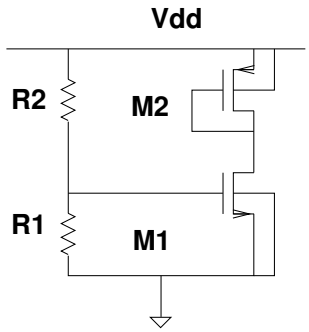
ENGI 5131
Assignment 1 — Winter 2019

- Parameters for NMOS transistors: $k'_n = 180\ \mu\text{A/V}^2$ and $V_{tn} = 0.65$ V, $|\partial L/\partial V_{DS}|_n = 0.03\ \mu\text{m/V}$
- Parameters for PMOS transistors: $k'_p = 50\ \mu\text{A/V}^2$ and $V_{tp} = -0.6$ V, $|\partial L/\partial V_{DS}|_p = 0.04\ \mu\text{m/V}$

1. Find the region of operation and calculate the bias points (I_D, V_{DS}) of M_1 and M_2. In the circuit of the figure, $R_1 = 40.4$ kΩ, $R_2 = 59.6$ kΩ, $V_{DD} = 5$ V, $(W/L)_1 = 6$ and $(W/L)_2 = 18$. Neglect channel-length modulation.



2. In the circuit below, $(W/L) = (20\mu\text{m}/0.8\mu\text{m})$. and $R_D = 10$ kΩ. Neglect channel-length modulation except for the last question.

   (a) Derive an analytic expression for v_O as a function of v_I. You may need a sectionally-defined function to consider the different regions of operation.

   (b) Sketch a plot v_O as a function of v_I. If this circuit is used as an amplifier, for what value of v_I the gain is maximum? Justify your answer.

   (c) Calculate the value of the maximum gain.

   (d) Calculate Δv_O if $\Delta v_I = -5$ mV when the circuit is biased at the point of maximum gain.

   (e) Use small-signal analysis to recalculate the maximum gain considering channel-length modulation.