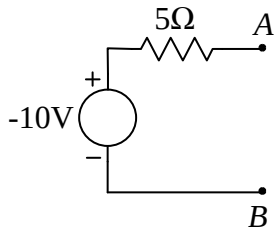
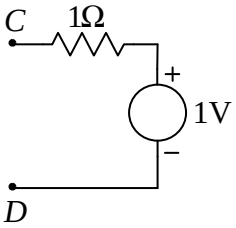
REŠENJA

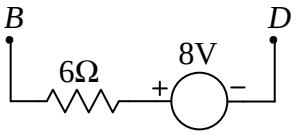
1. a)



b)



c)



d) $I_X = 0.5\text{A}$ $P_{8\Omega} = 2\text{W}$

2. $\frac{v_i}{v_g} = \frac{\beta+1}{\beta+11}$

3. a) $\underline{I}_1$ = -0.09-0.337j, $\underline{I}_2$ = 0.09 - 0.371j, $\underline{I}_3$ = -0.09 + 0.3371j, $\underline{I}_4$ = 1.414 +0.055j, $\underline{I}_5$ = 1.323 - 0.282j
b) $i_1 = 0.35\sqrt{2}\ cos(10000t\text{-}104.95°)$, $i_2 = 0.38\sqrt{2}\ cos(10000t\text{-}76°)$, $i_3 = 0.35\sqrt{2}\ cos(10000t\text{+}75°)$,
$i_4 = 1.41\sqrt{2}\ cos(10000t\text{+}2.23°)$, $i_5 = 1.35\sqrt{2}\ cos(10000t\text{-}12.03°)$
c) $\underline{S}$ = 2.07 – 0.84j; P=2.07W; Q= –0.84VAr

4. a) Kondenzatori se ponašaju kao kratak spoj za AC signal.

$$v_x\left(\frac{1}{R}+\frac{1}{2R}+\frac{1}{4R}\right) = v_u\frac{1}{R}+v_I\frac{1}{4R}$$

