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

Datum: 10. jun 2022.

OSNOVI ELEKTRONIKE

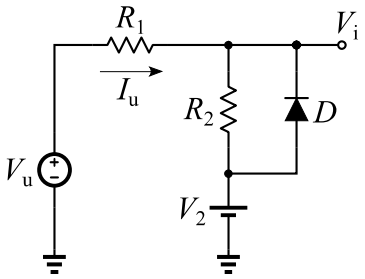
Zadaci

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.

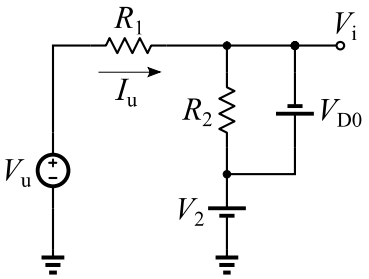
Poznato je:
$R_1=R_2=2k\Omega$, $V_2=4V$ i $-10V \le V_u \le 10V$.

Parametri modela diode su:
$V_{D0}=0.6V$, $r_d=0\Omega$.



Sl. 1

Dioda vodi za, $-10V \le V_u < 2.8V$ **10%**



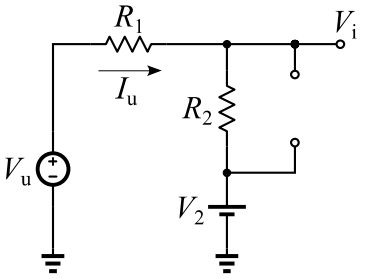
10%

$$V_i = -V_{D0} + V_2 = 3.4V$$

$$I_u = \frac{V_u - V_i}{R_1} = \frac{1}{2}V_u - 1.7mA$$

10%

Dioda ne vodi za , $2.8V \le V_u \le 10V$ **10%**

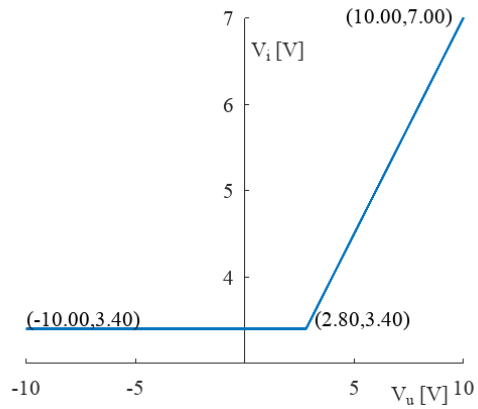


10%

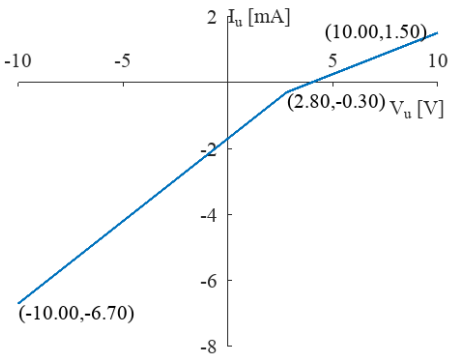
$$V_i = \frac{R_2}{R_2+R_1}V_u + \frac{R_1}{R_2+R_1}V_2 = \frac{1}{2}V_u + 2V$$

$$I_u = \frac{V_u - V_2}{R_1+R_2} = \frac{1}{4}V_u - 1mA$$

10%



20%



20%

2. Za pojačavač sa Sl. 2 odrediti:

a) parametre modela za male signale, g_m i r_0,
b) naponsko pojačanje, $A_n=v_p/v_u$ i
c) izlaznu otpornost, R_{iz}.

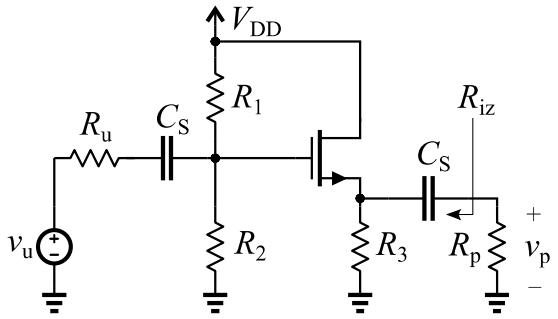
Poznato je:

R_1=100kΩ, R_2=400kΩ, R_3=1.5kΩ, R_u=100Ω, R_p=5kΩ, V_{DD}=5V.

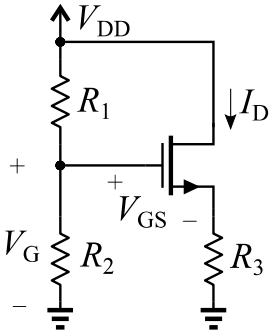
Parametri tranzistora su:

A = 8mA/V^2, V_{TH}=0.5V, V_A=100V.

