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EHB 262E: ELECTRONICS II
Homework 2
Due date: April 15, 2021 23.59

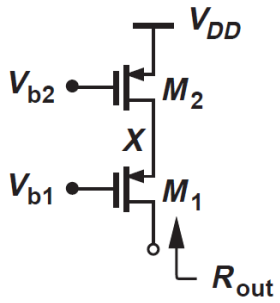

Fig. 1: MOS cascode current source

a) The figure above shows the MOS cascode current source. Draw the small-signal model and find the expression for R_{out}. V_{b1} and V_{b2} are DC voltages. $\lambda \neq 0$, so do not neglect the output resistances of the PMOS transistors. Your final expression must include $g_{m1,}$ g_{m2}, r_{o1} and $r_{o2.}$ (You may want to check the textbooks for derivation but do not just copy it. Learn it and derive it on your own.)

b) Consider that the cascode structure will be used as a load resistor for a NMOS common source amplifier such that the voltage gain of the amplifier is $-g_{m3}R_{out}$ where R_{out} is the resistance found in part a) and g_{m3} is the transconductance of the NMOS transistor M3. Device parameters are $(W/L)_{1,2} = 40$, $(W/L)_3 = 30$, $I_{D1,2,3} = 0.5$ mA, $\mu_n C_{ox} = 100\ \mu A/V^2$, $\mu_p C_{ox} = 50\ \mu A/V^2$, $\lambda_n = 0.1\ V^{-1}$ and $\lambda_p = 0.15\ V^{-1}$, calculate the voltage gain.