

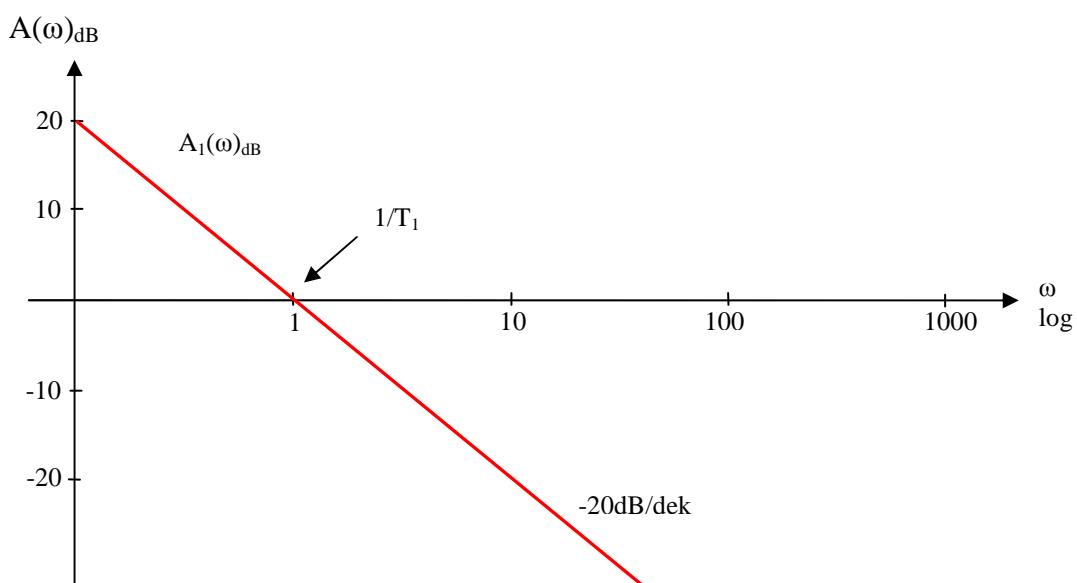
ZAD. Nacrtajte bodeov dijagram prijenosne funkcije $G(s) = \frac{1}{T_1 s} \frac{K_2 K_3 (1 + sT_2)}{(1 + sT_3)}$

1. Član: $G_1 = \frac{1}{j\omega T_1} \quad T_1 = 1 [s]$

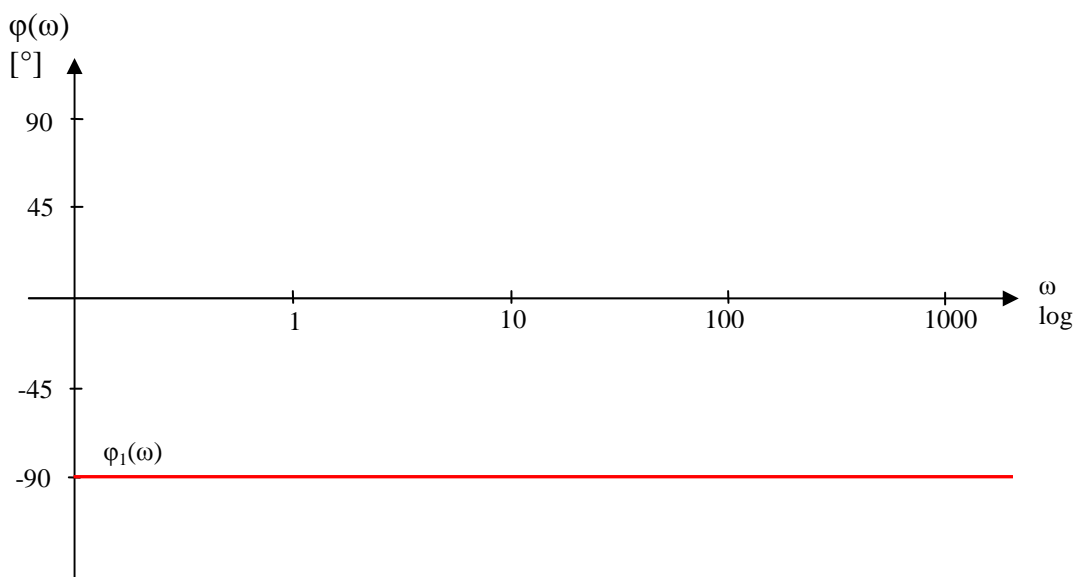
$$G_1 = \frac{1}{j\omega T_1} = \frac{1}{\omega T_1} e^{-j\frac{\pi}{2}} \quad A_1(\omega) = \frac{1}{\omega T_1} \quad \varphi_1(\omega) = -\frac{\pi}{2}$$

