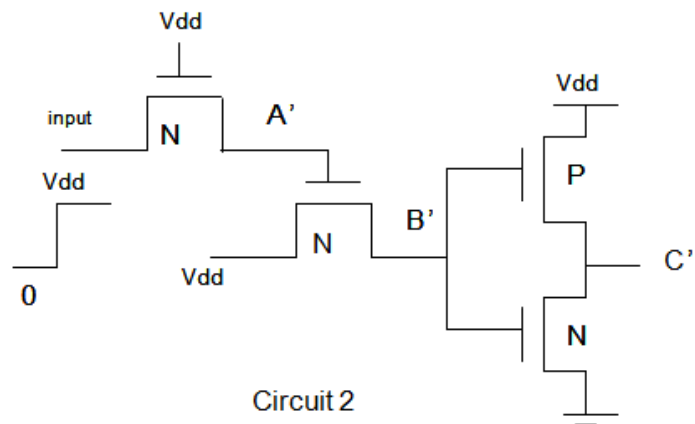
Answer the following questions with a single sentence.

- A) What is body effect in CMOS circuits?
- B) What does “dead zone” of a phase detector refer to?
- C) What is the primary difference between linear and nonlinear oscillators?
- D) What is the primary difference between a latch and a flip-flop?
- E) What is hysteresis effect? Provide an example to illustrate how it can be used.

QUESTION #2



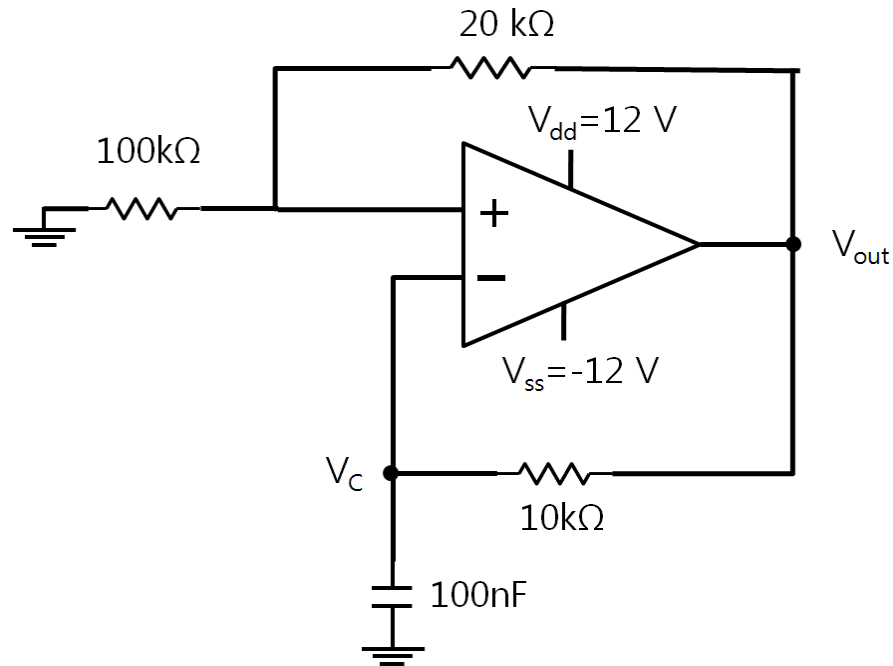
$V_{dd} = 7\text{ V}$



$(V_{th})_n = 3\text{ V}$
 $(V_{th})_p = -4\text{ V}$

Two circuits are shown in the figure above. Assume $V_{dd}=7$. The threshold voltage for NMOS transistors is 3 V and the threshold voltage for PMOS transistors is -4 V. Initially both inputs are at zero voltage. Nodes A and B are also initially at zero voltage. C is at Vdd. Similarly, nodes A' and B' are initially at zero voltage and C' is at Vdd. Both inputs have a step transition to Vdd. Determine the final voltage at nodes A, B, C, A', B', and C'.

QUESTION #3



A relaxation based nonlinear oscillator is shown in the figure above. Note that $V_{dd}=12$ Volts and $V_{ss}= -12$ Volts.

- A) Based on the resistances and capacitance, calculate the oscillation frequency at the output.
- B) What can be done to decrease the oscillation frequency?

Hint: The voltage of a capacitor that is charging or discharging through a resistor R toward a final voltage V_f is determined by

$v(t) = V_f - (V_f - V_{0+})e^{-t/\tau}$ where V_{0+} is the voltage at $t = 0+$ and $\tau = RC$ is the time constant