Laboratory no. 5

1 Theoretical aspects to be applied

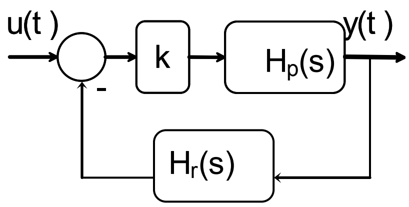
- Nyquist stability criterion
- Simplified Nyquist stability criterion
- Gain margin, phase margin(on Nyquist diagram and also on Bode)

2 Aims

Stability analysis of negative feedback control systems.
Use Nyquist criterion to analyze the stability of negative feedback control systems.
Use simplified Nyquist criterion to analyze the stability of negative feedback control systems.
Stability analysis of negative feedback control systems using Bode diagrams. (drawing m_k and γ_k)

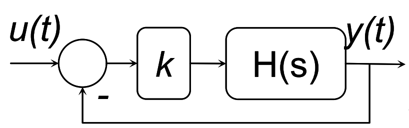
3 Stability analysis use frequency response

3.1 *For a negative feedback control structure:*



$$H_d(s) = kH_p(s);\ H_{des}(s) = H_r(s)H_d(s);\ H_o(s) = \frac{H_d(s)}{1 + H_{des}(s)}$$

using the next simplified approach:



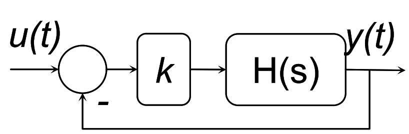
where $H_d(s) = kH(s);\ H_{des}(s) = H_d(s);\ H_o(s) = \frac{H_d(s)}{1 + H_d(s)}$

3.2 *Indicate in the notebook (in words and mathematical relatios) for the last considered negative feedback control structure :*

- The Nyquist criterion
- The simplified Nyquist
- The gain margin and phase margin

4 Problems

4.1 *Analyze the stability of the next negative feedback control structure (apply the criterion using Nyquist and also Bode diagrams)*



, with

a) $H_{des} = k\frac{s+9}{s+5}$ b) $H_{des} = k\frac{s-9}{s+5}$ c) $H_{des} = k\frac{s-9}{s-5}$ d) $H_{des} = k\frac{s+9}{s-5}$

e) $H_{des} = k\frac{-s+9}{s+5}$ f) $H_{des} = -k\frac{s-9}{s-5}$ g) $H_{des} = k\frac{s+9}{-s+5}$ h) $H_{des} = \frac{k}{s(s+1)(s+4)}$

4.2 *Matlab solution of the problems*

The next script can be used in Matlab to analyze the stability of the negative feedback control structure at point a):

```
for k=1:6
    zero=9; pol=5;
    subplot(2,3,i)
    nyquist(k*[1 zero],[1 pol])
end
```

Notice the position of the critical point with respect to the Nyquist diagram. (In case the values of the gain are not representative for stability analysis, choose another one)