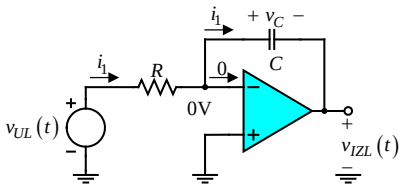
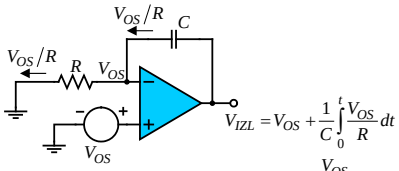
REŠENJA:

1. Beleške za predavanja, 9_Izlazni_pojacavacki_stepeni.pdf, slajdovi 3-5 (+ 6-8).

2. a)

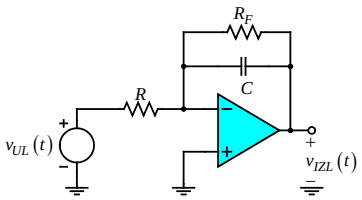


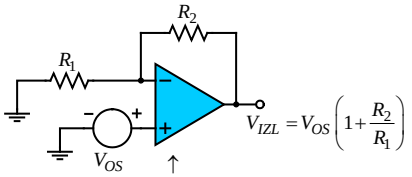
$$v_{IZL}(t) = -\frac{1}{CR}\int_0^t v_{UL}(t)\,dt$$



$$V_{IZL} = V_{OS} + \frac{1}{C}\int_0^t \frac{V_{OS}}{R}\,dt$$
$$= V_{OS} + \frac{V_{OS}}{CR}t$$

b)





$$V_{IZL} = V_{OS}\left(1 + \frac{R_2}{R_1}\right)$$

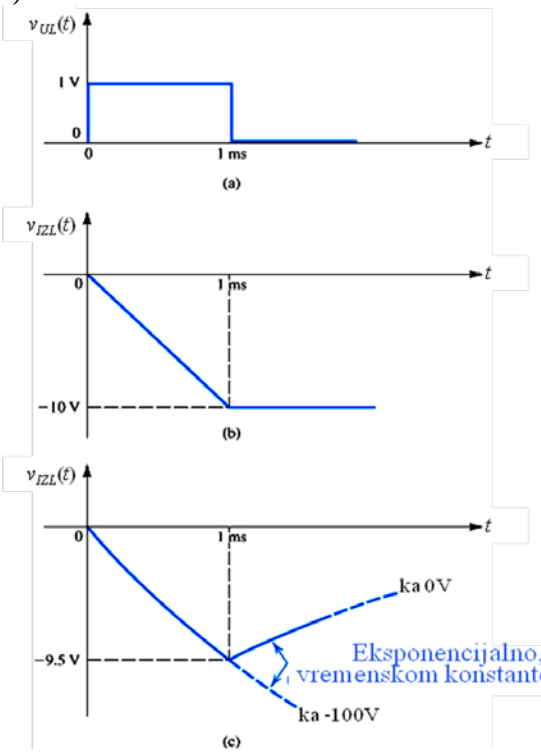
↑ Idealan OP (bez ofset napona)

Ako se paralelno kondenzatoru veže R_F :

$$1\text{V} = 5\text{mV}\left(1 + \frac{R_F}{R}\right)$$

$$R_F = 199R$$

c)



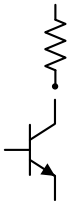
(a) Ulazni impuls. **(b)** Izlazni linearno-promenljivi napon idealnog integratora sa vremenskom konstantom 0,1 ms. **(c)** Izlazni eksponencijalni napon kada je otpornik R_F priključen paralelno sa kondenzatorom integratora.

