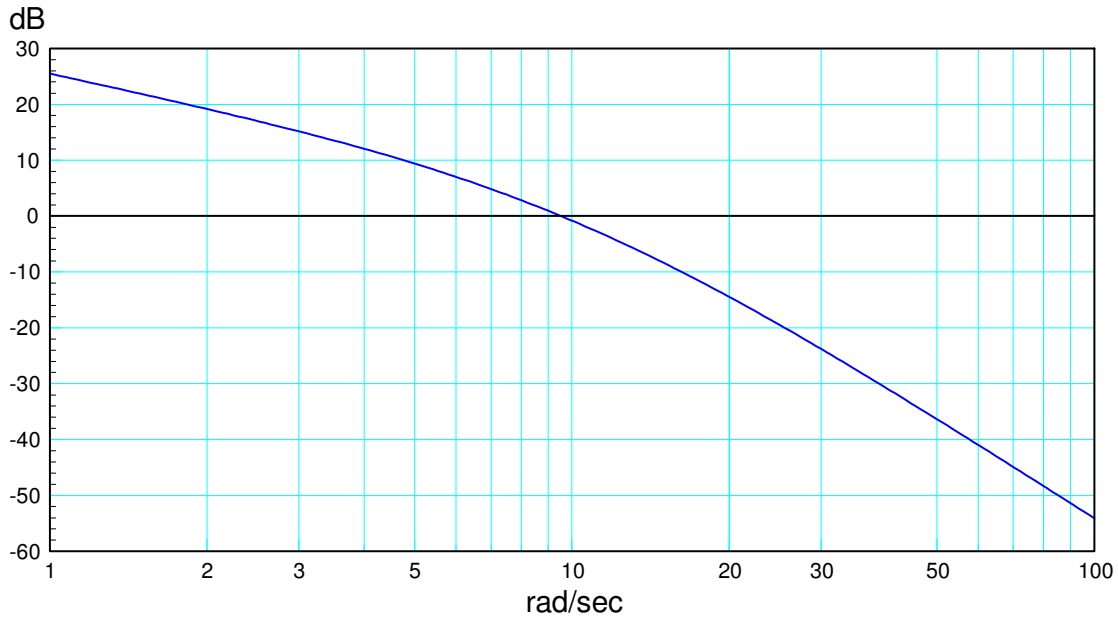
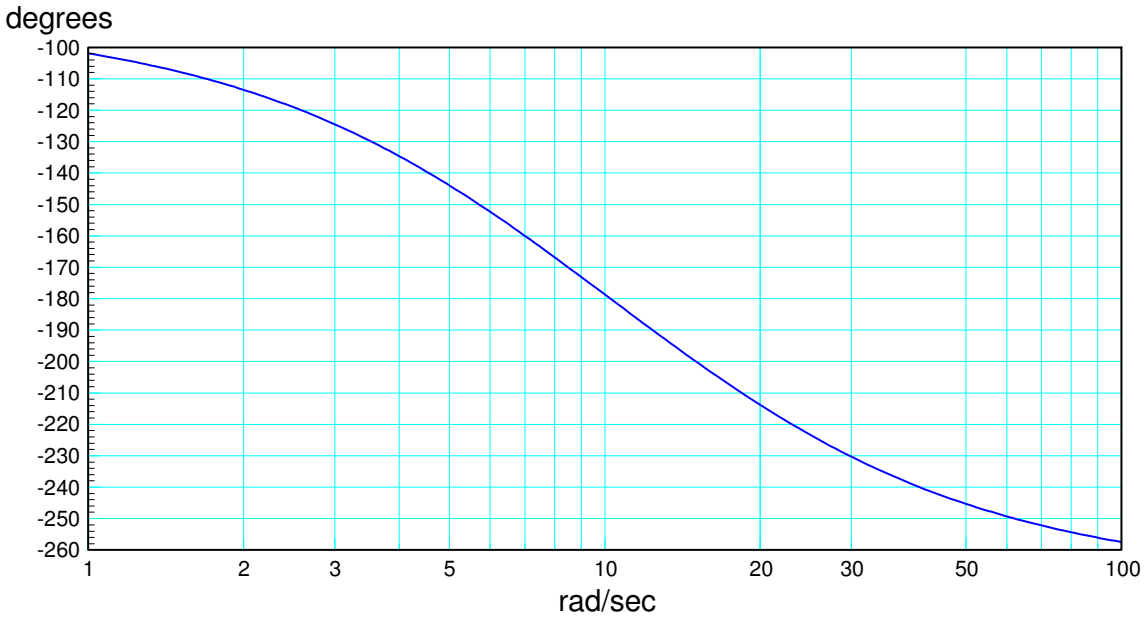
ECE 461/661 Handout #38