$$v_x\frac{7}{4} = v_u\frac{4}{4}+v_I\frac{1}{4}$$

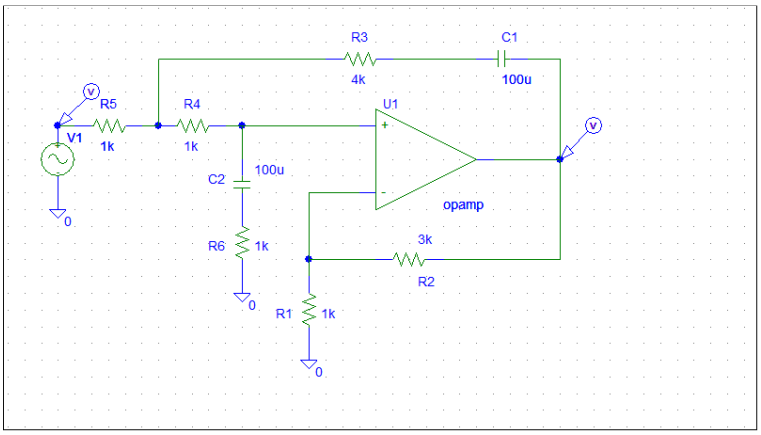
$$7v_x = 4v_u + v_I \quad \cdots(1)$$

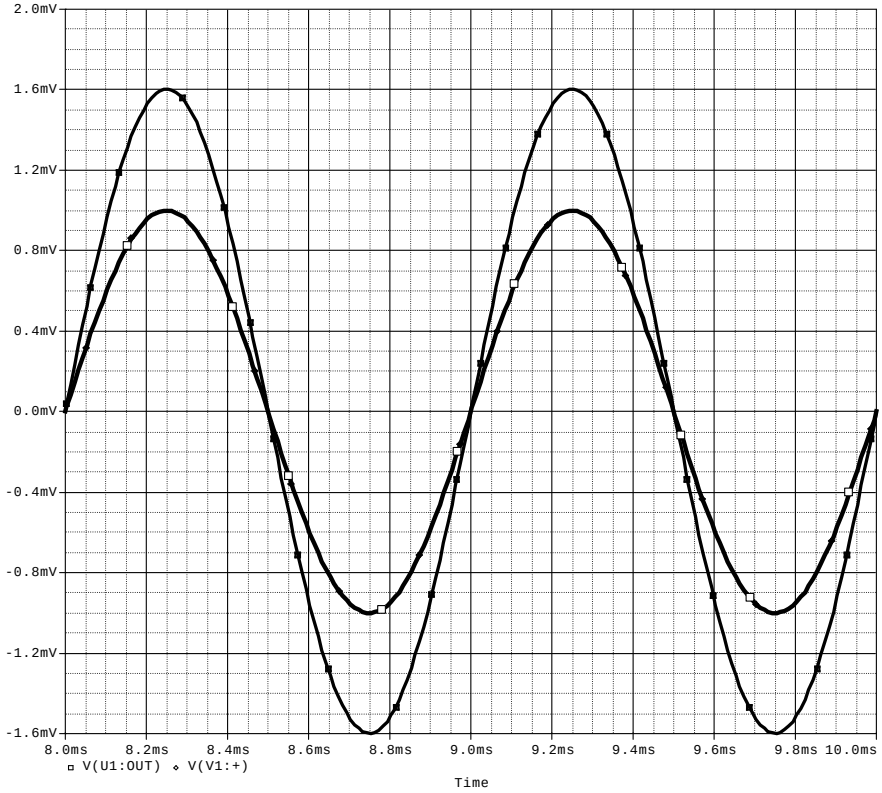
$v^+ = v_x / 2$

$v_I = 4v^+ = 2v_x$

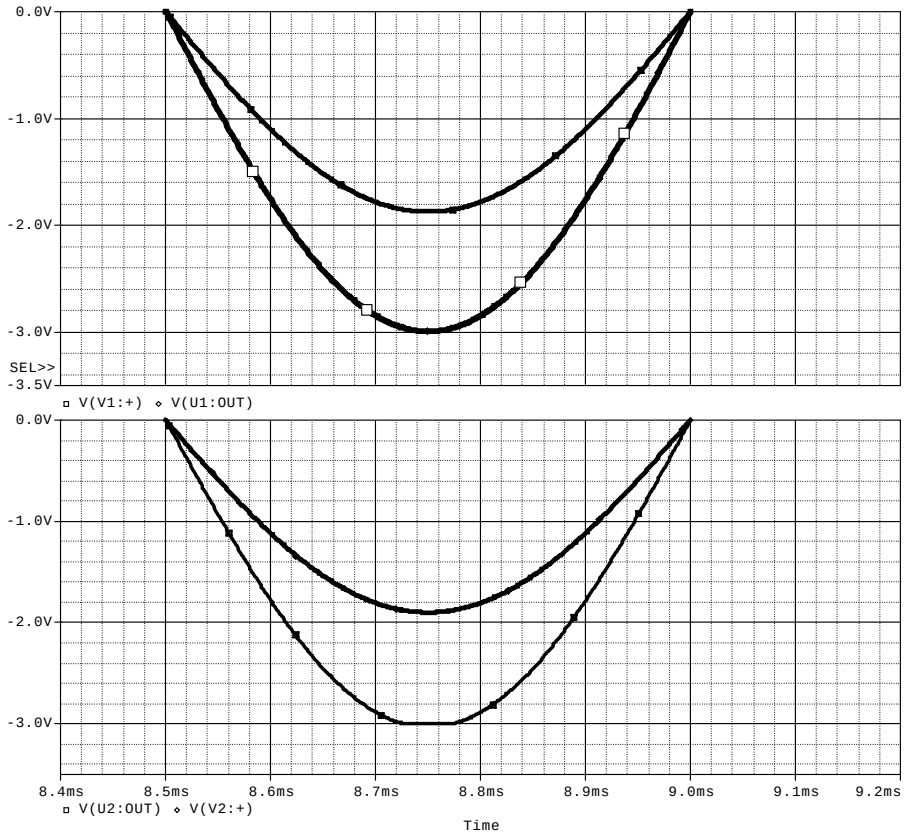
Zamenom u (1) dobija se

$$7v_x = 4v_u + 2v_x \Rightarrow 5v_x = 4v_u \Rightarrow v_x = \frac{4}{5}v_u \Rightarrow v_I = \frac{8}{5}v_u = 1.6v_u = 1.6mV \sin \omega t$$

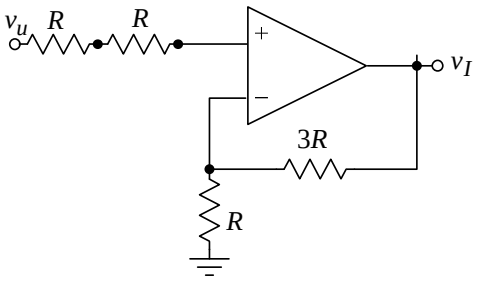




b) Maksimalna amplituda izlaznog napona može da bude 3V.
Prema tome maksimalna amplituda ulaznog napona je 3V/1.6=1.875V.
Na slici su primeri kada je amplituda 1.875V i 1.9V. u drugom slučaju se vidi izobličenje.



c) DC pojačanje se dobija tako što se kondenzatori uklone iz kola, a samim tim i grane u kojima se oni nalaze:



Pošto kroz + priključak nema struje $V^+=V_U$, pa je V_I=4V.

