

ESERCIZIO 1 (Settimana 7)

Dato l'amplificatore di figura, avente i seguenti parametri (a 25°C):

$$V_{DD} = 36 \text{ V}, R_g = 100 \text{ k}\Omega, R_B = 1 \text{ M}\Omega, R_D = 6 \text{ k}\Omega, R_{S1} = 0.2 \text{ k}\Omega, R_L = 4 \text{ k}\Omega;$$

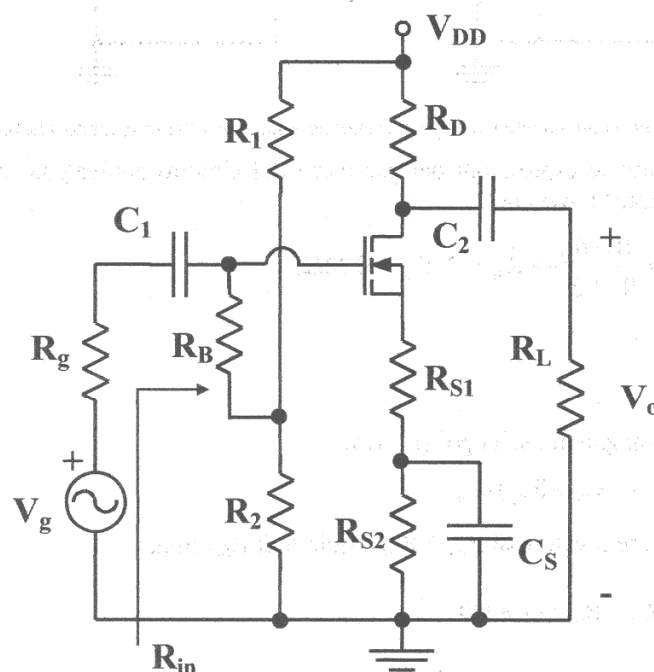
Q1: MOSFET ad arricchimento a canale n,

$$I_{DQ} = 3 \text{ mA}, V_{DSQ} = 12 \text{ V}, V_T = 5 \text{ V}, V_T^2 k W/L = 5 \text{ mA} \quad (k = \mu_n C_{ox}/2), r_d = 150 \text{ k}\Omega;$$

(I_{DSS})

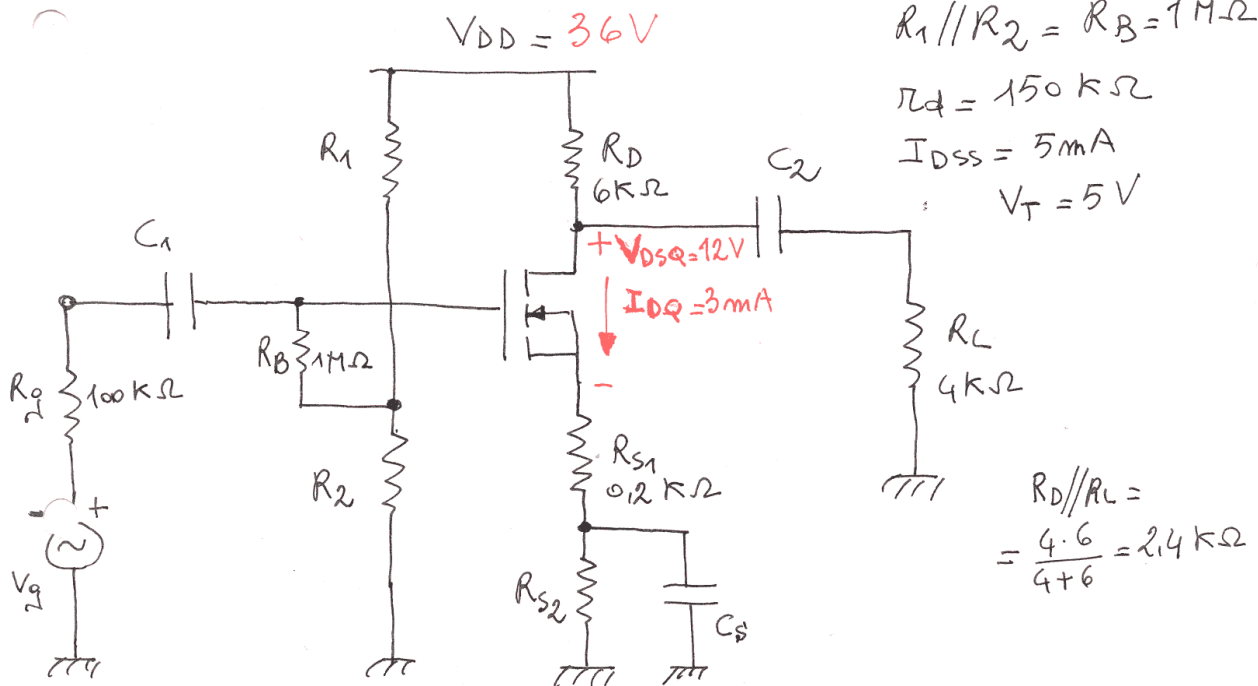
determinare:

