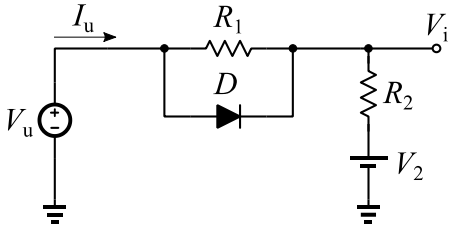
Elektronski fakultet u Nišu
Katedra za Elektroniku
Šifra: 2OEE3O01, 2OEM3O01, 2OET3O01, 2OEU3O02, 2OE3O03

Datum: 28. mart 2022.

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=1kΩ, R_2=2kΩ, V_2=3V i –12V ≤ V_u ≤ 12V.
Parametri modela diode su:
V_{D0}=0.6V, r_d=0Ω.

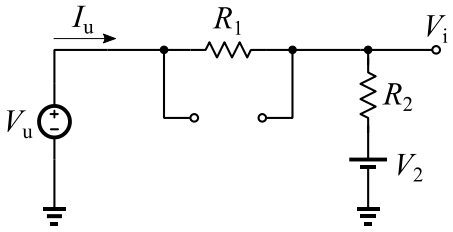


Sl. 1

Dioda ne vodi za $-12V \le V_u < V_i + V_{D0} = 4.8V$, **10%**

$$V_i = \frac{R_2}{R_2 + R_1} V_u + \frac{R_1}{R_1 + R_2} V_2 = \frac{2}{3} V_u + 1\ [V] \quad \textbf{5\%}$$

$$I_u = \frac{1}{R_2}(V_i - V_2) = \frac{1}{3} V_u - 1\ [mA] \quad \textbf{5\%}$$

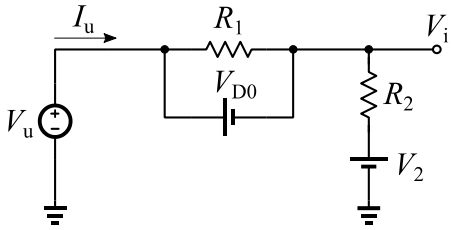


10%

Dioda vodi za $V_i + V_{D0} = 4.8V \le V_u < 12V$, **10%**

$$V_i = V_u - V_{D0} = V_u - 0.6\ [V] \quad \textbf{5\%}$$

$$I_u = \frac{1}{R_2}(V_i - V_2) = \frac{1}{2} V_u - 1.8\ [mA] \quad \textbf{5\%}$$



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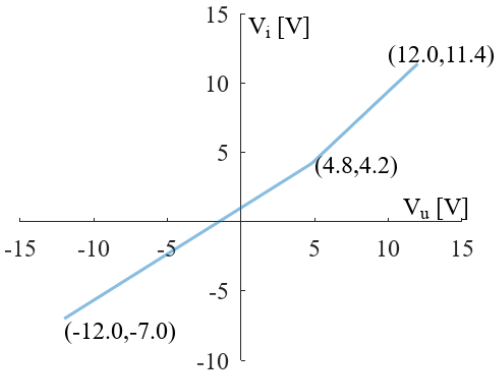

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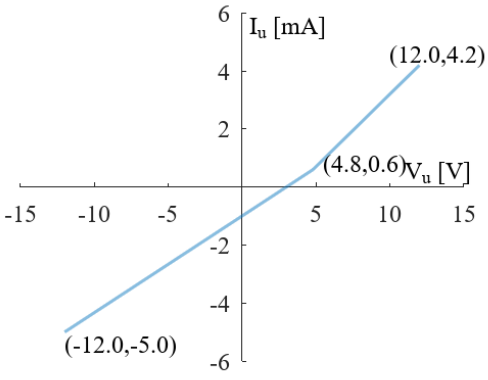

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2. Za pojačavač sa Sl. 2 odrediti:

a) parametre modela za male signale, g_m i r_π,
b) naponsko pojačanje, $A_n=v_p/v_u$ i
c) ulaznu otpornost, R_{ul}.

