1-In the circuit shown below, X represents \( \frac{W}{L} \) ratio of the transistors. **all the transistors are in saturation region.**

![Circuit Diagram]

\[ V_{thN} = |V_{thP}| = 0.5V \]
\[ X = \frac{W}{L} = 100 \]
\[ \mu_n C_{ox} = 2 \mu_p C_{ox} = 200 \mu A / V^2 \]
\[ \lambda = \frac{1}{r_o} = 0 \]

a) Find the DC voltage of output nodes (Vo+ or Vo-). (20%)
b) Find the small signal differential gain \( \frac{V_{o+} - V_{o-}}{V_{id}} \). (30%)
c) Find the **minimum and maximum** input common mode voltage (\( V_{CM} \)) so all the transistors remain in saturation region. (50%)
2- In the following circuit, the opamp is ideal and the **initial condition of the capacitor is zero**. When $\phi_s$ is high ($V_H$), the switch is closed and when $\phi_s$ is low ($V_L$), the switch is open.

![Circuit Diagram]

$$RC = 10^{-9}$$

$$T_s = 10^{-9} = 1\text{nS}$$

a) For a DC input signal of $V_{in}$, how many cycles of $\phi_s$ does it take for the output to reach $100V_{in}$? (30%)

b) If the input is $V_{in}=A \sin(\omega_{in}t)$, at what **input frequencies** the output remains zero at the end of each $T_s$ cycle? (70%)