1. For the Common-Base amplifier shown in Figure-1:
   (a) Draw the small-signal model of the amplifier. Assume the coupling capacitors ($C_{C1}, C_{C2}$) are shorts for the frequency of interest. Also neglect the output impedance ($r_o$) of the transistor.
   (b) From the small-signal model derive $A_v, A_{vo}, A_i, Z_{in}, Z_{out}$ and Power Gain (G) in terms of the circuit parameters.
   (c) For $R_L = 10k\Omega$, $R_C = 10k\Omega$, $V_{CC} = 10V$ and $R_s = 100\Omega$, to what value must the bias current $I_{dc}$ be set in order that the input impedance $Z_{in}$ matches $R_s$ (i.e. $Z_{in} = 100\Omega$)? What is the resulting voltage gain from the source to the load? Assume $\alpha \approx 1$.

![Figure-1](image1)

2. For the Common-Base amplifier in Prob-1 and for the values given in Prob-1(c), find the short-circuit two-port model parameters shown in Figure-2. where:
   \[ G_{in} = \left. \frac{I_o}{V_{in}} \right|_{v_o=0} \]
   \[ G_{mr} = \left. \frac{I_{in}}{v_o} \right|_{v_{in}=0} \]
   \[ Z_{in} = \left. \frac{V_{in}}{I_{in}} \right|_{v_o=0} \]
   \[ Z_o = \left. \frac{\Delta V}{\Delta I} \right|_{v_{in}=0} \]
3. A certain NMOS transistor has $W = 10\mu m$, $L = 1\mu m$, $k_n = 50\mu A/V^2$, and $V_T = 1V$. For the three circuits shown in Figure-3, find the region of operation (i.e. cut-off, triode or saturation) and using the appropriate equation determine the drain current ($I_D$).

![Figure-3](image)

4. In this problem you are trying to characterize a Common-Emitter amplifier to create a two-port equivalent circuit as shown in Figure-4. Based on measurement values extracted experimentally, you can derive the the two-port model of the amplifier. The experimental setup is:

- You are driving the amplifier with 1KHz source with amplitude of 100mV (i.e. $v_s = 100mV \cdot \sin(\omega t)$).
- In series with the source is a 100$\Omega$ resistance (i.e. $R_s = 100\Omega$). This source is AC coupled which is assumed to be a short for this particular frequency.
- The load resistance is 12k$\Omega$ (i.e. $R_L = 2k\Omega$).

Following are measurement values for the given experimental setup:

- The peak voltage measured at the input is 50mV (i.e. $v_{in} = 50mV$).
- The peak voltage measured at the output, without the load, is 500mV (i.e. $v_{out} = 500mV$).
- The peak voltage measured at the output, with the load, is 333mV (i.e. $v_{out} = 333mV$).

Based on the measurement, determine the two-port model parameters, $Z_{in}$, $Z_0$, $G_m$.

![Figure-4](image)
5. Find the transfer function \((O/I)\) for the given graph using Mason's Gain formula.