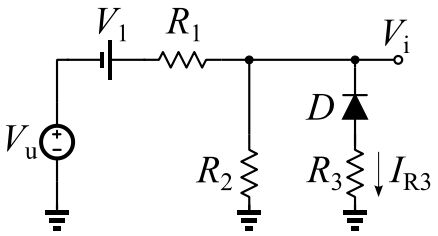
Elektronski fakultet u Nišu
Katedra za Elektroniku
Šifra: OEE3O01, OEM3O01,OEU3O02

Datum: 01. jul 2024.

OSNOVI ELEKTRONIKE

Zadaci

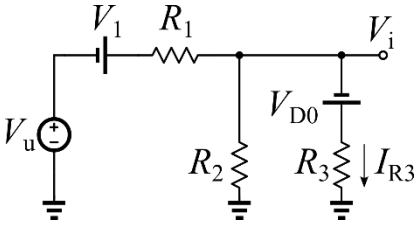
1. Za diodno kolo sa Sl. 1 odrediti i nacrtati zavisnost:
a) Izlaznog napona, V_i, i
b) Struje I_{R3}, u funkciji ulaznog napona, V_u.
Poznato je:
$R_1=R_2=R_3=1k\Omega$, $V_1=3V$ i $-10V \le V_u \le 10V$.
Parametri modela diode su:
$V_{D0}=0.6V$, $r_d=0\Omega$.



Sl. 1

Uslov da dioda vodi je: $\frac{R_2}{R_1+R_2}(V_u+V_1) \le -V_{D0}$. 10%

Iz uslova se dobija da dioda vodi za $-10V \le V_u \le -4.2V$ i tada važi:

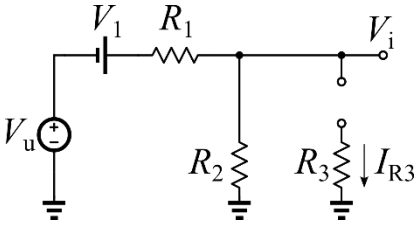


5%

$$V_i = \frac{R_2||R_3}{R_2||R_3+R_1}(V_u+V_1) - \frac{R_1||R_2}{R_1||R_2+R_3}V_{D0} = \frac{1}{3}V_u + 0.8\ [V]$$ 10%

$$I_{R3} = \frac{V_i + V_{D0}}{R_3} = \frac{1}{3}V_u + 1.4\ [mA]$$ 10%

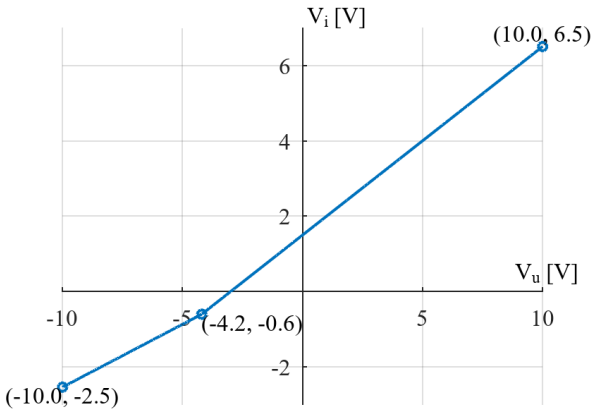
Dioda ne vodi za $-4.2V < V_u \le 10V$ i tada važi:



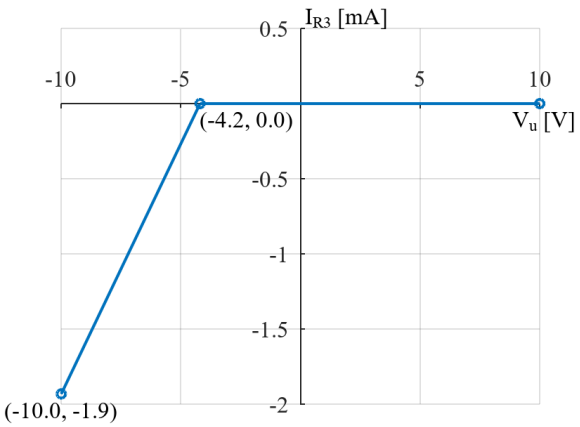
5%

$$V_i = \frac{R_2}{R_1+R_2}(V_u+V_1) = \frac{1}{2}V_u + 1.5\ [V]$$ 10%

$$I_{R3} = 0\ [mA]$$ 10%



20%



20%

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}.

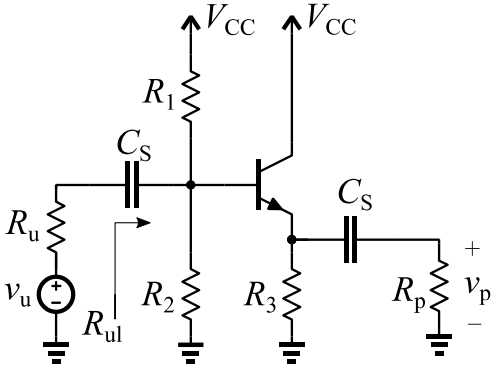
Poznato je:

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.