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



a)



10%

$$V_G = V_{GS} + I_D R_3$$
$$V_G - V_{TH} = V_{GS} - V_{TH} + A\left(V_{GS} - V_{TH}\right)^2 R_3$$
$$V_{ov} = V_{GS} - V_{TH}$$
$$AR_3 V_{ov}^2 + V_{ov} - \left(V_G - V_{TH}\right) = 0$$
$$V_{ov} = 0.5V \Rightarrow I_D = AV_{ov}^2 = 2mA$$

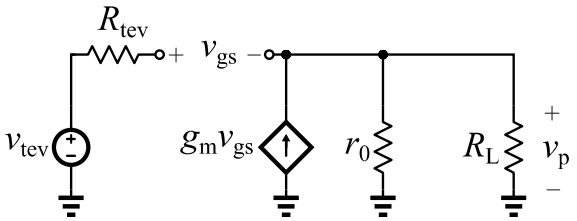
10%

$$g_m = 2AV_{ov} = 8mS,\ r_0 = \frac{V_A}{I_D} = 50k\Omega$$

10%

b)

$$R_g = R_1||R_2 = 80k\Omega$$
$$R_{tev} = R_g||R_u = 99.875\Omega$$
$$v_{tev} = \frac{R_g}{R_g + R_u} v_u = 0.9988 v_u$$
$$R_L = R_3||R_p = 1.154k\Omega$$



10%

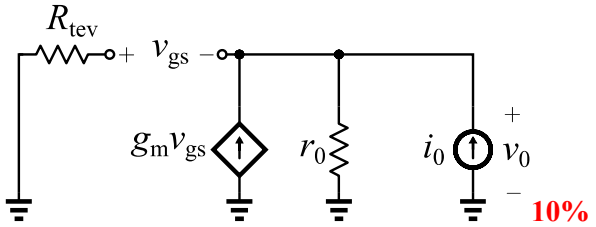
$$EQ1: v_{gs} = v_{tev} - v_p$$
$$EQ2: v_p \frac{1}{R_L||r_0} - g_m v_{gs} = 0$$

20%

$$A_n = \frac{v_p}{v_{tev}} \times \frac{v_{tev}}{v_u} = \frac{g_m\left(R_L||r_0\right)}{1 + g_m\left(R_L||r_0\right)} \times \frac{R_g}{R_g + R_u} = 0.899V/V$$

10%

c)



10%

$$EQ1: v_{gs} = -v_0$$

$$EQ1: -i_0 - g_m v_{gs} + v_0 \frac{1}{r_0} = 0$$

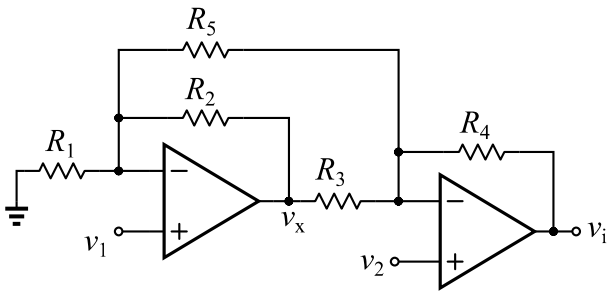
$$R_T = \frac{v_0}{i_0} = \frac{r_0}{1+\mu} = 124.69\Omega$$

$$R_{iz} = R_T || R_3 = 115.119\Omega$$

20%

3. Za kolo sa Sl. 3 odrediti:
a) $v_x = f(v_1, v_2)$,
b) diferencijalno pojačanje, $A_d = v_i/(v_2 - v_1)$ i
c) otpornost R_5 tako da je A_d=18 V/V.

Poznato je: $R_1 = R_2 = R_3 = R_4 = R$=15kΩ
Operacioni pojačavači su idealni.



Sl. 3

a)

$$v_x = \left(1 + \frac{R_2}{R_5||R_1}\right) v_1 - \frac{R_2}{R_5} v_2$$

30%

b)

$$v_i = \left(1 + \frac{R_4}{R_5||R_3}\right) v_2 - \frac{R_4}{R_3} v_x - \frac{R_4}{R_5} v_1$$

$$= \left(1 + \frac{R_4}{R_5||R_3} + \frac{R_4}{R_3}\frac{R_2}{R_5}\right) v_2 - \left(\frac{R_4}{R_5} + \frac{R_4}{R_3}\left(1 + \frac{R_2}{R_5||R_1}\right)\right) v_1$$

