Control Systems

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Contents

1 Stability

2 Routh Hurwitz Criterion

3 Compensators

3.1 Phase

3.1. The Transfer function of Phase Lead Compensator is given by

$$D(s) = \frac{3(s+\frac{1}{3T})}{(s+\frac{1}{T})} \tag{3.1.1}$$

Find out the frequency (in rad/sec), at which $\angle D(j\omega)$ is maximum?

Solution: The basic requirement of the phase lead network is that all poles and zeros of the transfer function of the network must lie on negative real axis interlacing each other with a zero located as the nearest point to origin.
Substituting $s = j\omega$ in D(s), we get

$$D(j\omega) = \frac{3(j\omega+\frac{1}{3T})}{(j\omega+\frac{1}{T})} \tag{3.1.2}$$

The phase of this transfer function () is given by,

$$\phi(\omega) = \tan^{-1}(3\omega T) - \tan^{-1}(\omega T) \tag{3.1.3}$$

$\phi(\omega)$ has its maximum at ω_c Where $\phi'(\omega_c) = 0$,

$$\phi'(\omega_c) = 0 = \frac{3T}{1+(3\omega_c T)^2} - \frac{T}{1+(\omega_c T)^2} \tag{3.1.4}$$

After solving and Simplification , we have

$$\omega_c^2 T^2 = \frac{1}{3} \tag{3.1.5}$$

$$\omega_c = \sqrt{\frac{1}{3T^2}} \tag{3.1.6}$$

The following plots the Phase value of the transfer function,

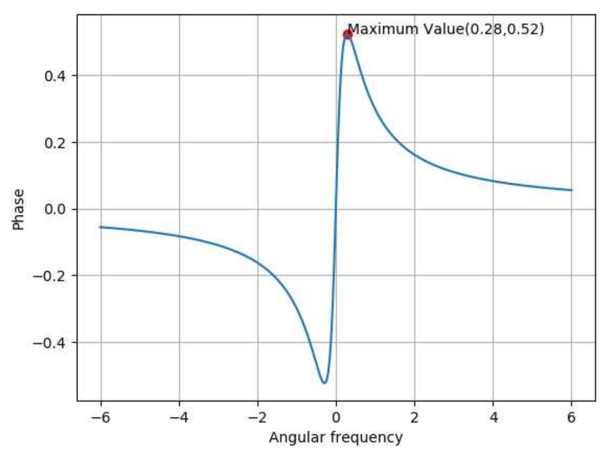

Fig. 3.1

Applications:

a) Phase lead Compensators can be used as High pass filters,Differentiators.

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b) They are used to reduce steady state errors.
c) Increases Phase Margin , relative stability.

4 Nyquist Plot