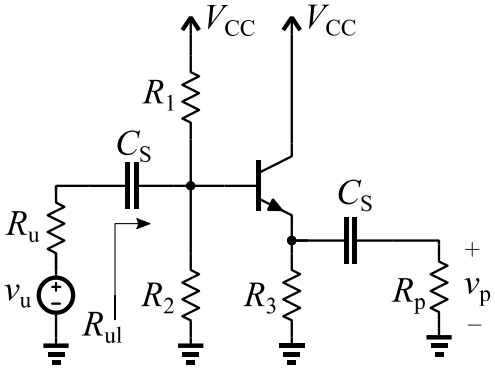
Poznato je:

R_1=50kΩ, R_2=140kΩ, R_3=1kΩ, R_u=50Ω, R_p=1kΩ, V_{CC}=10V.

Parametri tranzistora su:

β = 100, V_{BE} = 0.6V, $V_A \rightarrow \infty$V.

Smatrati da su kapacitivnosti sprežnih kondenzatora, C_S, izuzetno velike.



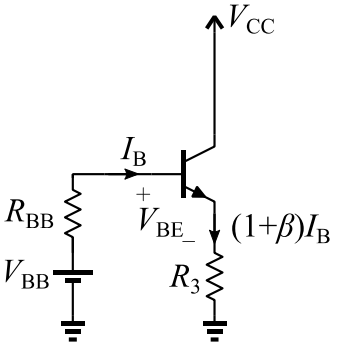
Sl. 2

a)

$$V_{BB} = V_{CC} \cdot \frac{R_2}{R_2 + R_1} = 7.368V, R_{BB} = R_1||R_2 = 36.842k\Omega \ \mathbf{10\%}$$

$$I_B = \frac{V_{BB} - V_{BE}}{R_{BB} + (1+\beta)R_3} = 49.103\mu A, I_C = \beta I_C = 4.910mA \ \mathbf{10\%}$$

$$g_m = \frac{I_C}{V_T} = 196.411mS, r_\pi = 509.137\Omega \ \mathbf{10\%}$$



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b)

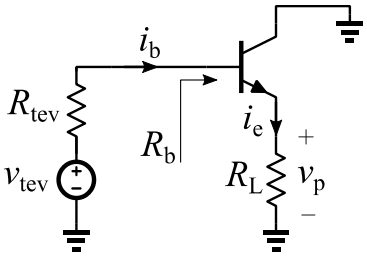
$$v_{tev} = \frac{R_{BB}}{R_{BB} + R_u} v_u, \ R_{tev} = R_{BB}||R_u = 49.932\Omega \ \mathbf{10\%}$$

$$R_L = R_3||R_p = 500\Omega, R_b = r_\pi + (1+\beta)R_L = 51.01k\Omega \ \mathbf{10\%}$$

$$A_n = \frac{v_p}{v_u} = \frac{v_p}{i_e} \cdot \frac{i_e}{i_b} \cdot \frac{i_b}{v_{tev}} \cdot \frac{v_{tev}}{v_u}$$

$$= R_L \cdot (1+\beta) \cdot \frac{1}{R_{tev} + R_b} \cdot \frac{R_{BB}}{R_{BB} + R_u}$$

$$= 0.988 \ \mathbf{10\%}$$



10%

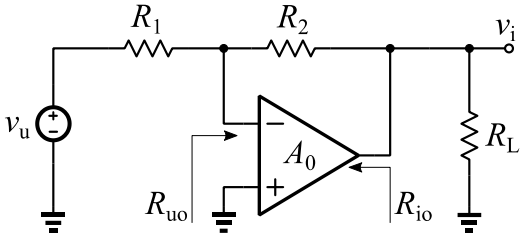
c)

$R_{ul} = R_{BB}||R_b = 21.392 \ k\Omega$ **20%**

3. Za kolo sa Sl. 3 odrediti:
a) tip povratne sprege,
b) faktor povratne sprege, F (β),
c) prenosnu funkciju otvorene petlje, A,
d) naponsko pojačanje, A_{nr}, ulaznu, R_{ulr}, i izlaznu, R_{izr}, otpornost zatvorene petlje.

Poznato je:
R_1= 10kΩ, R_2= 30kΩ, R_L=100Ω.

Parametri modela operacionog pojačavača su:
A_0=500 V/V, R_{uo}=500kΩ, R_{io}=1kΩ.