- 1) il valore delle resistenze R_1, R_2, R_{S2} , sapendo che $R_1/R_2 = R_B$;
- 2) il guadagno di tensione $A_v = V_o/V_g$ a centro banda;
- 3) la resistenza di ingresso R_{in} indicata;

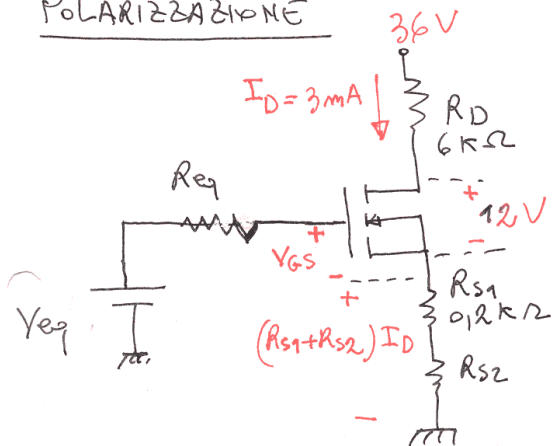


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POLARIZZAZIONE



$$I_D = I_{DSS} \left(1 - \frac{V_{GS}}{V_T}\right)^2 \quad V_{GS} = V_T \left(1 \mp \sqrt{\frac{I_D}{I_{DSS}}}\right) = 5 \left(1 \mp \sqrt{\frac{3}{5}}\right) = 8.87V$$

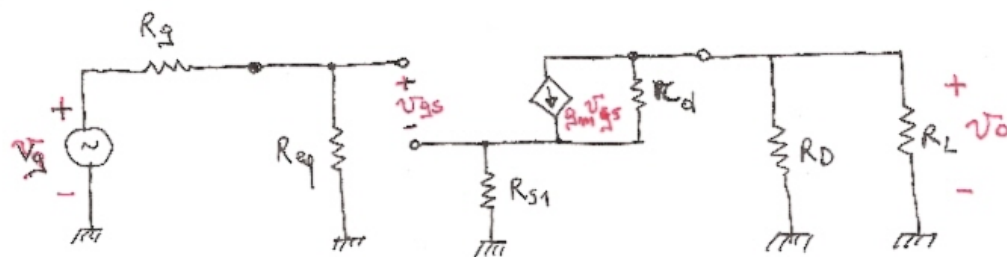
$$V_{eq} = V_{GS} + (R_{S1} + R_{S2}) I_D = 8.87 + (0.2 + 1.8) \cdot 3 = 14.87V$$

$$14.87 = 36 \cdot \frac{R_2}{R_1 + R_2} \quad ; \quad \frac{R_2}{R_1 + R_2} = 0.412 \quad \left\{ \frac{R_1 R_2}{R_1 + R_2} \right\} = 1M$$

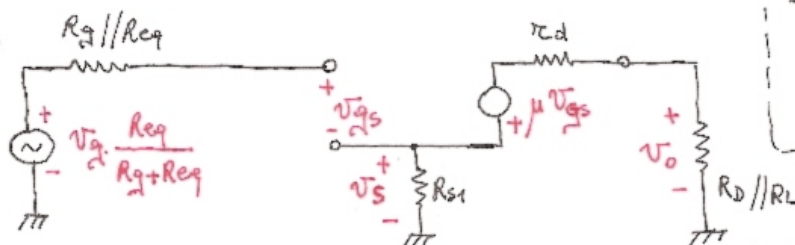
$$R_1 = \frac{1M}{0.412} = 2.42M\Omega$$

$$R_2 = (2.42 + R_2) \cdot 0.412$$

$$R_2 \approx 1.7M\Omega$$



$$g_m = 2 \sqrt{\frac{k_W}{L} I_{DQ}} = \frac{2}{V_T} \sqrt{I_{DQ} \cdot I_{DSS}} = \frac{2}{5V} \sqrt{3mA \cdot 5mA} \approx \frac{1,55 \text{ mA}}{V}$$



$$\begin{aligned} I_D &= \frac{k_W}{L} (V_{GS} - V_T)^2 \\ &= \frac{k_W}{L} V_T^2 \left(1 - \frac{V_{GS}}{V_T}\right)^2 \\ &= I_{DSS} \left(1 - \frac{V_{GS}}{V_T}\right)^2 \end{aligned}$$

$$\mu = g_m \cdot r_{ds} = \mu \cdot V_{GS}$$

$$\mu = \frac{g_m r_{ds}}{1} = 1,55 \cdot 150 = 232,5$$

$$v_o = -\mu \cdot v_{gs} \cdot \frac{R_D // R_L}{R_{S1} + r_{ds} + R_D // R_L}$$

$$v_g \frac{R_{eq}}{R_g + R_{eq}} = v_{gs} + v_s = v_{gs} + \mu \cdot v_{gs} \cdot \frac{R_{S1}}{R_{S1} + r_{ds} + R_D // R_L}$$

