A CMOS variable gain amplifier is shown below.

\[ C_1 \text{ and } C_2 \text{ and } C_3 \text{ are large capacitors.} \]

1. Calculate bias current and voltage for each device.

2. Calculate the small-signal gain for dc control voltage \( V_C = 3, 4, 5V \).

3. Use ZVT to calculate the upper -3dB frequency for \( V_C = 3V \). Neglect capacitance of \( M_7 \) because of its distributed structure.

4. Calculate the peak-to-peak output sinusoidal voltage swing at \( v_0 \) for \( HD_2 = 10\% \) with \( V_C = 3V \). Assume capacitive effects are negligible and that \( V_{GS} \) and \( V_{DS} \) are constant.

5. Check the above on SPICE.