$$A_1(\omega)_{dB} = 20 \log \frac{1}{\omega T_1} = -20 \log \omega T_1$$

Amplitudna karakteristika:



Fazna karakteristika:



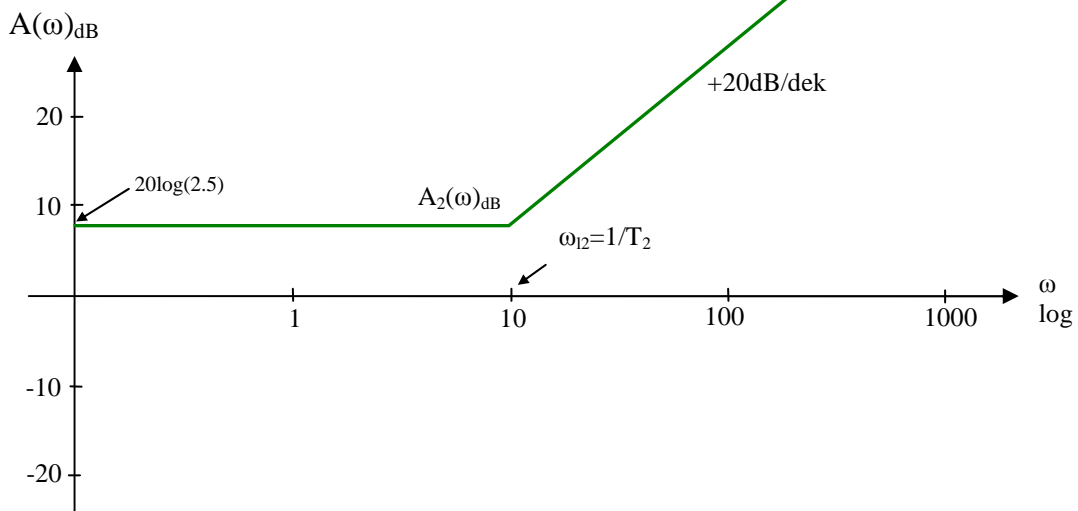
2. Član: $G_2 = K_2(1 + j\omega T_2)$ $T_2 = 100 \text{ [ms]}$, $K_2 = 2.5$

$$G_2 = K_2 \left(1 + j \frac{\omega}{\omega_{l_2}}\right) \quad A_2(\omega) = K_2 \sqrt{1 + \left(\frac{\omega}{\omega_{l_2}}\right)^2} \quad \varphi_2(\omega) = \arctg\left(\frac{\omega}{\omega_{l_2}}\right)$$

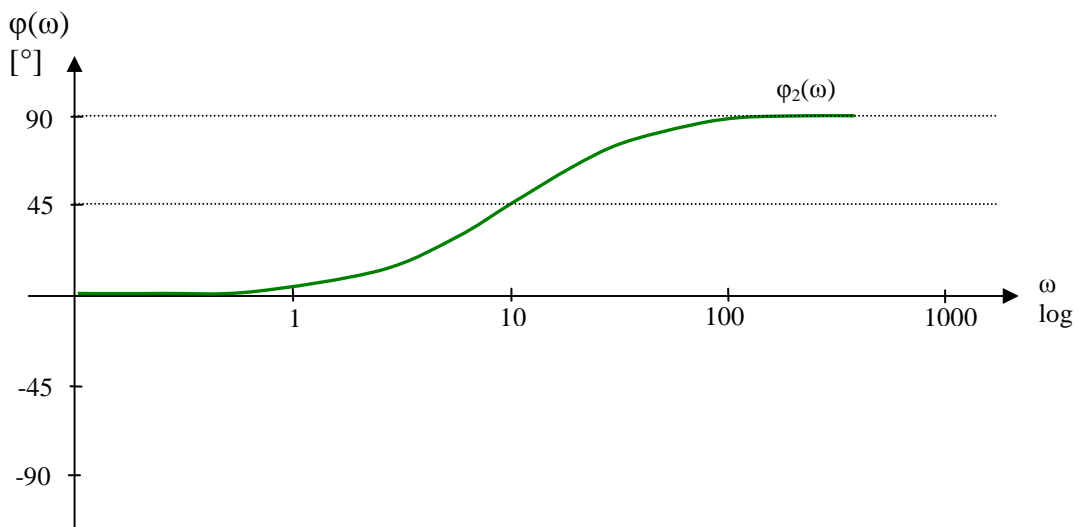
$$A_2(\omega)_{dB} = 20 \log K_2 + 20 \log \sqrt{1 + \left(\frac{\omega}{\omega_{l_2}}\right)^2}$$

