Bode diagrams [1-5]

References:

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Bode diagram for the system having the transfer function $G_p(s) = \dfrac{1}{s+1}$.

Amplitude ratio and phase angle for first order system:

$$AR = \frac{K_p}{(\tau^2 w^2 + 1)^{0.5}} = \frac{1}{(w^2 + 1)^{0.5}} \qquad \phi = tan^{-1}(-\tau w) = tan^{-1}(-w)$$

Taking the logarithm of amplitude ratio,

$$\log(AR) = \log\left(\frac{1}{(w^2+1)^{0.5}}\right)$$

Low frequency asimptode;

$$w \rightarrow 0,\ \log(AR) = \log\left(\frac{1}{(w^2+1)^{0.5}}\right) \rightarrow \log(AR) = 0 \rightarrow AR = 1$$
$$\phi = tan^{-1}(-1 \times 0) = 0^o$$

High frequency asimptode;

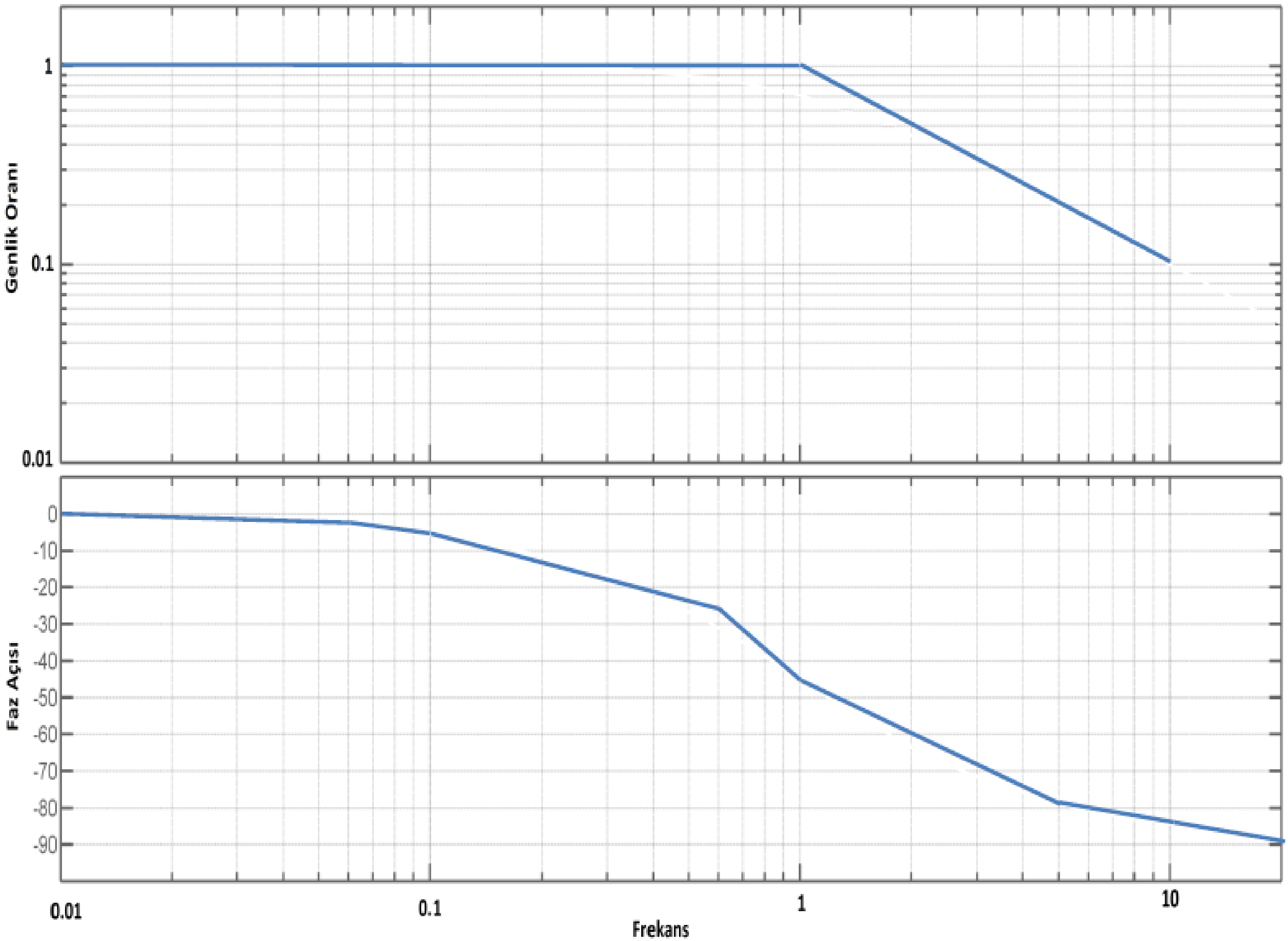
$$w \rightarrow \infty,\ AR = \frac{1}{(w^2+1)^{0.5}} \rightarrow AR = \frac{1}{w}$$

$$\log(AR) = log\,\frac{1}{w} = -\log(w) \rightarrow eğim = -1$$
$$\phi = tan^{-1}(-\infty) = -90^o$$

