



OSNOVI ELEKTRONIKE

Zadaci

1. Za diodno kolo sa Sl. 1 odrediti i nacrtati zavisnost:

a) izlaznog napona, V_i , i

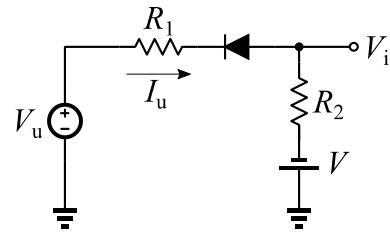
b) ulazne struje, I_u , u funkciji ulaznog napona V_u .

Poznato je:

$R_1=1k\Omega$, $R_2=3k\Omega$, $V=2V$ i $-4V \leq V_u \leq 4V$.

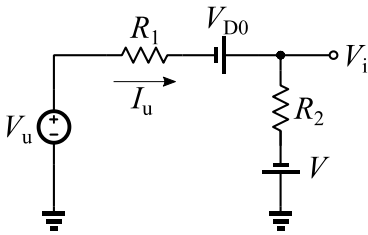
Parametri modela diode su:

$V_{D0}=0.6V$, $r_d=0\Omega$.



Sl. 1

Za $-4V \leq V_u < -2.6V$ dioda vodi: 5%

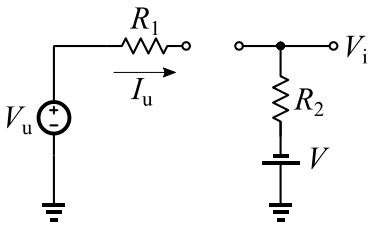


5%

$$V_i = \frac{R_2}{R_2 + R_1} (V_u + V_{D0}) - \frac{R_1}{R_1 + R_2} V = \frac{3}{4} V_u - \frac{1}{20} [V] 10\%$$

$$I_u = \frac{(V_i + V)}{R_2} = \frac{1}{4} V_u + \frac{13}{20} [mA] 10\%$$

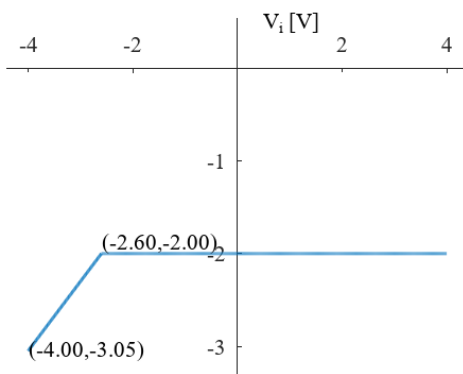
Za $-2.6V \leq V_u \leq 4V$ dioda ne vodi: 5%



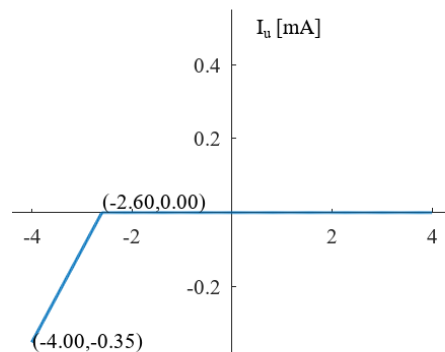
5%

$$V_i = -V = -2 [V] 10\%$$

$$I_u = 0 [mA] 10\%$$



20%



20%

2. Za pojačavač sa Sl. 2 odrediti:

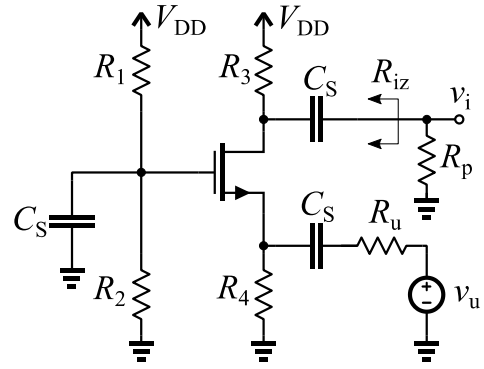
- parametre modela za male signle, μ i r_o ,
- naponsko pojačanje, $A_n = v_i/v_u$ i
- izlaznu otpornost, R_{iz} .

Poznato je:

$R_1=100k\Omega$, $R_2=400k\Omega$, $R_3=R_4=R_p=500\Omega$, $R_u=50\Omega$ i $V_{DD}=5V$.

Parametri tranzistora su:

$V_{TH}=1V$, $V_A=80V$ i $A=4mA/V^2$.



Sl. 2

a)

5% $V_G = \frac{R_2}{R_2 + R_1} V_{DD} = 4V$, $V_{ov} = V_{GS} - V_{TH}$

5% $V_G - V_{TH} = V_{GS} - V_{TH} + I_D R_4$

5% $A R_4 V_{ov}^2 + V_{ov} - (V_G - V_{TH}) = 0 \Rightarrow V_{ov} = 1V$

5% $I_D = A V_{ov}^2 = 4mA$

5% $g_m = 2A V_{ov} = 8mS$

5% $r_o = \frac{V_A}{I_D} = 20k\Omega$, $\mu = g_m r_o = 160$

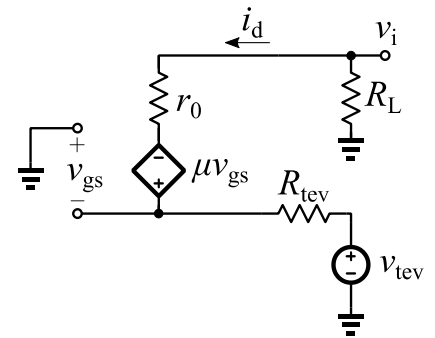
b)

