Parțial 2 – Dispozitive Electronice
11.01.2019

Rezolvare problema

a) M1 – conexiune DC deoarece in - G, out - S
M2 – conexiune SC deoarece in – G, out - D

b) PSF

- M1 - TEC-MOS canal inițial

$$\left.\begin{aligned} V_{GS1} &= V_{G1} - V_{S1} \\ V_{G1} &= 0 \\ V_{S1} &= I_{D1}R_2 = 6I_{D1} \end{aligned}\right\} \Rightarrow V_{GS1} = -6I_{D1}$$

$$I_{D1} = I_{DSS}\left(1 - \frac{V_{GS1}}{V_{GS(off)}}\right)^2 = 5\left(1 - \frac{-6I_{D1}}{-2}\right)^2 = 5(1-3I_{D1})^2$$

$$I_{D1} = 5\left(1 - 6I_{D1} + 9I_{D1}^2\right) = 5 - 30I_{D1} + 45I_{D1}^2$$

$$45I_{D1}^2 - 31I_{D1} + 5 = 0$$

$$I_{D1(1,2)} = \frac{31 \pm \sqrt{31^2 - 4\cdot 45\cdot 5}}{90} = \frac{31 \pm 7{,}8}{90} \Rightarrow \begin{cases} I_{D1(1)} = \dfrac{31+7{,}8}{90} = 0{,}43mA \\ I_{D1(2)} = \dfrac{31-7.8}{90} = 0{,}26mA \end{cases}$$

$$V_{GS1(1)} = -6\cdot 0{,}43 = -2{,}58V$$

$$V_{GS1(2)} = -6\cdot 0{,}26 = -1{,}56V \rightarrow |-1{,}56| \langle |-2| \Rightarrow I_{D1} = 0{,}26mA$$

$$TIIK: V_{DD} = I_{D1}R_2 + V_{DS1} + I_{D1}R_3 \Rightarrow V_{DS1} = V_{DD} - I_{D1}(R_2 + R_3) = 18V - (0{,}26mA)(9k\Omega) = 15{,}66V$$

$$PSF_{J1(M1)} = \begin{cases} V_{GS1} = -1{,}56V \\ I_{D1} = 0{,}26mA \\ V_{DS1} = 15{,}66V \end{cases}$$

- M2 - TEC-MOS canal indus

$$I_{D(on)} = K\left(V_{GS} - V_{GS(th)}\right)^2 \Rightarrow K = \frac{I_{D(on)}}{\left(V_{GS} - V_{GS(th)}\right)^2} = \frac{324mA}{(10-1)^2V^2} = 4\,mA/V^2$$

$$\left.\begin{aligned} V_{GS2} &= V_{G2} - V_{S2} \\ V_{G2} &\overset{RDT}{=} \frac{R_5}{R_4 + R_5}V_{DD} = \frac{1M}{9M}18V = 2V \\ V_{S2} &= 0 \end{aligned}\right\} \Rightarrow V_{GS2} = V_{G2} = 2V$$

$$I_{D2} = K\left(V_{GS2} - V_{GS(th)}\right)^2 = 4(2-1)^2 = 4mA$$

$$TIIK: V_{DD} = I_{D2}R_6 + V_{DS2} \Rightarrow V_{DS2} = V_{DD} - I_{D2}R_6 = 18V - (4mA)(2k\Omega) = 10V$$

$$PSF_{M1(M2)} = \begin{cases} V_{GS2} = 2V \\ I_{D2} = 4mA \\ V_{DS2} = 10V \end{cases}$$

c) Parametrii de s.m.

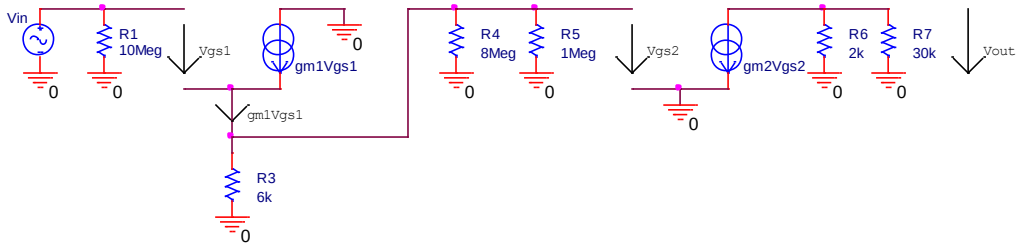
$$g_{m1} = \frac{2I_{DSS}}{|V_{GS(off)}|}\left(1 - \frac{V_{GS1}}{V_{GS(off)}}\right) = \frac{2\cdot 5}{2}\left(1 - \frac{-1{,}56}{-2}\right) = 1{,}1mS$$

$$g_{m2} = 2K\left(V_{GS2} - V_{GS(th)}\right) = 2\times 4\times(2-1) = 8mS$$

$V_{DS1} > \left(V_{GS1} - V_{GS(off)}\right) = -1{,}56 - (-2) = 0{,}44\ V$, 15,66V>0,44V

$V_{DS2} \geq \left(V_{GS2} - V_{GS(th)}\right) = 2V - 1V = 1V$; 10V>1V

d) A_V



Schema de semnal mic

$$A_v = \frac{V_{out}}{V_{in}}$$

$$V_{out} = -g_{m2} v_{gs2} \left(R_6 \| R_7\right)$$

$$g_{m1} v_{gs1} \left(R_3 \| R_4 \| R5\right) = v_{gs2}$$

$$V_{in} = v_{gs1} + g_{m1} v_{gs1} \left(R_3 \| R_4 \| R_5\right) \Rightarrow v_{gs1} = \frac{V_{in}}{1 + g_{m1}\left(R_3 \| R_4 \| R_5\right)}$$

$$A_v = -g_{m2}\left(R_6 \| R_7\right) \times \frac{g_{m1}\left(R_3 \| R_4 \| R_5\right)}{1 + g_{m1}\left(R_3 \| R_4 \| R_5\right)}$$

$$R_6 \| R_7 = \frac{2k \times 30k}{32k} = 1{,}875k$$

$$R_3 \| R_4 \| R_5 = \frac{1}{\frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}} = \frac{1}{\frac{1}{6k} + \frac{1}{8M} + \frac{1}{1M}} = 5{,}96k\Omega$$

$$A_v = -(8mS)(1{,}875k\Omega) \times \frac{(1{,}1mS)(5{,}96k\Omega)}{1 + (1{,}1mS)(5{,}96k\Omega)} = -13$$