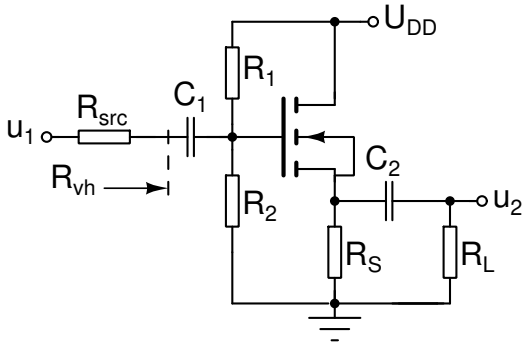
Pisni izpit 19. 8. 2019

Ime in priimek: _____

Vpisna številka: _____

Naloga 1

Določite elemente vezja, da bo v delovni točki $I_D = 0.5\text{mA}, U_{DS} = 4\text{V}$. Vhodna upornost za majhne signale pri srednjih frekvencah naj bo $R_{vh} = 20\text{k}\Omega$.



$U_{DD} = 9\text{V}$

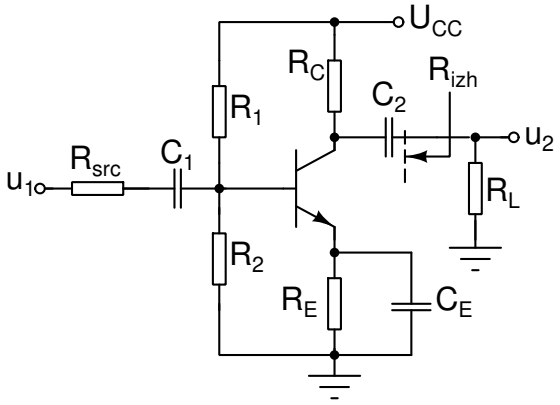
$K = 0.2\text{mA/V}^2, U_T = 0.6\text{V}, \lambda = 0$

$R_{src} = 50\Omega, R_L = 10\text{k}\Omega$

$C_1, C_2 \to \infty$

Naloga 2

Določite delovno točko tranzistorja (I_C, U_{CE}) in izhodno upornost R_{izh}.



$U_{CC} = 5\text{V}, R_{src} = 50\Omega, R_L = 10\text{k}\Omega$

$\beta = 200, V_{AF} = 100\text{V}$

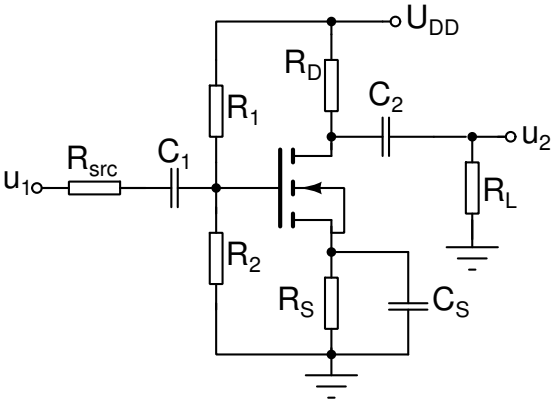
$R_1 = 20\text{k}\Omega, R_2 = 10\text{k}\Omega$

$R_C = 1.5\text{k}\Omega, R_E = 500\Omega$

$C_1, C_2, C_E \to \infty$

Naloga 3

Delovni tok tranzistorja je $I_D = 1.3\text{mA}$. Določite napetostno ojačenje $A_u = \frac{U_2}{U_1}$ pri srednjih frekvencah in zgornjo frekvenčno mejo.



$U_{DD} = 9\text{V}, R_{src} = 1\text{k}\Omega, R_L = 20\text{k}\Omega$

$R_1 = 100\text{k}\Omega, R_2 = 30\text{k}\Omega, R_S = 1\text{k}\Omega, R_D = 5\text{k}\Omega$

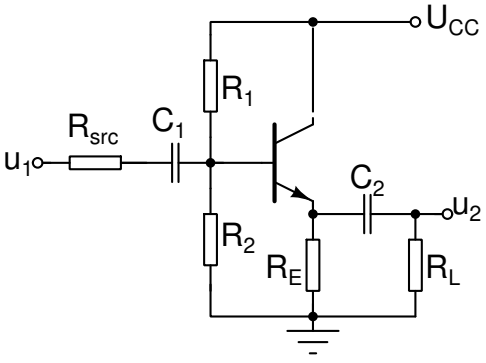
$C_1 = C_2 = C_S = 10\mu\text{F}$

$K = 15\text{mA/V}^2, U_T = 0.4\text{V}, \lambda = 10^{-3}\text{V}$

$C_{gs} = 5\text{pF}, C_{gd} = 0.5\text{pF}$

Naloga 4

Določite spodjo frekvenčno mejo za napetostno ojačenje $A_u = \frac{U_2}{U_1}$. Admitančni parametri tranzistorja za orientacijo s skupnim emitorjem so:



$$Y_E = \begin{bmatrix} 0.19\text{mS} & 0 \\ 44.5\text{mS} & 13.7\mu\text{S} \end{bmatrix}$$

