بنام آنکه جان را فکرت آموخت

کنترل غیرخطی

تمرین سری چهارم

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استاد: حمید رضا تقی راد

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گروه کنترل و سیستم

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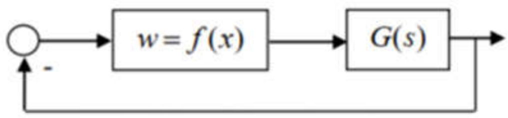
Exercise 1:

Consider the following closed loop system:



where $G(s) = \frac{4(s+1)(s+2)}{(s-1)(s-2)(s-4)}$ and nonlinear element $w = f(x)$ and type Sector are in range $[k_1, k_2]$. Assuming the nonlinear element is an odd function$(k_1, k_2 > 0)$, Find the largest approximate range for $[k_1, k_2]$ such that the closed loop system is absolutely stable.

Exercise 2:

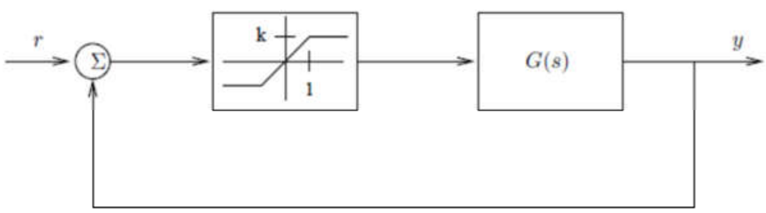
Using Popov's criterion, find a stability sector [0,k] for the following scalar transfer functions:

$$G(s) = \frac{2}{(s+1)^2(1+0.01s)}$$

In all cases, find a stability sector as large as possible.

Exercise 3:

Consider the system in the following figure, which is typical of the dynamics of electronic oscillators used in laboratories. Let



$$G(s) = \frac{-5s}{s^2 + s + 25}$$

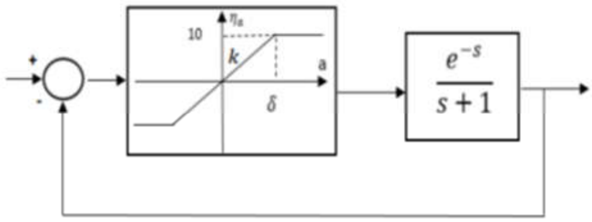
1. Assess intuitively the possibility of a limit cycle by assuming that the system is started at some small initial state, and notice that the system can neither stay small (because of instability) nor at saturation values (by applying the final value theorem of linear control).

2. Use describing function to predict whether the system exhibits a limit cycle, depending on the saturation level H. In such cases, determine the frequency and amplitude of the limit cycle.

3. Use the extended Nyquist criterion to assess whether the limit cycle is stable or unstable.

Exercise 4:

Consider the following control loop:



$$\eta(a) = \frac{2k}{\pi}\left[\sin^{-1}\frac{\delta}{a} + \frac{\delta}{a}\sqrt{1-\left(\frac{\delta}{a}\right)^2}\right]$$

1. Argue for which k the limit cycle occurs? Check its stability.

2. In such cases, determine the limit cycle frequency.

3. Assuming $k = 5$, calculate the amplitude of the resulting limit cycle.