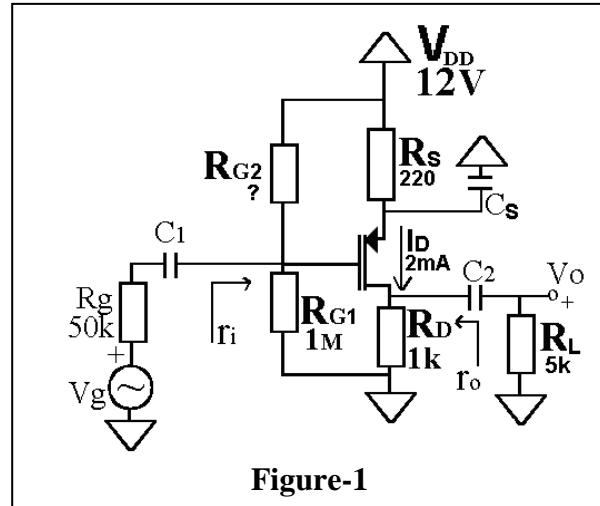


**EE232-INTRODUCTION TO ELECTRONICS-FALL 2009**  
**EXERCISE-M4**

**Q-1-**  $\beta = 6\text{mA/V}^2$  and  $V_t = -1\text{V}$  are given for the MOSFET in Figure-1.

- Find  $R_{G2}$  in order to get  $I_D = 2\text{mA}$  in DC case.
- Find the power dissipated on the MOSFET.
- Find the ac input ( $r_i$ ) and output ( $r_o$ ) resistances.
- Find the ac gain ( $V_o/V_i$ ) of the circuit.
- Find the total ac gain ( $V_o/V_g$ ) of the circuit.



**SOLUTION**

**a)**

**Source voltage:**

$$V_S = V_{DD} - I_D R_S$$

$$V_S = 12 - 2\text{mA} \times 0.22\Omega$$

$$V_S = 11.56\text{V}$$

**Gate Voltage:**

The transistor is assumed in the saturation region

$$I_D = \frac{\beta}{2} (V_{GS} - V_t)^2$$

$$I_D = \frac{6\text{mA/V}^2}{2} (V_G - V_S - V_t)^2$$

$$I_D = \frac{6\text{mA/V}^2}{2} (V_G - 11.56\text{V} - (-1))^2 = 2\text{mA}$$

$$(V_G - 11.56\text{V} - (-1))^2 = \frac{2}{3}$$

$$(V_G - 11.56\text{V} - (-1)) = -0.82$$

$$V_G = 9.74\text{V}$$

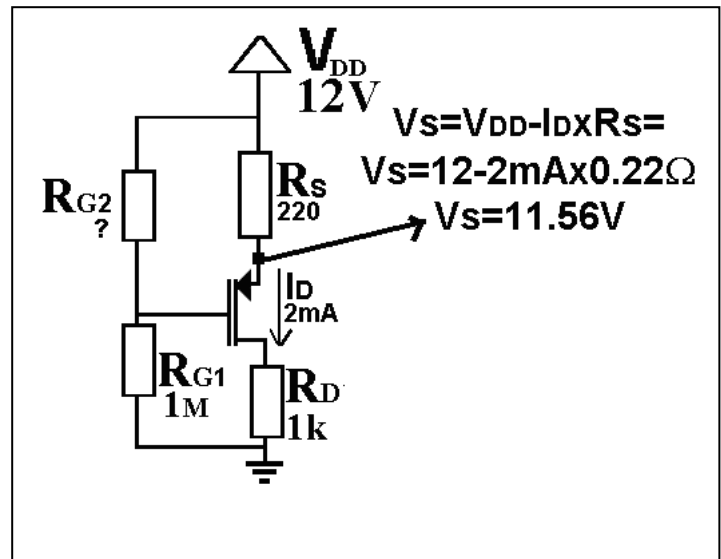
**$R_{G2}$ :**

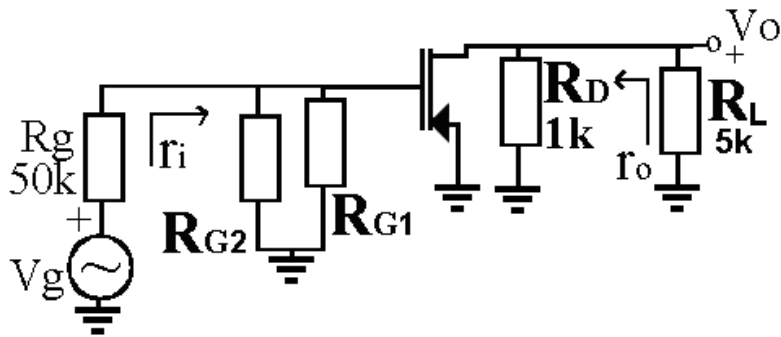
$$V_G = \frac{R_{G1}}{R_{G2} + R_{G1}} V_{DD} = 9.74\text{V} \Rightarrow \frac{R_{G1}}{R_{G2} + R_{G1}} = \frac{9.74\text{V}}{12\text{V}} \Rightarrow R_{G2} \cong 232\text{k}\Omega$$

**b)**

**Dissipated Power on MOSFET:**

$$P_{MOS} = I_D \times V_{SD} = 2\text{mA} \times (V_S - V_D) = 2\text{mA} \times (11.56\text{V} - I_D \times R_D) = 2\text{mA} \times 9.56\text{V} = 19.12\text{mW}$$





ac case of the circuit.

c)

**input resistance**

$$r_i = R_{G1} \parallel R_{G2} = 188k\Omega$$

*Note that the input resistance of the MOSFET is infinite.*

**Output resistance**

$$r_o = R_D = 1k$$

*Note that  $V_A$  is infinite, therefore the ac resistance seen from the drain is infinite.*

d)

**the gain  $V_o/V_i$**

$$\frac{V_o}{V_i} = -\frac{g_m R_d}{1 + g_m R_s} = \frac{-g_m R_D \parallel R_L}{1 + 0} = -\sqrt{2\beta I_D} \times 0.83k\Omega \cong -4.1$$

e)

**the gain  $V_o/V_g$**

$$\frac{V_o}{V_g} = \frac{V_i}{V_g} \frac{V_o}{V_i} = \frac{R_{G2} \parallel R_{G1}}{R_g + R_{G2} \parallel R_{G1}} \times (-4.1) \cong -3.2$$

\*\*\*\*\*