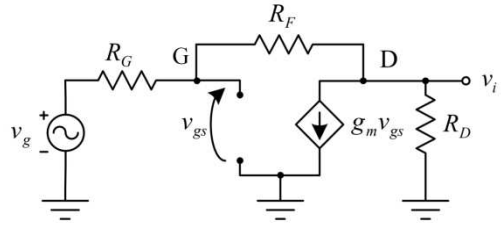
5. a) $v_I = 2V_U$ pod uslovom da tranzistor radi u direktnom aktivnom režimu.
Minimum napona na kolektoru je 8V tako da je maksimum napona na emitoru 7.8V, a maksimum napona na katodi diode je 7.8V-0.6V= 7.2V što je ujedno i max{V_I}.
Prema tome maksimalni napon max{V_U}= 7.2V /2=3.6V

b) Dok god tranzistor radi u direktnom aktivnom režimu $v_I = 2V_U$, a
$v_O= v_I +V_{BE}+V_D+R_2\, v_I / (\beta\, R_1)=2v_I+1.2V=4V_U +1.2V$
Tranzistor odlazi u zasićenje kada je napon na emitoru 9.8V a napon na katodi diode 9.2V.
Tada je V_U = 9.2V /2=4.6V, a v_O= 18.4V +1.2V=19.6V.
Nakon toga je transistor u zasićenju, i promena ulaznog napona ne utiče na v_I, dok operacioni pojačavač odlazi u pozitivno zasićenje jednako njegovom pozitivnom napajanju.

6. a)

$$I_D = \frac{B}{2}(V_{SG} - |V_{TP}|)^2$$
$$V_{SG} = V_S - V_G$$
$$V_G = V_D = I_D R_D$$
$$V_{SG} = V_{DD} - I_D R_D$$
$$I_D = \frac{B}{2}(V_{DD} - I_D R_D - |V_{TP}|)^2$$
$$I_D = 2mA$$

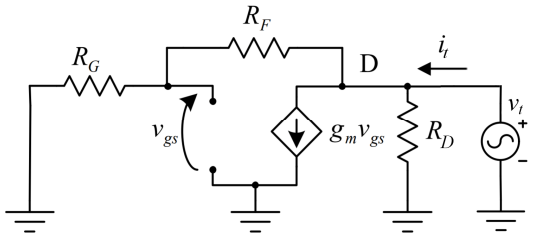
b)



$$A_V = \frac{R_D(1 - g_m R_F)}{R_D + R_F + R_G + g_m R_D R_G} = -3.26$$

c)

$$i_g = \frac{v_g - v_i}{R_G + R_F} = \frac{v_g - A_V v_g}{R_G + R_F}$$
$$R_U = \frac{v_g}{i_g} = \frac{R_G + R_F}{1 - A_V} \approx 14.1k\Omega$$



$$i_t = g_m v_{gs} + \frac{v_t}{R_F + R_G} + \frac{v_t}{R_D}$$
$$v_{gs} = v_t \frac{R_G}{R_G + R_F}$$
$$R_i = \frac{v_t}{i_t} = \frac{1}{\frac{g_m R_G}{R_G + R_F} + \frac{1}{R_F + R_G} + \frac{1}{R_D}} \approx 983\Omega$$

7. a)

$$I_{E1} = I_{E2} = I_E$$
$$2I_E = I_{EE} + \frac{0 - V_{BE} - (-V_{CC})}{R} = 4mA$$
$$I_E = 2mA$$
$$I_C = \frac{\beta}{\beta + 1} I_E = 1.98mA$$
$$I_B = \frac{I_C}{\beta} = 19.8\mu A$$
$$V_C = V_{CC} - R_C I_C = 4.06V$$

b)

$$g_m = \frac{I_C}{V_T} = 79.2mS \approx 80mS$$

$$r_\pi = \frac{\beta}{g_m} = 1.25k\Omega$$

$$A_V = g_m R_C = 240$$

c)

$$R_u = 2r_\pi = 2.5k\Omega$$