EE232-INTRODUCTION TO ELECTRONICS-FALL 2009
EXERCISE-M4

Q-1-β=6mA/V^2 and V_t=-1V are given for the MOSFET in Figure-1.

a) What should be R_{G2} in order to get I_D=2mA in DC case.

b)Find the power dissipiated on the MOSFET.

c) Find the ac input (ri) and output (ro) resistances.

d) Find the ac gain (Vo/Vi) of the circuit.

e) Find the total ac gain (Vo/Vg) of the circuit.

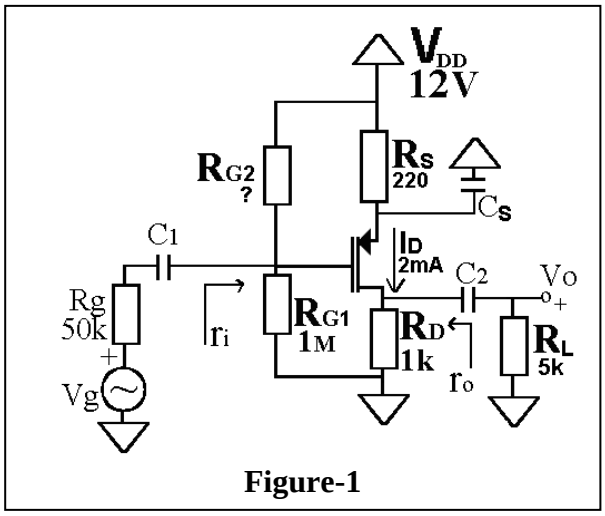


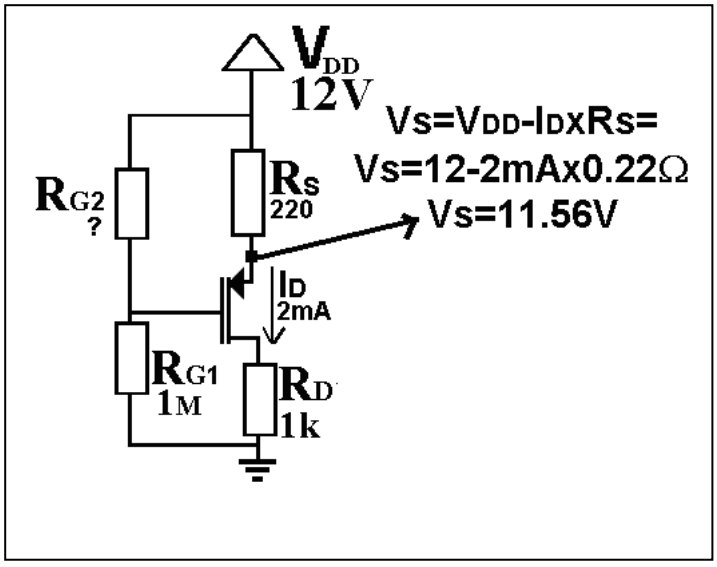
Figure-1

SOLUTION

a)

Source voltage:

$$Vs = V_{DD} - I_D R_S$$
$$Vs = 12 - 2mAx0.22\Omega$$
$$Vs = 11.56V$$



Gate Voltage:

The transistor is assumed in the saturation region

$$I_D = \frac{\beta}{2}(V_{GS} - V_t)^2$$
$$I_D = \frac{6mA/V^2}{2}(V_G - V_S - V_t)^2$$
$$I_D = \frac{6mA/V^2}{2}(V_G - 11.56V - (-1))^2 = 2mA$$
$$(V_G - 11.56V - (-1))^2 = \frac{2}{3}$$
$$(V_G - 11.56V - (-1)) = -0.82$$
$$V_G = 9.74V$$

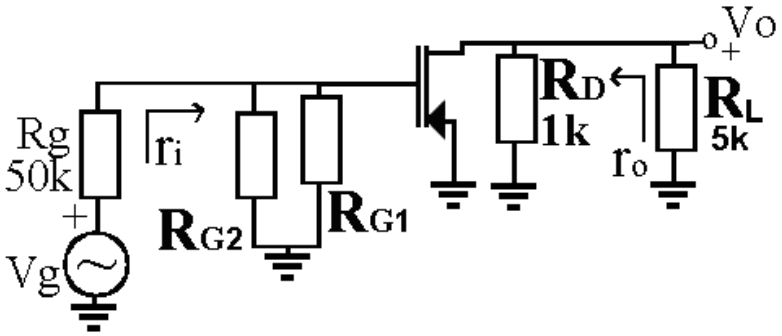
R_{G2}:

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

b)

Dissipated Power on MOSFET:

$$P_{MOS} = I_D x V_{SD} = 2mAx(V_S - V_D) = 2mAx(11.56V - I_D x R_D) = 2mAx9.56V = 19.12mW$$



ac case of the circuit.

c)
input resistance

$ri = R_{G1} // R_{G2} = 188k\Omega$ ***Note that the input resistance of the MOSFET is infinite.***

Output resistance

$ro = R_D = 1k$ ***Note that V_A is infinite, therefore the ac resistance seen from the drain is infinite.***

d)
the gain Vo/Vi

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

e)
the gain Vo/Vg

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

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