$$\omega_{l_2} = \frac{1}{T_2} = \frac{1}{0.1} = 10 \text{ rad/s}, \quad K_2 = 2.5$$

Amplitudna karakteristika:



Fazna karakteristika:



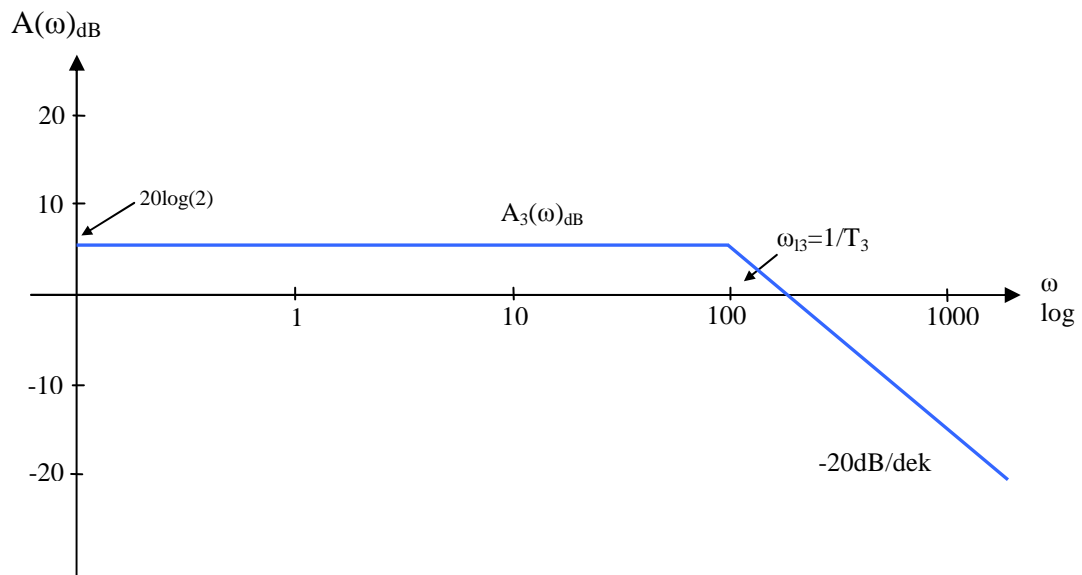
3. Član: $G_3 = \frac{K_3}{1 + j\omega T_3}$ $T_3 = 10 [ms]$, $K_3 = 2$

$$G_3 = \frac{K_3}{1 + j\frac{\omega}{\omega_{l3}}} \quad A_3(\omega) = K_3 \frac{1}{\sqrt{1 + \left(\frac{\omega}{\omega_{l3}}\right)^2}} \quad \varphi_3(\omega) = -\arctg\left(\frac{\omega}{\omega_{l3}}\right)$$