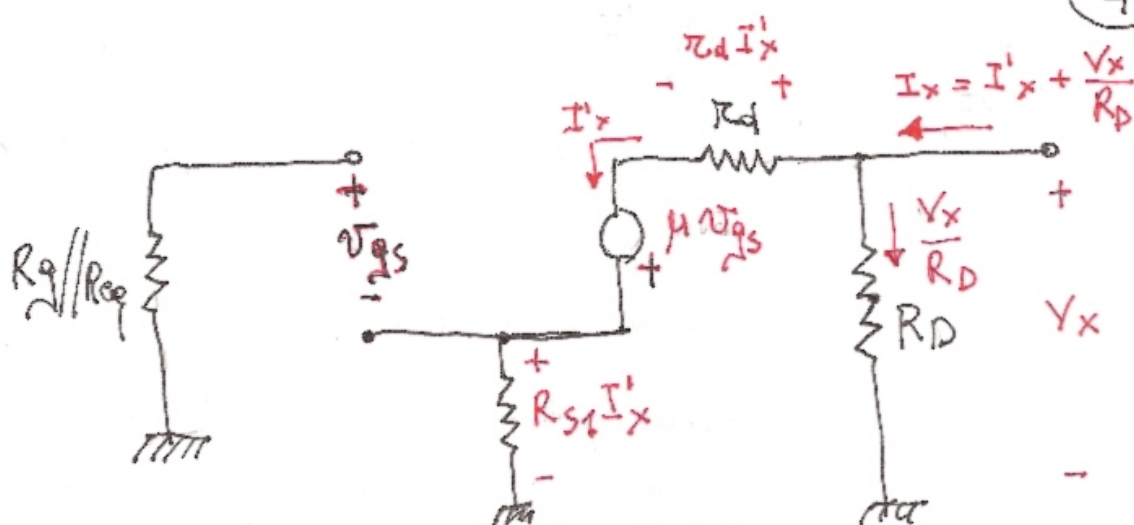
$$v_{gs} = \frac{R_{eq}}{R_g + R_{eq}} \cdot \frac{R_{S1} + r_{ds} + R_D // R_L}{(1 + \mu) R_{S1} + r_{ds} + R_D // R_L} \cdot v_g$$

$$v_o = -\mu \cdot \frac{R_{eq}}{R_g + R_{eq}} \cdot \frac{(R_{S1} + r_{ds} + R_D // R_L)}{(1 + \mu) R_{S1} + r_{ds} + R_D // R_L} \cdot v_g \cdot \frac{R_D // R_L}{(R_{S1} + r_{ds} + R_D // R_L)}$$

$$A_v = \frac{v_o}{v_g} = -\mu \cdot \frac{R_{eq}}{R_g + R_{eq}} \cdot \frac{R_D // R_L}{(1 + \mu) R_{S1} + r_{ds} + R_D // R_L} = -\frac{232,5 \cdot 2}{0,100 + 2 \cdot (1 + 232,5) \cdot 0,02 + 150 + 2,4} = -2,67$$

$$R_i = R_{eq} = R_D + R_1 // R_2 = 1M\Omega + 1M\Omega = 2M\Omega$$

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$$V_{gs} = -R_{s1} I_x' \quad \mu V_{gs} = -\mu R_{s1} I_x'$$

$$-V_x + r_d I_x' - \mu V_{gs} + R_{s1} I_x' = 0$$

$$V_x = r_d I_x' + \mu R_{s1} I_x' + R_{s1} I_x'$$

$$I_x' = \frac{V_x}{r_d + (\mu + 1) R_{s1}}$$

$$R_o = \frac{V_x}{I_x} = \frac{V_x}{I_x' + \frac{V_x}{R_D}} = \frac{1}{\frac{1}{r_d + (\mu + 1) R_{s1}} + \frac{1}{R_D}}$$

$$= \frac{1}{\frac{1}{150 + (232,5 + 1) \cdot 0,2} + \frac{1}{6}} = \frac{6 \cdot [150 + 233,5 \cdot 0,2]}{6 + 150 + 233,5 \cdot 0,2}$$

$$\cong 5,82 \text{ k}\Omega$$