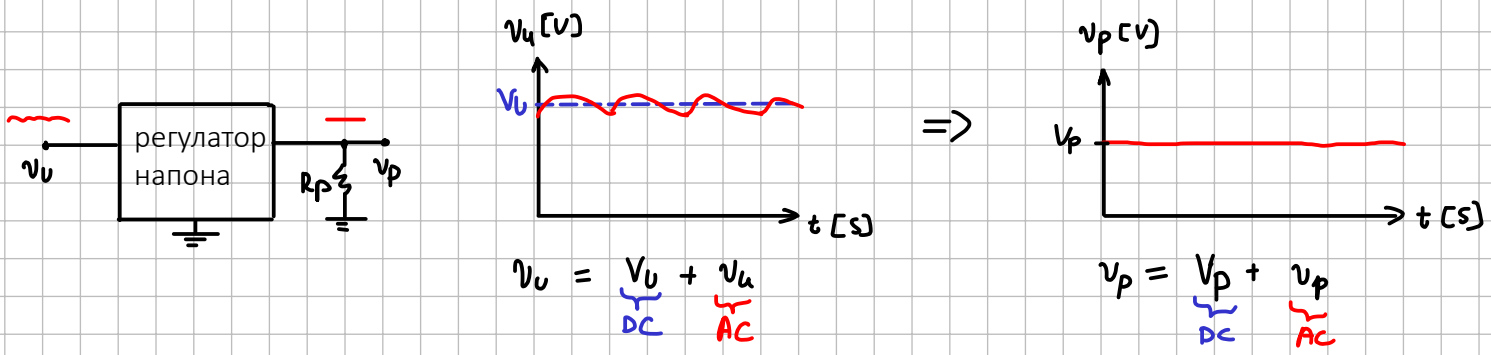
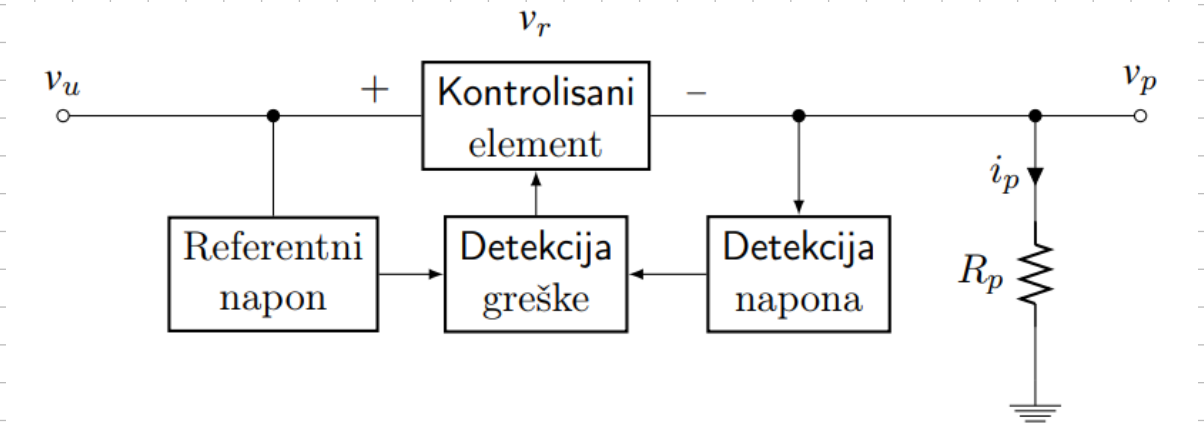
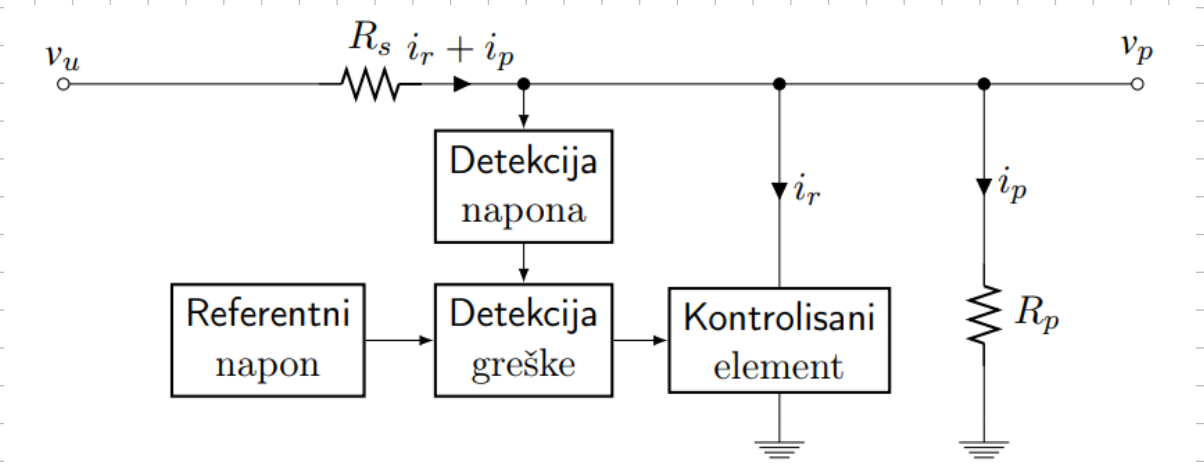
Регулатори напона