$U_{CC} = 9\text{V}, R_{src} = 500\Omega, R_L = 1\text{k}\Omega$

$\beta = 250, V_{AF} = 80\text{V}$

$R_1 = 20\text{k}\Omega, R_2 = 30\text{k}\Omega, R_E = 4\text{k}\Omega$

$C_1 \to \infty, C_2 = 4.7\mu\text{F}$

Admitančni parametri:

$$i_1 = y_{11}u_1 + y_{12}u_2$$
$$i_2 = y_{21}u_1 + y_{22}u_2$$
$$y_{11} = \frac{1}{h_{11}}, \qquad y_{12} = -\frac{h_{12}}{h_{11}}$$
$$y_{21} = \frac{h_{21}}{h_{11}}, \qquad y_{22} = \frac{D_h}{h_{11}}$$

Hibridni parametri:

$$u_1 = h_{11}i_1 + h_{12}u_2$$
$$i_2 = h_{21}i_1 + h_{22}u_2$$
$$h_{11} = \frac{1}{y_{11}}, \qquad h_{12} = -\frac{y_{12}}{y_{11}}$$
$$h_{21} = \frac{y_{21}}{y_{11}}, \qquad h_{22} = \frac{D_y}{y_{11}}$$

$$A_u = -\frac{y_{21}}{y_{22} + Y_L}, \quad A_i = \frac{y_{21}}{y_{11} + Z_L D_y}, \quad Y_{in} = y_{11} - \frac{y_{12}y_{21}}{y_{22} + Y_L}, \quad Y_{out} = y_{22} - \frac{y_{12}y_{21}}{y_{11} + Y_{src}}$$

NMOS (skupni izvor):
za $u_{GS} > U_T, u_{DS} > u_{GS} - U_T$):

$$i_D = \frac{1}{2}K(u_{GS} - U_T)^2(1 + \lambda u_{DS})$$
$$g_{21} = \frac{2I_D}{U_{GS} - U_T}, \quad g_{22} = \frac{\lambda I_D}{1 + \lambda U_{DS}}$$

PMOS (skupni izvor):
za $-u_{GS} > U_T, -u_{DS} > -u_{GS} - U_T$):

$$-i_D = \frac{1}{2}K(u_{GS} + U_T)^2(1 - \lambda u_{DS})$$
$$g_{21} = \frac{2I_D}{U_{GS} + U_T}, \quad g_{22} = \frac{\lambda I_D}{1 - \lambda U_{DS}}$$

NPN (skupni emitor):
v aktivnem področju:

$$g_{11} = \frac{I_B}{V_T}, \quad g_{21} = \frac{I_C}{V_T},$$
$$g_{22} = \frac{I_C}{U_{CE} + V_{AF}}$$
$$\frac{g_{21}}{g_{11}} = \beta = \beta_F(1 + \frac{U_{CE}}{V_{AF}})$$

PNP (skupni emitor):
v aktivnem področju:

$$g_{11} = -\frac{I_B}{V_T}, \quad g_{21} = -\frac{I_C}{V_T},$$
$$g_{22} = \frac{-I_C}{-U_{CE} + V_{AF}}$$
$$\frac{g_{21}}{g_{11}} = \beta = \beta_F(1 + \frac{-U_{CE}}{V_{AF}})$$

RC člen - mejna frekvenca: $f_{-3dB} = \frac{1}{2\pi\tau} = \frac{1}{2\pi R_{eq}C}$

Miller-jev pojav (preslikava impedance med vhodom in izhodom tranzistorja z napetostnim ojačenjem A_0 na vhod tranzistorja):
$Z_{M,vhod} = \frac{Z_{vhod-izhod}}{1-A_0}$ => za skupni emitor: $C_M = (1 - A_0)C_{bc}$

Kvadratna enačba:

$$ax^2 + bx + c = 0$$
$$D = b^2 - 4ac$$
$$x_{i,2} = \frac{-b \pm \sqrt{D}}{2a}$$