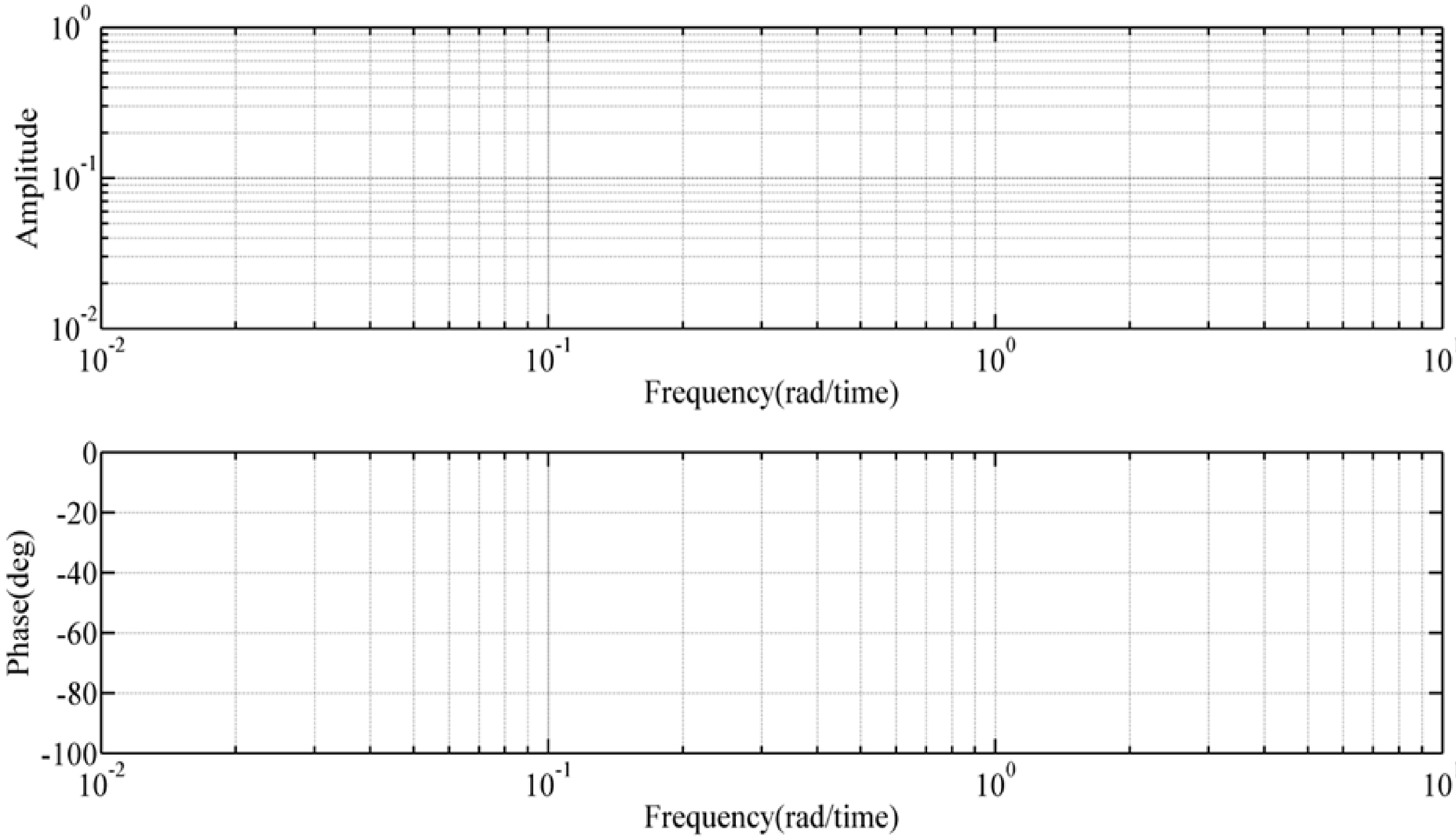
Intercept of two asimptode;

$$w_c = \frac{1}{\tau} = 1$$

Frequency	Phase angle
0	0
0.05	-2.86
0.1	-5.71
0.5	-26.6
1	-45
5	-78.69
10	-84.28


1
0.1
0.01
Genlik Oranı
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Faz Açısı
0.01
0.1
1
10
Frekans

Bode diagram for the system having the transfer function $G_p(s) = \frac{1}{5s+1}$



Amplitude ratio and phase angle for first order system:

$$AR = \frac{K_p}{\sqrt{(\tau^2 w^2 + 1)}} = \frac{1}{\sqrt{(25w^2 + 1)}} \qquad \phi = tan^{-1}(-\tau w) = tan^{-1}(-5w)$$

