Nanyang Technological University
School of Electrical & Electronic Engineering
E2002 Analog Electronics – Tutorial 8

1. The DC operating point of the common-drain amplifier in Figure 1 has been calculated in Question 2 of Tutorial 7 to be $I_D = 1.87\ mA$ and $V_{DS} = 9.39$ V. The *n*-MOS transistor M_1 has $K_n = 1$ mA/V^2, $V_{TN} = 1$ V and $\lambda = 0.02$ V^{-1}. Assume that the capacitors have infinite value, $R_I = 100\ \Omega$, $R_1 = 1.2$ MΩ, $R_2 = 910$ kΩ, $R_S = 3$ kΩ, $R_L = 250\ \Omega$ and $V_{DD} = 15$ V, calculate the voltage gain, input resistance and output resistance of the amplifier.
(Ans: $A_v = 0.31$, $R_{in} = 517.54$ kΩ, $R_{out} = 434.6\ \Omega$)

What is the maximum input signal amplitude for small signal operation?
(Ans: 556.52 mV)

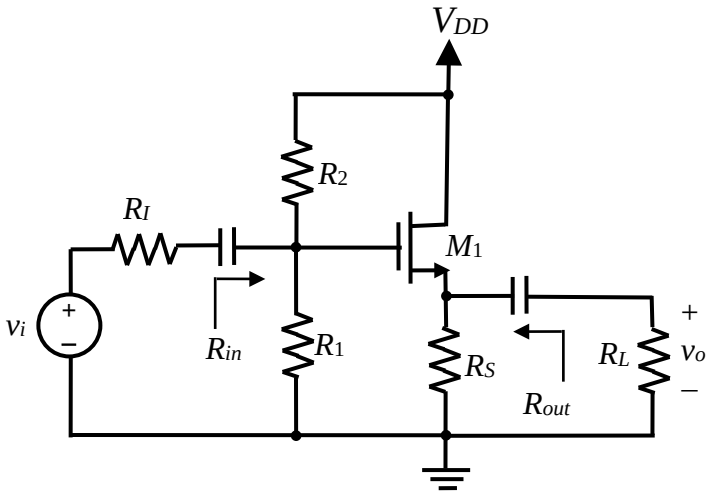

Figure 1

2. What are the voltage gain, input resistance and output resistance for the amplifier in Figure 2. if $R_I = 250\Omega$, $R_S = 68$ kΩ, $R_L = 200$ kΩ, $R_D = 43$ kΩ and $V_{DD} = V_{SS} = 15$ V? What is the maximum input signal for the amplifier that satisfies the small-signal limit? Use $K_p = 200\ \mu$A/V^2 and $V_{TP} = -1$V for your calculation.
(Ans: $A_v = 8.98$, $R_{in} = 3.47$ kΩ, $R_{out} = 43$ kΩ, $v_i \le 0.292$ V)

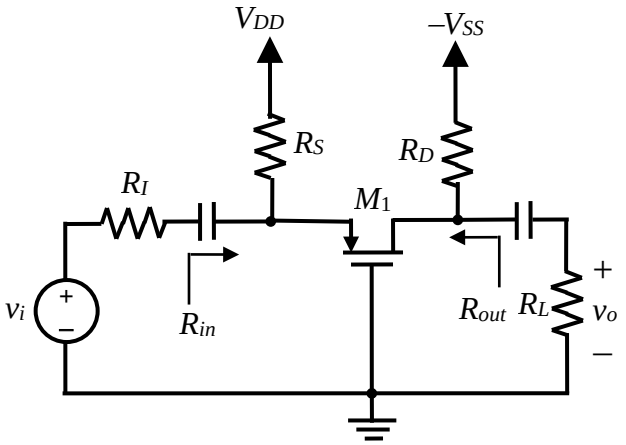

Figure 2

3. The gate resistor R_G in Figure 3 is said to be "bootstrapped" by the action of the source follower.

   a. Assume that the MOSFET is operating with g_m = 3.54 mS and r_o can be neglected. Draw the small signal model and find the voltage gain, input resistance and output resistance for the amplifier if R_G = 1 MΩ, R_S = 2 kΩ, R_L = 100 kΩ and $V_{DD} = V_{SS}$ = 10 V.
   (Ans: A_v = 0.874, R_{in} = 7.94 MΩ, R_{out} = 247 Ω)

   b. What would R_{in} be if A_v were exactly +1?
   (Ans: ∞)

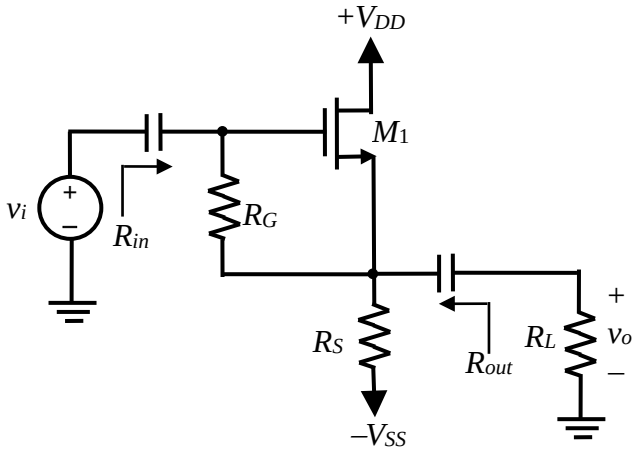

Figure 3