3. Beleške za predavanja, 13_Regulator_(stabilizator)_napona.pdf, slajd 2, 3.

4. a) $v_{BE3} = v_{BE4} \Rightarrow I_{C3} = I_{C4}$

$$\left.\begin{aligned} &I_{C4} = \frac{V_{CC} - V_{BE} - V_{EE}}{R_1} = 4\text{mA} = I_{C3} \\ &I_{C1} + I_{C2} = I_{C3} \\ &I_{C1} = I_{C2} \end{aligned}\right\} \Rightarrow I_{C1} = I_{C2} = \frac{I_{C3}}{2} = 2\text{mA}$$

b)



$$r_{\pi 1} = r_{\pi 2} = \frac{\beta_0 V_T}{I_{C1}} = 1.25\text{k}\Omega$$

$$\frac{v_p}{2} = (R_C \parallel \frac{R_P}{2})\beta_0 \frac{\frac{v_d}{2}}{r_\pi + (1+\beta_0)R_E} \Rightarrow a_d = \frac{v_p}{v_d} = \beta_0 \frac{R_C \parallel \frac{R_P}{2}}{r_\pi + (1+\beta_0)R_E} = 5 \Rightarrow R_C = 5.36\text{k}\Omega$$

c) $V_{\min}$ - određeno zasićenjem tranzistora Q_3

$$V - V_{BE} - I_{C1}R_E - V_{EE} \geq V_{CES} \Rightarrow V \geq V_{BE} + I_{C1}R_E + V_{EE} + V_{CES} \Rightarrow V_{\min} = -10.2\text{V}$$

$V_{\max}$ - određeno zasićenjem tranzistora Q_1

$$V_{CC} - I_{C1}R_C - V + V_{BE} \geq V_{CES} \Rightarrow V \leq V_{CC} - I_{C1}R_C + V_{BE} - V_{CES} \Rightarrow V_{\max} = 1.68\text{V}$$

5.

a)

$$v_r = -\frac{(R_1 \parallel R_u + R_2) \parallel R_3}{(R_1 \parallel R_u + R_2) \parallel R_3 + R_4 + R_i} \frac{R_1 \parallel R_u}{R_1 \parallel R_u + R_2} v_t \Rightarrow$$

$$A_{inv} = \frac{v_r}{v_t} = -\frac{(R_1 \parallel R_u + R_2) \parallel R_3}{(R_1 \parallel R_u + R_2) \parallel R_3 + R_4 + R_i} \frac{R_1 \parallel R_u}{R_1 \parallel R_u + R_2} = -0.0832 \Rightarrow T = -aA_{inv} = 8.32$$

b)

$$a_{r\infty} = a_r(a \to \infty) \Rightarrow v_u = 0 \Rightarrow v_x = -R_2 \frac{v_g}{R_1} \Rightarrow v_i = v_x - R_4(\frac{v_g}{R_1} - \frac{v_x}{R_3})$$

$$v_i = -\frac{v_g}{R_1}(R_2 + R_4 + \frac{R_2 R_4}{R_3}) \Rightarrow a_{r\infty} = -\frac{R_2 + R_4 + \frac{R_2 R_4}{R_3}}{R_1} = -8$$

$$a_{r0} = a_r(a = 0) \Rightarrow$$

c) $$v_i = \frac{R_u \parallel (R_2 + R_3 \parallel (R_4 + R_i))}{R_u \parallel (R_2 + R_3 \parallel (R_4 + R_i)) + R_1} \frac{R_3 \parallel (R_4 + R_i)}{R_3 \parallel (R_4 + R_i) + R_2} \frac{R_i}{R_i + R_4} v_g \Rightarrow a_{r0} = 0.017$$

d) $a_r = a_{r\infty} \frac{T}{1+T} + a_{r0} \frac{1}{1+T} = -7.14$

e) $R_{ir} = R_{i0} \frac{1 + T_{ks}}{1 + T_{ov}}$

$R_{i0} = R_i \parallel (R_4 + R_3 \parallel (R_2 + R_u \parallel R_1)) = 932\Omega$, $T_{ks} = 0$, $T_{ov} = T = 8.32$

$R_{ir} = 100\Omega$