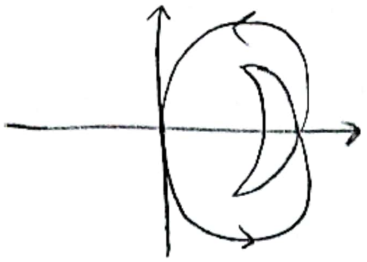
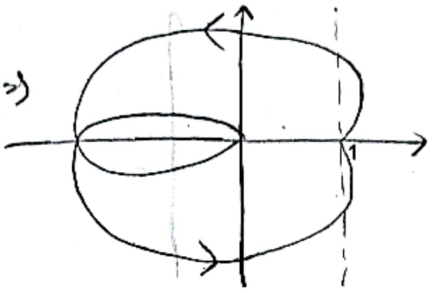
①

$$G(s) = \frac{1}{s^3 + 0.2s^2 + s + 1}$$



$\rightsquigarrow \begin{cases} N = 0 \\ P = 2 \end{cases} \Rightarrow$ ناپایدار

$$G(s) = \frac{s^2 + 2s + 1}{s^3 + 0.2s^2 + s + 1}$$



$\rightsquigarrow \begin{cases} N = -2 \\ P = 2 \end{cases} \Rightarrow$ پایدار

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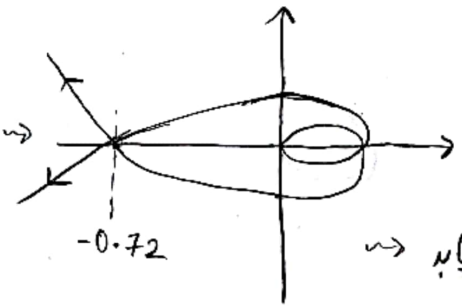
②

سیستم اول:

if $K=1 \Rightarrow$ Nyquist $\rightsquigarrow$

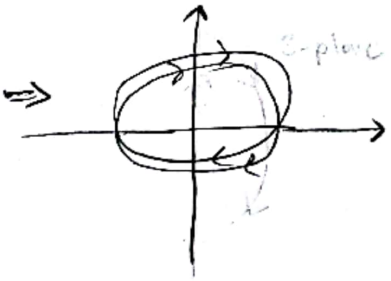


$\rightsquigarrow$ K می تواند تا مقدار 1.39 افزایش یابد

$$P = 0 \Rightarrow Z = \begin{cases} 0 & \text{if } K < 1.39 \\ 2 & \text{if } K > 1.39 \end{cases} \Rightarrow \boxed{0 < K < 1.39}$$

سیستم دوم:

if $K=1 \Rightarrow$

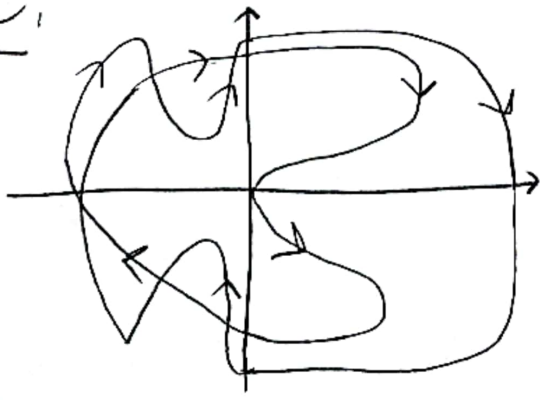


$\Rightarrow \boxed{0 < K < 1}$

---

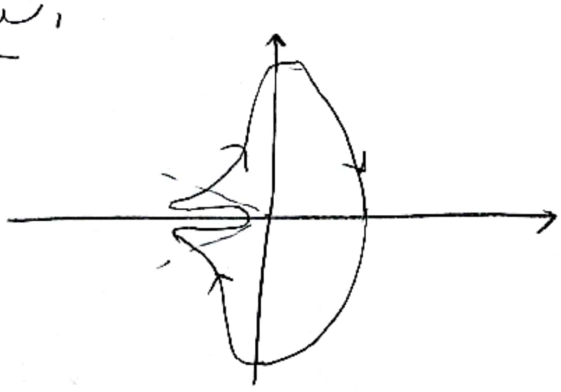
③

سیستم اول:



$$\begin{cases} P = 0 \\ N = -2 \end{cases} \Rightarrow$$ ناپایدار

سیستم دوم:



$$\begin{cases} P = 0 \\ N = 0 \end{cases} \Rightarrow$$ پایدار

④ $G(s) = \dfrac{(s+3)\,e^{-Ts}}{s^2+s}$

تقریب ۱:

$$e^{-Ts} \approx \frac{1}{1+Ts} \Rightarrow G(s) \approx \frac{s+3}{s(s+1)(1+Ts)} \Rightarrow \overbrace{s(s+1)(1+Ts)+(s+3)}^{\text{معادله مشخصه}} = 0$$

$$\Rightarrow Ts^3 + (1+T)s^2 + s = 0 \Rightarrow \begin{cases} T>0 \\ T+1>0 \end{cases} \xrightarrow{\cap} \boxed{T>0}$$

پایداری:

$$|G(j\omega)| = 1 \Rightarrow \frac{\sqrt{\omega^2+9}}{|\omega|\sqrt{\omega^2+1}} = 1 \Rightarrow \omega_g = \sqrt{3}$$

$$\gamma = 180 + \angle G(\omega_g) = 180 + \left(-53.7\sqrt{3}\,T + \tan^{-1}\left(\frac{\sqrt{3}}{3}\right) - 90^\circ - \tan^{-1}\left(\frac{\sqrt{3}}{1}\right)\right) > 0$$

$$\Rightarrow 180 + 30 - 90 - 60 > 53.7 \times \sqrt{3}\,T \Rightarrow \boxed{T < 0.64}$$

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⑤

$$P(s) = \frac{10^{-6}s^2 + (1.314\times10^{-9})s + 2.66\times10^{-13}}{s^3 + 0.00163\,s^2 + (5.272\times10^{-7})s + (3.538\times10^{-11})}$$