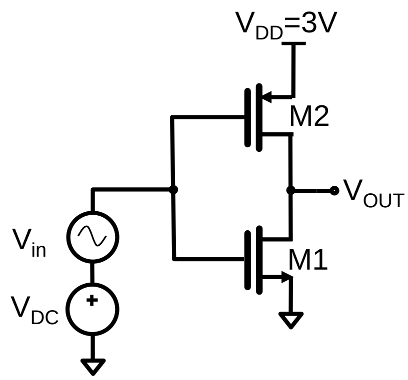
Name:

50 points total

EE 473 Quiz 1 Winter 2022

1) Assume that M1 and M2 are in the saturation region and that V_{DC} is set to produce a DC V_{OUT} which is optimal for maximum headroom and output voltage swing. Also, assume that the drain currents of M1 and M2 are I_D = 0.5mA (Total: 25 points)
Device characteristics: $\mu_n C_{ox} = 4mA/V^2$, $\mu_p C_{ox} = 2mA/V^2$
$(W/L)_{M1}$ = (10µm/0.5µm), and $(W/L)_{M2}$ = (20µm/0.5µm), $\lambda_p=\lambda_n=0.1V^{-1}$ and V_{THn}=0.7V and V_{THp} = 0.8V.



a) What is the small-signal gain $A_v = \frac{v_{OUT}}{v_{in}}$? (15 points)
b) What is the optimal DC value of V_{OUT} to produce a maximum peak-to-peak output swing? This question is ***not*** asking you to compute V_{OUT} DC using the drain current equations for M1 and M2, but rather find the optimal VOUT DC given the $(V_{GS}-V_{TH})$ of M1 and M2. (5 points) What is the corresponding peak output swing? (5 points)

2) For the below single-transistor amplifier, both an ideal DC current source and ideal AC current are applied to the input. It is fair to assume M_1 is in the saturation region and behaves like a "square law" device. Find the DC value of V_{OUT} (5 points) – note: ignore the body affect (λ=0) to make the calculation of the DC bias easier. Next, draw the small signal circuit for this amplifier and derive an expression for the small-signal AC transresistance (v_{out}/i_{in}), state any assumptions made to get your answer. Lastly, compute the value of the transresistance. (20 points) Note: for the AC-SS analysis you cannot ignore the body effect – e.g. $\lambda=0.01V^{-1}$
Device characteristics: $\mu_n C_{ox} = 5mA/V^2$, $(W/L)_{M1}$ = (10µm/1µm), $\lambda=0.01V^{-1}$ and V_t=0.7V.