Taking the logarithm of amplitude ratio,

$$\log(AR) = \log(\frac{1}{\sqrt{(25w^2+1)}})$$

Low frequency asimptode;

w→0, $\log(AR) = \log\left(\frac{1}{\sqrt{(25w^2+1)}}\right) \rightarrow \log(AR) = 0 \rightarrow AR = 1$

$$\phi = tan^{-1}(-5 \times 0) = 0^o$$

High frequency asymptote;

w→∞, $AR = \frac{1}{\sqrt{(25w^2+1)}} \rightarrow AR = \frac{1}{5w}$

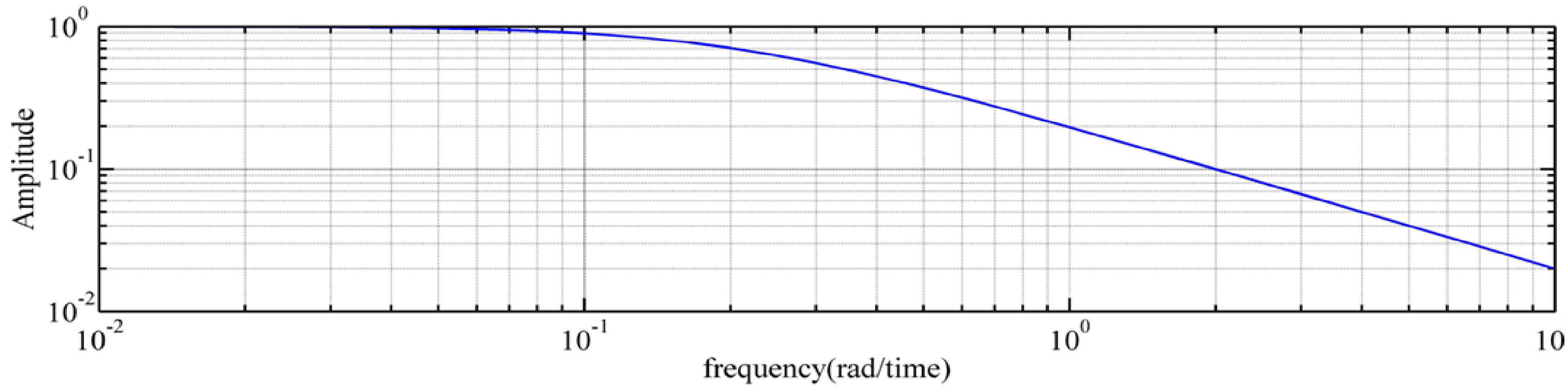
$$\log(AR) = log\,\frac{1}{5w} = -\log(5w) \rightarrow slope = -1$$

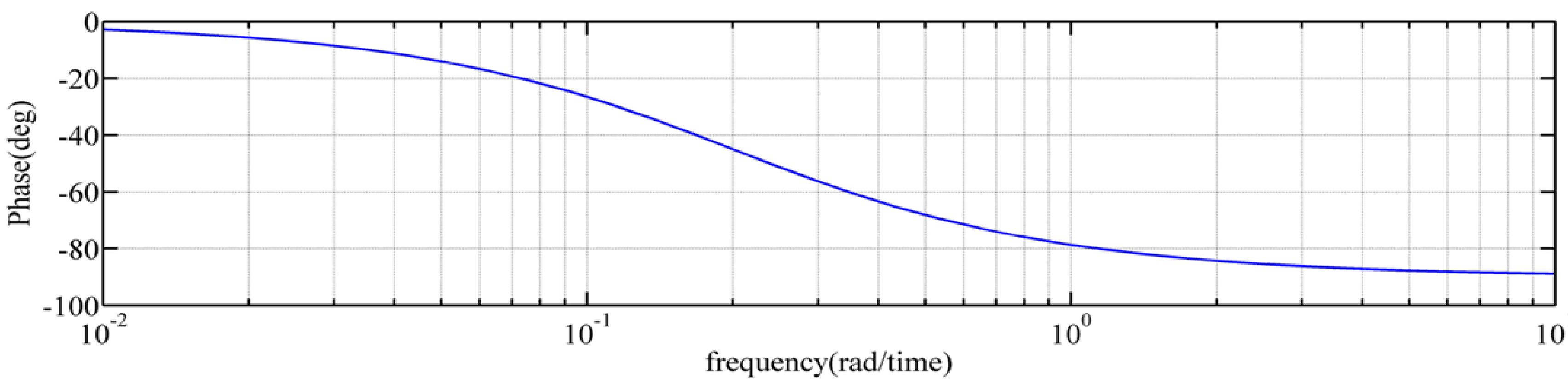
$$\phi = tan^{-1}(-\infty) = -90^o$$

Intercept of two asymptote;

$$w_c = \frac{1}{\tau} = \frac{1}{5} = 0.2$$

Frequency	Phase angle	Amplitude ratio
0.001	-2.86	0.99
0.005	-14.04	0.97
0.1	-26.57	0.89
0.5	-68.20	0.37
1	-78.69	0.20
5	-87.71	0.04
10	-88.85	0.02





THE BODE CRITERION:

$AR_{wco} \leq 1$ Stable

$AR_{wco} > 1$ Unstable