Блок шема регулатора са редним контролисаним елементом



Блок шема регулатора са паралелним контролисаним елементом

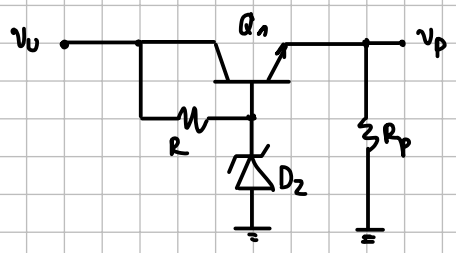
Осетљивост величине x на промену неке величине y :

$$S = \frac{\partial x}{\partial y} \approx \frac{x}{y}$$ ← мали сигнали

Фактор стабилизације регулатора- осетљивост излазног напона на промене улазног:

$$S_v = \frac{\partial v_p}{\partial v_u} \approx \frac{v_p}{v_u}$$ ← добија се анализом за мале сигнале

Пр. 1.

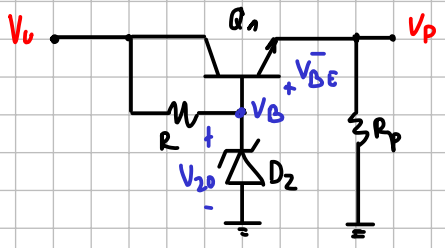


Познато је: $R,\ R_p,\ V_{Z0},\ V_{BE},\ r_z,\ g_m,\ r_\pi,\ V_A \to \infty$

а) $V_P = ?$ - Једносмерни излазни напон

б) $S_V = ?$ - Осетљивост стабилизатора

а) DC:



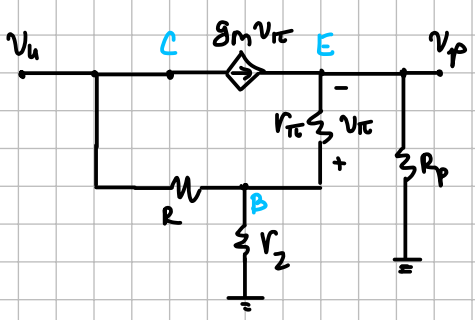
$V_B - V_p = V_{BE}$ $\quad r_z \approx 0$

$V_B = V_{Z0}$

$$\boxed{V_p = -V_{BE} + V_{Z0}}$$

б)

AC: $\quad S_v = \dfrac{v_p}{v_u}$



E: $\dfrac{v_p}{R_p} + \dfrac{v_p - v_B}{r_\pi} - g_m v_\pi = 0$

B: $\dfrac{v_B}{r_z} + \dfrac{v_B - v_u}{R} + \dfrac{v_B - v_p}{r_\pi} = 0$

Q_1: $v_\pi = v_B - v_p$

E: $\dfrac{v_p}{R_p} + \dfrac{v_p - v_B}{r_\pi} - g_m(v_B - v_p) = \left(\dfrac{1}{R_p} + \dfrac{1}{r_\pi} + g_m\right)v_p - \left(\dfrac{1}{r_\pi} + g_m\right)v_B = 0$

B: $\dfrac{v_B}{r_z} + \dfrac{v_B}{R} + \dfrac{v_B}{r_\pi} - \dfrac{v_p}{r_\pi} = \dfrac{v_u}{R} \Rightarrow \left(\dfrac{1}{R} + \dfrac{1}{r_\pi} + \dfrac{1}{r_z}\right)v_B - \dfrac{v_p}{r_\pi} = \dfrac{v_u}{R}$