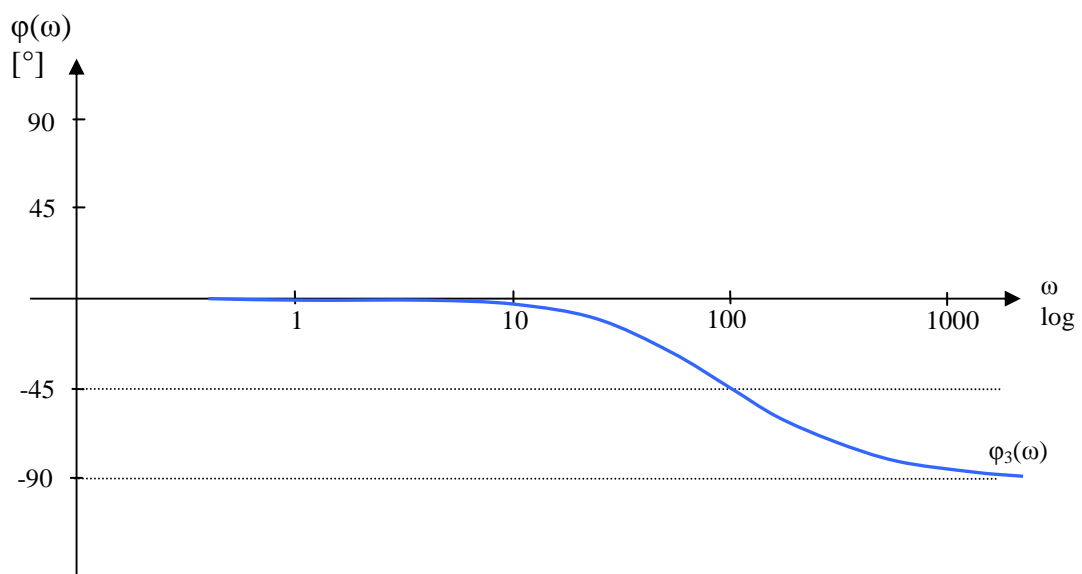
$$A_3(\omega)_{dB} = 20 \log K_3 - 20 \log \sqrt{1 + \left(\frac{\omega}{\omega_{l3}}\right)^2}$$

$$\omega_{l3} = \frac{1}{T_3} = \frac{1}{0.01} = 100 \text{ rad / s}, \quad K_3 = 2$$

Amplitudna karakteristika:



Fazna karakteristika:

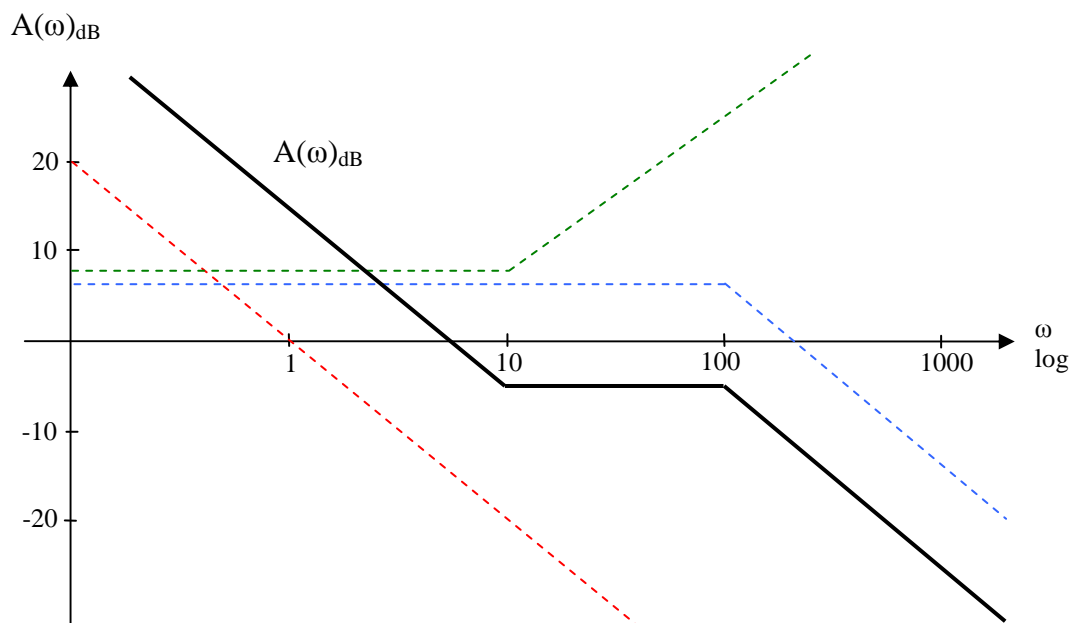


4. Sustav: $G(j\omega) = G_1(j\omega)G_2(j\omega)G_3(j\omega)$

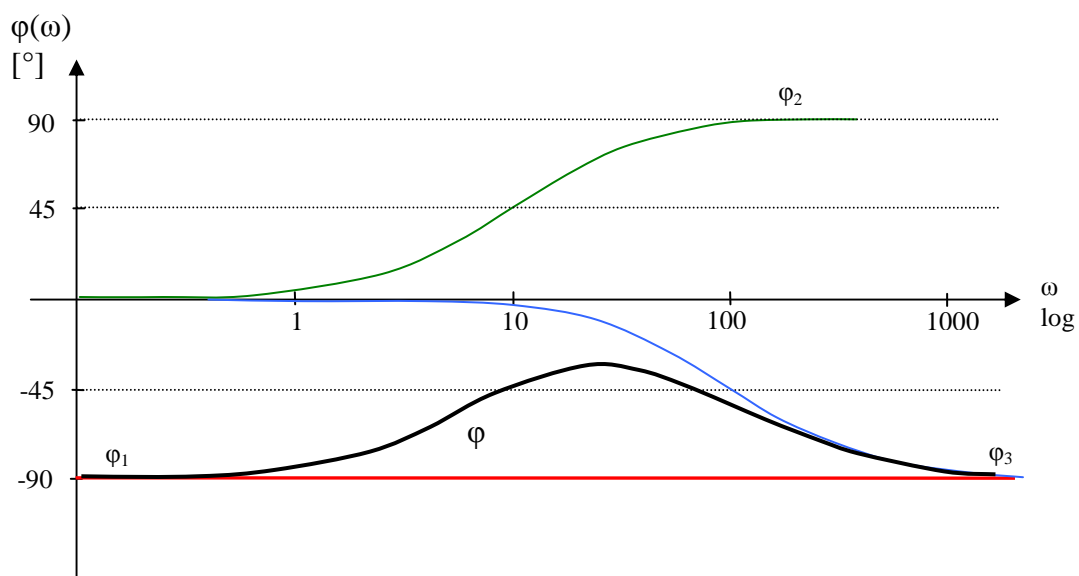
Amplitudna karakteristika: $A(\omega)_{dB} = A_1(\omega)_{dB} + A_2(\omega)_{dB} + A_3(\omega)_{dB}$

Fazna karakteristika: $\varphi(\omega) = -\frac{\pi}{2} + \arctg\left(\frac{\omega}{\omega_{l2}}\right) - \arctg\left(\frac{\omega}{\omega_{l3}}\right)$

Amplitudna karakteristika (zbroy amplitudnih karakteristika pojedinačnih elemenata):



Fazna karakteristika sustava (zbroy faznih karakteristika pojedinačnih elemenata):



Radi preciznijeg crtanja fazne karakteristike preporuča se slijedeće. Izračuna se vrijednost fazne karakteristike $\varphi(\omega)$ za desetak različitih frekvencija.

$$\text{Ukupna fazna karakteristika sustava: } \varphi(\omega) = -\frac{\pi}{2} + \arctg\left(\frac{\omega}{\omega_{l2}}\right) - \arctg\left(\frac{\omega}{\omega_{l3}}\right)$$

ω [rad/s]	0.5	1	5	8	10	30	50	100	300	700
$\varphi(\omega)$ [rad]	-1.52	-1.48	-1.16	-0.98	-0.88	-0.61	-0.66	-0.89	-1.28	-1.44
$\varphi(\omega)$ [°]	-87.4	-84.7	-66.3	-56.0	-50.7	-35.1	-37.9	-50.7	-73.5	-82.7

Napomena: vrijednosti frekvencije su u radijanima u sekundi! (na kalkulatoru prebaciti na "rad" prilikom računanja arctg funkcije). Izračunatu faznu karakteristiku pomnožiti s $180/\pi$ da bi se dobila vrijednost faze u stupnjevima.

Dobivene točke ucrtaju se na dijagram te se spoje. Rezultat je frekvencijska karakteristika sustava.

D.Z. Nacrtati Bodeov dijagram na lin-log papiru te odredite ustaljenu komponentu odziva sustava na pobudu oblika $\sin(2t) + 1.5\sin(10t - \pi/6)$