$$A_d = \frac{v_i}{v_2 - v_1} = 3 + \frac{R}{R_5}$$

50%

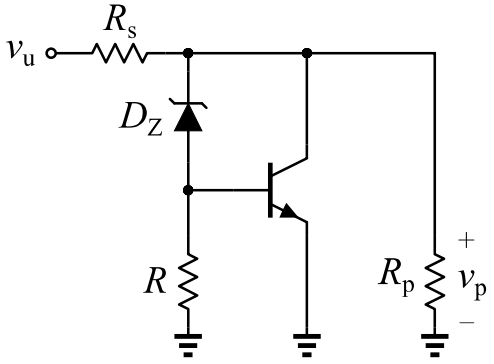
c)

$$R_5 = \frac{R}{A_d - 3} = 15k\Omega$$

20%

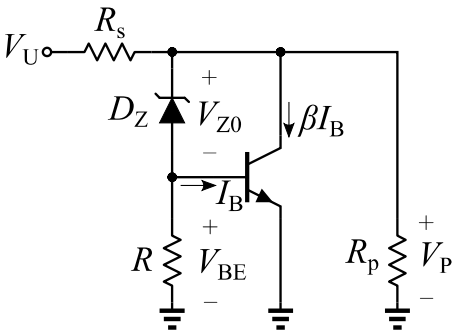
4. Za regulator sa Sl. 4 odrediti:
a) parametre modela za male signale, g_m i r_π,
b) osetljivost, $S = v_p/v_u$, i
c) izlaznu otpornost, R_{iz}.

Poznato je:
$R_s = R_p$=500Ω, R=100kΩ, V_U=15V i V_T=25mV.
Parametri tranzistora su:
β=100, V_{BE}=0.7V.
Parametri Zener diode su:
V_{Z0}=6.2V, r_z=15Ω.



Sl. 4

a)



10%

$$EQ1: V_P \approx V_{Z0} + V_{BE} = 6.9V$$

$$EQ2: \frac{V_U - V_P}{R_s} = I_B + \frac{V_{BE}}{R} + \beta I_B + \frac{V_P}{R_P}$$

$$I_B = \frac{1}{1+\beta}\left(\frac{V_U}{R_s} - \frac{V_{BE}}{R} - \frac{V_P}{R_s||R_p}\right) = 23.693\mu A$$

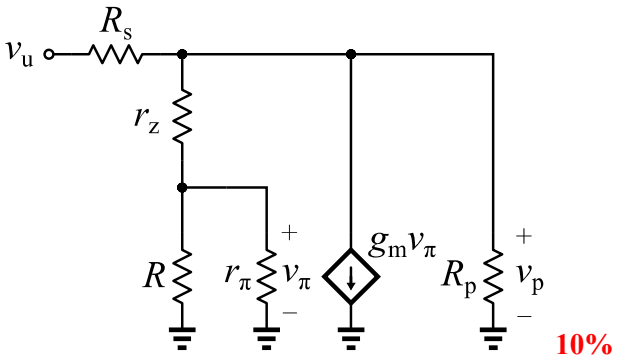
$$I_C = \beta I_B = 2.369mA$$

$$g_m = \frac{I_C}{V_T} = 94.772mS$$

$$r_\pi = \frac{\beta}{g_m} = \frac{V_T}{I_B} = 1.055k\Omega$$

20%

b)



10%

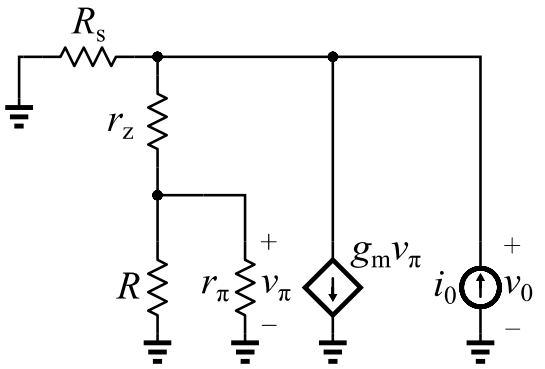
$$EQ1: \frac{v_u - v_p}{R_s} = \frac{v_p - v_\pi}{r_z} + \frac{v_p}{R_p} + g_m v_\pi$$

$$EQ2: \frac{v_p - v_\pi}{r_z} = \frac{v_\pi}{R||r_\pi}$$

$$S = \frac{v_p}{v_u} = \frac{1}{1 + R_s\left(\frac{1}{R_p} + \frac{1+g_m(r_\pi||R)}{r_z + r_\pi||R}\right)} = 2.033 \times 10^{-2} V/V$$

30%

c)



10%

$$EQ1: i_0 = g_m v_\pi + v_0 \frac{1}{R_s || (r_z + R || r_\pi)}$$

$$EQ2: \frac{v_0 - v_\pi}{r_z} = \frac{v_\pi}{R || r_\pi}$$

$$R_{iz} = \frac{v_0}{i_0} = R_s || \left(\frac{r_z + r_\pi || R}{1 + g_m (r_\pi || R)} \right) = 10.376\Omega$$

20%