$g_{PP} = \dfrac{1}{R_p} + \dfrac{1}{r_\pi} + g_m \approx \ldots \qquad g_{BB} = \dfrac{1}{R} + \dfrac{1}{r_\pi} + \dfrac{1}{r_z} \approx \ldots$

$g_{PB} = -\left(\dfrac{1}{r_\pi} + g_m\right) \approx \ldots \qquad g_{BP} = -\dfrac{1}{r_\pi} = \ldots$

E: $g_{PP} \cdot v_p + g_{PB} \cdot v_B = 0$

B: $g_{BP} \cdot v_p + g_{BB} \cdot v_B = \dfrac{v_u}{R}$

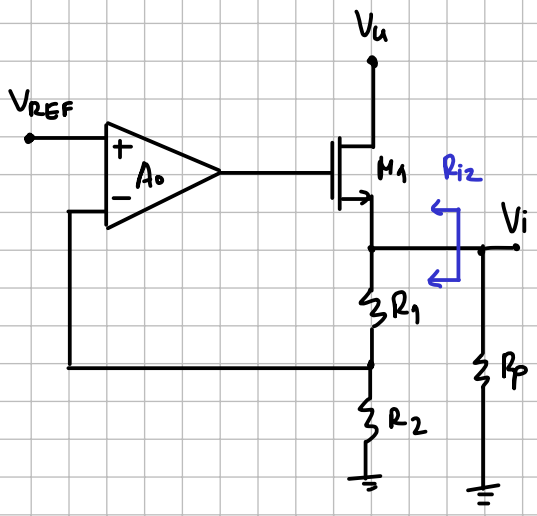
$\Rightarrow \quad v_B = -\dfrac{g_{PP}}{g_{PB}} \cdot v_p$

$\Rightarrow \quad g_{BP} \cdot v_p + g_{BB} \cdot \left(-\dfrac{g_{PP}}{g_{PB}} \cdot v_p\right) = \dfrac{v_u}{R}$

$\Rightarrow$

$$\boxed{S_v = \frac{v_p}{v_u} = \frac{1}{\left(g_{BP} - \dfrac{g_{BB} \cdot g_{PP}}{g_{PB}}\right) \cdot R} \approx \ldots}$$

Пр. 2.



а) $V_1 = ?$

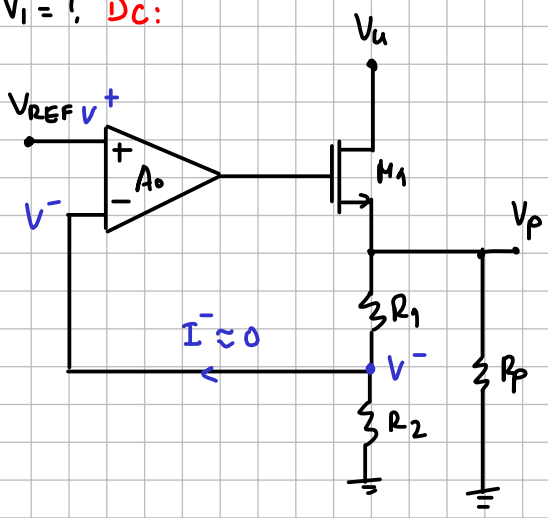
б) $S_v = ?$

в) $R_{i2} = ?$

$r_0 < \infty$
$A_0,\ R_1,\ R_2,\ g_m$

ОП није идеалан - $R_{i0} \to \infty$
$R_{i0} = 0$
$A_0 < \infty$

а) $V_1 = ?$ DC:



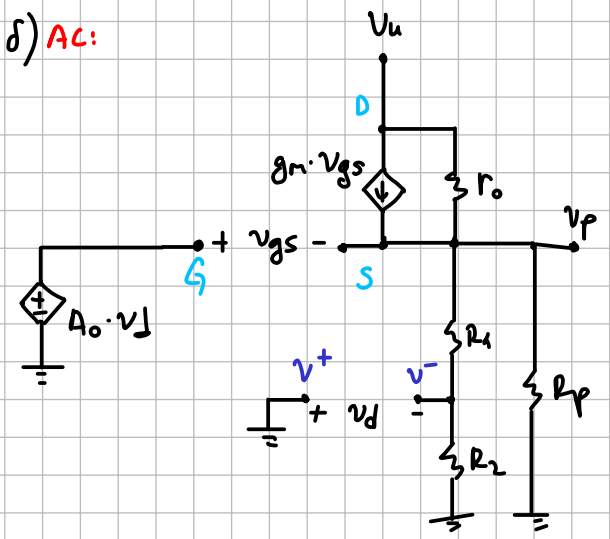
$V^+ \approx V^-$

$V^+ = V_{REF} \Rightarrow V^- \approx V_{REF}$

$$V^- = \frac{R_2}{R_1 + R_2} \cdot V_p$$

$$V_p = \frac{R_1 + R_2}{R_2} \cdot V^- \approx \left(1 + \frac{R_1}{R_2}\right) \cdot V_{REF} \approx \dots$$

б) AC:



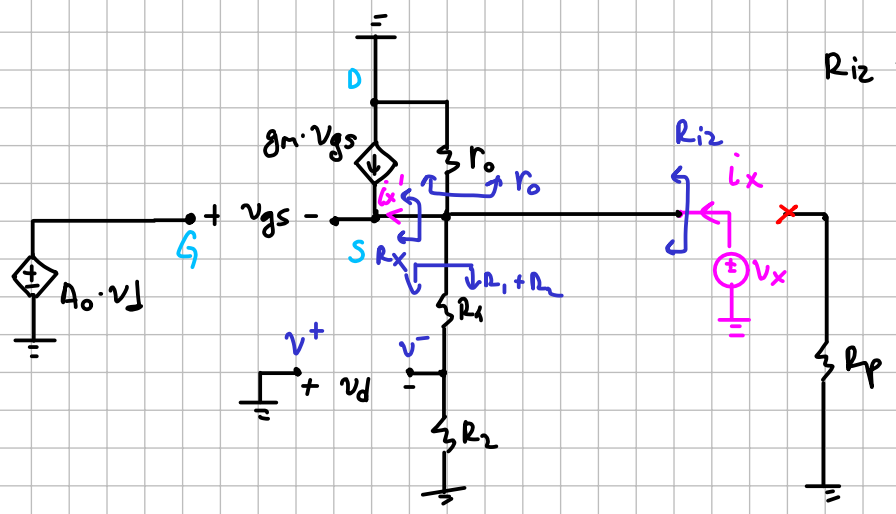
S: $\frac{v_p - v_u}{r_0} + \frac{v_p}{R_1 + R_2} + \frac{v_p}{R_p} - g_m v_{gs} = 0$

$$\left.\begin{aligned} v_{gs} &= A_0 \cdot v_d - v_p \\ v_d &= 0 - \frac{R_2}{R_1 + R_2} \cdot v_p \end{aligned}\right\} \Rightarrow v_{gs} = -\left(\frac{A_0 R_2}{R_1 + R_2} + 1\right) \cdot v_p$$

$$\left(\frac{1}{r_0} + \frac{1}{R_1 + R_2} + \frac{1}{R_p} + g_m \cdot \left(A_0 \frac{R_2}{R_1 + R_2} + 1\right)\right) v_p = \frac{v_u}{r_0}$$

$$S_v = \frac{v_p}{v_u} = \frac{1}{r_0 \cdot \left(\frac{1}{r_0} + \frac{1}{R_1 + R_2} + \frac{1}{R_p} + g_m \cdot \left(A_0 \frac{R_2}{R_1 + R_2} + 1\right)\right)} = \dots$$

B)



$$R_{iz} = \frac{v_x}{i_x} = ?$$

$$R_{iz} = r_o \,||\, (R_1+R_2) \,||\, R_x$$

$R_x = ?$

$$R_x = \frac{v_x}{i_x'}$$

$$\left.\begin{aligned} i_x' &= -g_m v_{gs} \\ v_{gs} &= A_0 \cdot v_d - v_x \\ v_d &= -\frac{R_2}{R_1+R_2} v_x \end{aligned}\right\} \Rightarrow i_x' = -g_m \left(A_0 \cdot \left(-\frac{R_2}{R_1+R_2} \cdot v_x \right) - v_x \right)$$

$$= g_m v_x \left(A_0 \frac{R_2}{R_1+R_2} + 1 \right)$$

$$R_x = \frac{v_x}{i_x'} = \frac{1}{g_m \left(A_0 \frac{R_2}{R_1+R_2} + 1 \right)} \approx \cdots \Rightarrow R_{iz} = r_o \,||\, (R_1+R_2) \,||\, R_x \approx \cdots$$