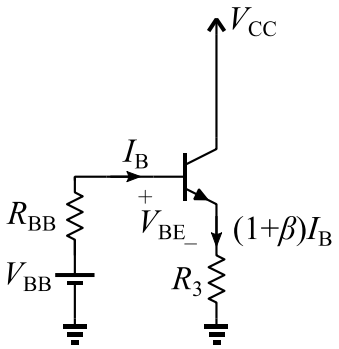
Sl. 2

a)

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

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

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



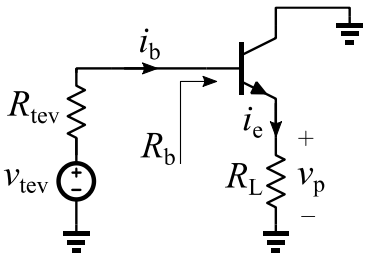
10%

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%

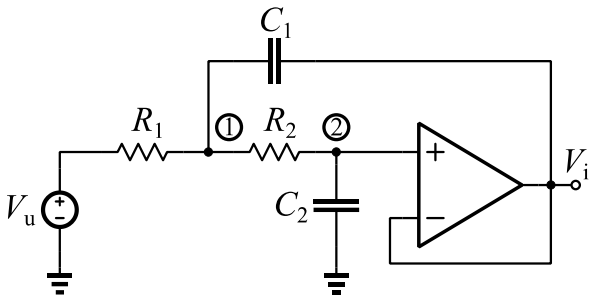
c)

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

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

Operacioni pojačavač je idealan.



a)

10% $v_i = v_2$

20% $\begin{bmatrix} G_1+G_2+sC_1 & -G_2-s_{C2} \\ -G_2 & G_2+sC_2 \end{bmatrix}\begin{bmatrix} v_1 \\ v_i \end{bmatrix} = \begin{bmatrix} G_1 v_u \\ 0 \end{bmatrix}$

40% $H(s) = \dfrac{v_i}{v_u} = \dfrac{1}{1+C_2(R_1+R_2)s+s^2C_1C_2R_1R_2} = \dfrac{N(s)}{D(s)}$

b)

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

c)

10% NF (LP) filtar

4. Za regulator sa Sl. 4 odrediti:

a) jednosmerni napon na gejtu tranzistora, V_G
b) parametre za male signale, g_m i r_0, i
c) izlaznu otpornost R_0.

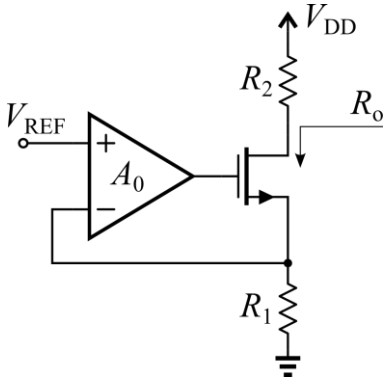
Poznato je:
R_1=10kΩ, R_2=15kΩ, V_{REF}=1V i V_{DD}=3.3V.

Tranzistor ima sledeće parametre:
V_{TH}=0.35V, A=1.6mA/V^2, V_A=50V.

Operacioni pojačavač ima sledeće parametre:

A_0 =10^3 V/V, $R_{ul} \to \infty\Omega$, $R_{iz} \to 0\Omega$.

Za jednosmerni režim smatrati da $A_0 \to \infty$ V/V.



Sl. 4

a)

(10%) $V_S = V_{REF} = 1\text{V}$

(10%) $I_D = \dfrac{V_S}{R_1} = 100\mu\text{A}$

(10%) $V_{ov} = \sqrt{\dfrac{I_D}{A}} = 250\text{mV}$

(5%) $g_m = 2AV_{ov} = 800\mu\text{S}$

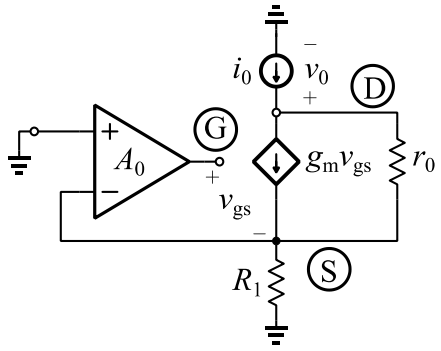
(5%) $r_o = \dfrac{V_A}{I_D} = 500\text{k}\Omega$

b)

(5%) $V_{GS} = V_{TH} + V_{ov} = 0.6\text{V}$

(5%) $V_G = V_{GS} + V_S = 1.6\text{V}$

c)



(10%) $i_0 = \dfrac{v_0 - v_s}{r_0} + g_m v_{gs}$

(10%) $i_0 = \dfrac{v_s}{R_1}$

(10%) $v_g = -A_0 v_s$

(10%) $R_0 = r_o + (1 + g_m r_o\,(1 + A_0))\,R_1 = 4.005\text{G}\Omega$

10%