5% $R_L = R_3 || R_p = 250\Omega$

5% $v_{tev} = \frac{R_4}{R_4 + R_u} v_u$, $R_{tev} = R_4 || R_u = 45.45\Omega$

15%
$$\begin{bmatrix} -(r_o + R_{tev} + R_L) & \mu & 0 \\ R_L & 0 & 1 \\ -R_{tev} & -1 & 0 \end{bmatrix} \begin{bmatrix} i_d \\ v_{gs} \\ v_i \end{bmatrix} = \begin{bmatrix} v_{tev} \\ 0 \\ v_{tev} \end{bmatrix}$$

5% $A_n = \frac{v_p}{v_i} = \frac{R_4}{R_4 + R_u} \cdot \frac{(1 + \mu) R_L}{R_L + r_o + (1 + \mu) R_{tev}}$
 $= 1.33 \frac{V}{V}$



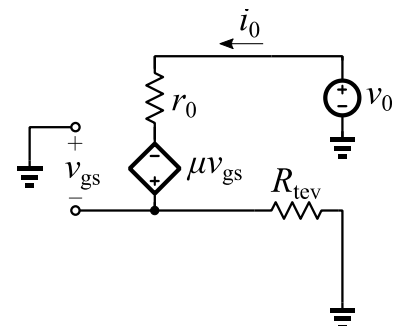
10%

c)

10% $\begin{bmatrix} \mu & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} v_{gs} \\ v_o \end{bmatrix} = \begin{bmatrix} i_o (r_o + R_{tev}) \\ -i_o R_{tev} \end{bmatrix}$

5% $R_{iz,T} = \frac{v_o}{i_o} = r_o + (1 + \mu) R_{tev} = 27.32k\Omega$

5% $R_{iz} = R_{iz,T} || R_3 = 491.01\Omega$



10%

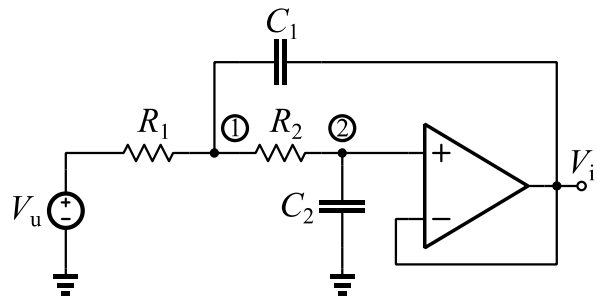
3. Za kolo filtra sa Sl. 3 odrediti:

- a) prenosnu funkciju, $T(s)=V_i/V_u$,
- b) polove prenosne funkcije i
- c) tip filtra.

Poznato je:

$$R_1=R_2=10\text{k}\Omega \text{ i } C_1=C_2=100\text{nF}.$$

Operacioni pojačavač je idealan.



a)

$$10\% v_i = v_2$$

$$20\% \begin{bmatrix} G_1 + G_2 + sC_1 & -G_2 - sC_2 \\ -G_2 & G_2 + sC_2 \end{bmatrix} \begin{bmatrix} v_1 \\ v_i \end{bmatrix} = \begin{bmatrix} G_1 v_u \\ 0 \end{bmatrix}$$

$$40\% T(s) = \frac{v_i}{v_u} = \frac{1}{1 + C_2(R_1 + R_2)s + s^2 C_1 C_2 R_1 R_2} = \frac{N(s)}{D(s)}$$

b)

$$20\% D(s) = 1 + 2 \cdot 10^{-3}s + 10^{-6}s^2 = 0 \Rightarrow s_1 = s_2 = -10^3 \frac{\text{rad}}{s}$$

c)

10% NF (LP) filter

4. Za regulator sa Sl. 4 odrediti:

- a) jednosmerni, stabilisani, napon, V_P i
 b) osetljivost, $S=v_p/v_u$.

Poznato je:

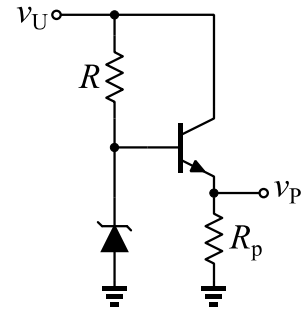
$R=1.4k\Omega$ i $R_p=3k\Omega$.

Parametri tranzistora su:

$\beta=100$, $V_{BE}=0.6V$, $g_m=40mS$ i $r_\pi=2.5k\Omega$.

Parametri Zener diode su:

$V_{Z0}=3.6V$ i $r_z=50\Omega$.



Sl. 4

a)

20% $V_P \approx -V_{BE} + V_{Z0} = 3V$

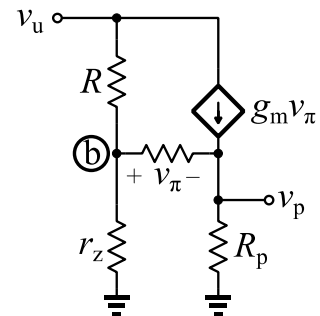
b)

10% $v_\pi = v_b - v_i$

20%
$$\begin{bmatrix} G + g_\pi + g_z & -g_\pi \\ -g_\pi - g_m & G_p + g_\pi + g_m \end{bmatrix} \begin{bmatrix} v_b \\ v_i \end{bmatrix} = \begin{bmatrix} G v_u \\ 0 \end{bmatrix}$$

20%
$$S = \frac{v_i}{v_u} = \frac{(g_\pi + g_m)G}{g_\pi G_p + (G + g_z)(G_p + g_\pi + g_m)}$$

20%
$$S = \frac{1}{1 + \frac{R}{r_z} + \frac{r_\pi}{R_p(1+\beta)} \left(1 + \frac{R}{r_z || r_\pi}\right)} = 34.195 \cdot 10^{-3} \frac{V}{V}$$



10%