Sl. 3

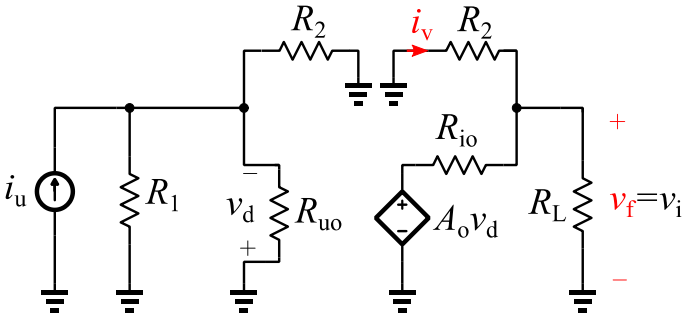
a) Paralelno-naponska **10%**

b)

$$F = \frac{i_v}{v_f} = -\frac{1}{R_2} = -33.333\mu S \ \mathbf{10\%}$$

c)

$$i_u = \frac{v_u}{R_1}$$



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$$A = \frac{v_i}{i_u} = \frac{v_i}{A_o v_d} \cdot \frac{A_o v_d}{v_d} \cdot \frac{v_d}{i_u} = \frac{R_L||R_2}{R_L||R_2 + R_{io}} \cdot A_o \cdot \left(-R_1||R_2||R_{uo}\right) = -334.856k\Omega \ \mathbf{10\%}$$

d)

$$R_{ul} = R_1||R_2||R_{uo} = 7.389k\Omega, R_{ulr} = \frac{R_{ul}}{1 + AF} = 607.568\Omega \ \mathbf{20\%}$$

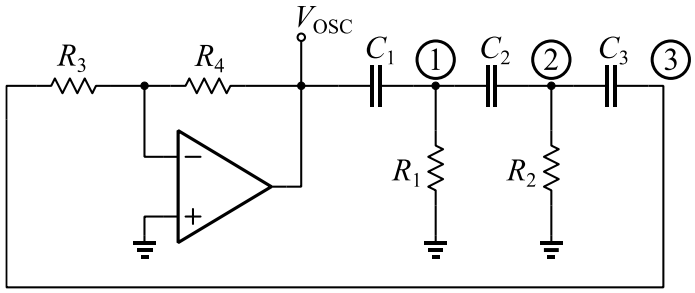
$$R_{iz} = R_L||R_2||R_{io} = 90.634\Omega, R_{izr} = \frac{R_{iz}}{1 + AF} = 7.452\Omega \ \mathbf{20\%}$$

$$A_r = \frac{A}{1 + AF} = -27.533k\Omega, A_{nr} = \frac{v_i}{v_u} = \frac{v_i}{i_u} \cdot \frac{i_u}{v_u} = A_r \cdot \frac{1}{R_1} = -2.753\frac{V}{V} \ \mathbf{20\%}$$

4. Za oscilator sa Sl. 4 odrediti:

a) determinantu sistema,
b) frekvenciju oscilovanja, f_0, i
c) vrednost otpornosti, R_4.

Poznato je:
$R_1 = R_2 = R_3 = R = 10\text{k}\Omega$, $C_1 = C_2 = C_3 = C = 1\text{nF}$.
Operacioni pojačavač je idealan.



Sl. 4

$$V_{osc} = KV_3, K = -\frac{R_4}{R_3}$$ **10%**

$$\begin{bmatrix} s(C_1+C_2)+\frac{1}{R_1} & -sC_2 & -KsC_1 \\ -sC_2 & s(C_2+C_3)+\frac{1}{R_2} & -sC_3 \\ 0 & -sC_3 & sC_3+\frac{1}{R_3} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$ **30%**

a)

$$\Delta = (s\tau)^3(1-K) + 6(s\tau)^2 + 5s\tau + 1 = 0, \tau = RC = 10\mu s$$ **20%**

b)

$$Re\{\Delta\} = 1 - 6(\omega_o\tau)^2 = 0 \Rightarrow \omega_o = \frac{1}{\tau\sqrt{6}} = 4.082 \times 10^4 \frac{rad}{sec}, f_o = \frac{\omega_o}{2\pi} = 6.497kHz$$ **20%**

c)

$$Im\{\Delta\} = 5\omega_o\tau - (\omega_o\tau)^3(1-K) = 0 \Rightarrow K = -29, R_4 = 29R = 290k\Omega$$ **20%**