Department of Electrical Engineering
Indian Institute of Technology, Kanpur

EE 210 **Assignment #8** **Assigned: 5/3/21**

1. Consider a simple CE amplifier, as given in class, biased with $I_C = 1$ mA (assume $\beta = 100$). With $R_C = 1$ kΩ, what is the maximum value of the ac small-signal midband voltage gain A_v achievable from the circuit? If, however, the actual value of A_v is found to be −32, estimate the Early voltage V_A of the transistor. What is this indicative of? Now, assuming that the input signal source has a resistance R_S of 1 kΩ, and that the bias current remains unchanged, compute A_v and the input resistance under this condition.

2. For a CS amplifier, as given in class, calculate the ac small-signal midband voltage gain and the dc bias values of the input and output voltages (i.e., V_I and V_0) for the transistor to operate at the boundary between linear and saturation regions. (***Note: this happens to be the maximum voltage gain attainable from this stage, dissipating the least dc power in the transistor.***) Also, calculate the values of V_I and V_0, which would make the transistor operate in the saturation region, and, at the same time, the circuit would have an ac small-signal midband voltage gain of unity. Assume $V_{DD} = 3$ V, $R_D = 5$ kΩ, $k'_N = 200$ μA/V^2, W = 10 μm, L = 1 μm, $V_{TN0} = 0.6$ V, and neglect body effect and channel length modulation effect.

3. Consider a CS amplifier, as given in class, with $R_D = 10$ kΩ, $I_D = 100$ μA, $k'_N = 40$ μA/V^2, and W/L = 10. Determine its ac small-signal midband voltage gain, and input and output resistances. Repeat if $\lambda = 0.2$ V^{-1}, but assume that $\lambda V_{DS} \ll 1$, and also that the bias current is maintained at 100 μA. With what gate overdrive voltage (ΔV) is the device operating? What is the maximum value of the voltage gain that is possible to be attained from the circuit? Also, compute the transconductance to drain current ratio, and compare this with $1/V_T$.

4. Determine the input resistance, voltage gain, and output resistance of the CC circuit, as given in class, in the presence of a source resistance R_S of 5 kΩ. Assume $R_E = 500$ Ω, bias current $I_C = 1$ mA, and $\beta = 100$. Neglect r_0.

5. For the CD circuit shown in Fig.1, assume that the MOSFET M has W/L = 10 and $\lambda \to 0$. Other parameters are: $k'_N = 40$ μA/V^2, $\gamma = 0.4$ V$^{1/2}$, $2\phi_F = 0.6$ V, and $V_{TN0} = 0.7$ V. Find the dc output voltage V_0, and the ac small-signal midband voltage gain v_0/v_i under the following conditions:
   i) Ignoring body effect and with $R \to \infty$.
   ii) Including body effect and with $R \to \infty$.

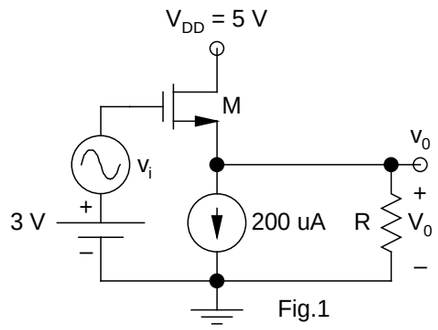

Fig.1

6. Repeat Prob.5 under the following conditions:
   i) Including body effect and with R = 100 kΩ.
   ii) Including body effect and with R = 10 kΩ.