Source-coupled differential pair

In the CMOS circuit shown in the figure below, device parameters are:

**NMOS:** \( \mu_n C_{oo} = 100 \mu A/V^2, V_{in} = 1V, \gamma_n \approx 0, \lambda_n \approx 0.015 \)

The device aspect ratios \( W/L \) in \( \mu m/\mu m \) are shown in the figure. Complete the following sub-parts.

(a) Specify the required value of the bias resistor \( R_B \) to force the bias current \( I_B = 20 \mu A \). Then, at this bias current, solve for the DC bias solution for the circuit assuming the input voltage \( V_{IN} = 0V \) (solve for all labeled voltages and currents).

(b) At the DC operating point solved in (a), determine the voltage gain of the circuit \( A_v = v_o/v_{in} \). Give an analytical solution in terms of device parameters and bias current in addition to a numerical solution.