Lag Compensators

1) Design a lag compensator for a 50 degree phase margin
2) Determine the resulting error constant, Kv





Solution:

First, pick the rule you want to use

- Lag zero = 1/3 to 1/10th of the resonant frequency.

Pick the lag zero = 1/5th. Assuming the resonance is at 1 rad/sec

$$K(s) = k\left(\frac{s+0.2}{s+0.02}\right)$$

At 1 rad/sec

$$K(j1) = 1.0196k\angle -10.16^0$$

What this means is we need to design for an *extra* 10.16 degree phase margin.

Next, determine what frequency has a phase shift of

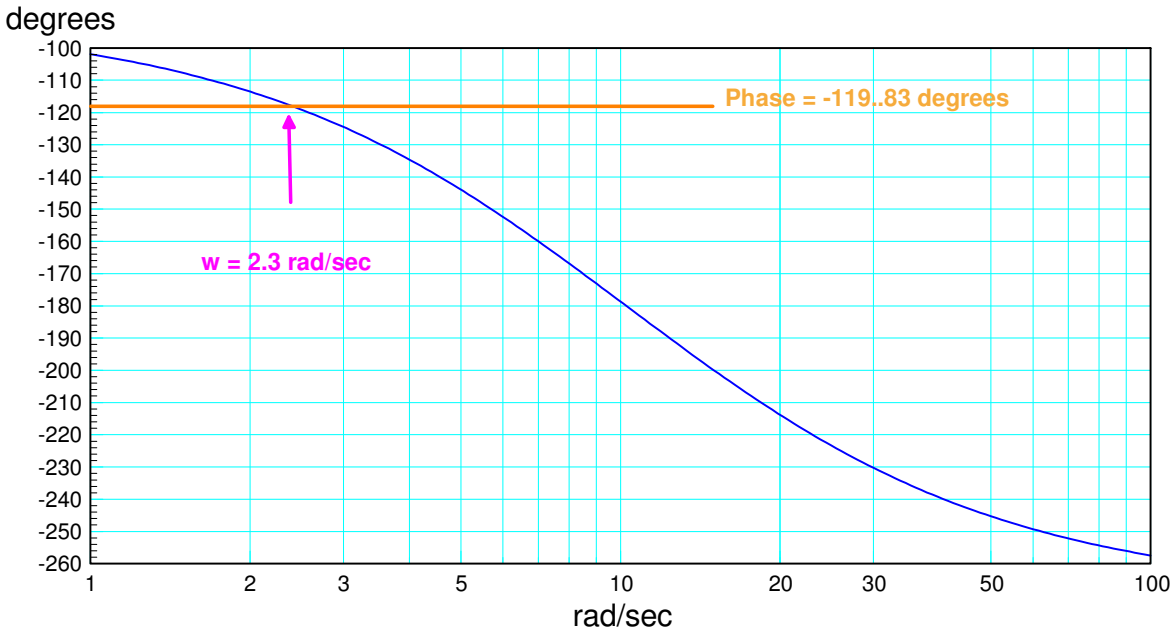
$$\theta = -130^0 + 10.16^0$$

$$\theta = -119.83^0$$

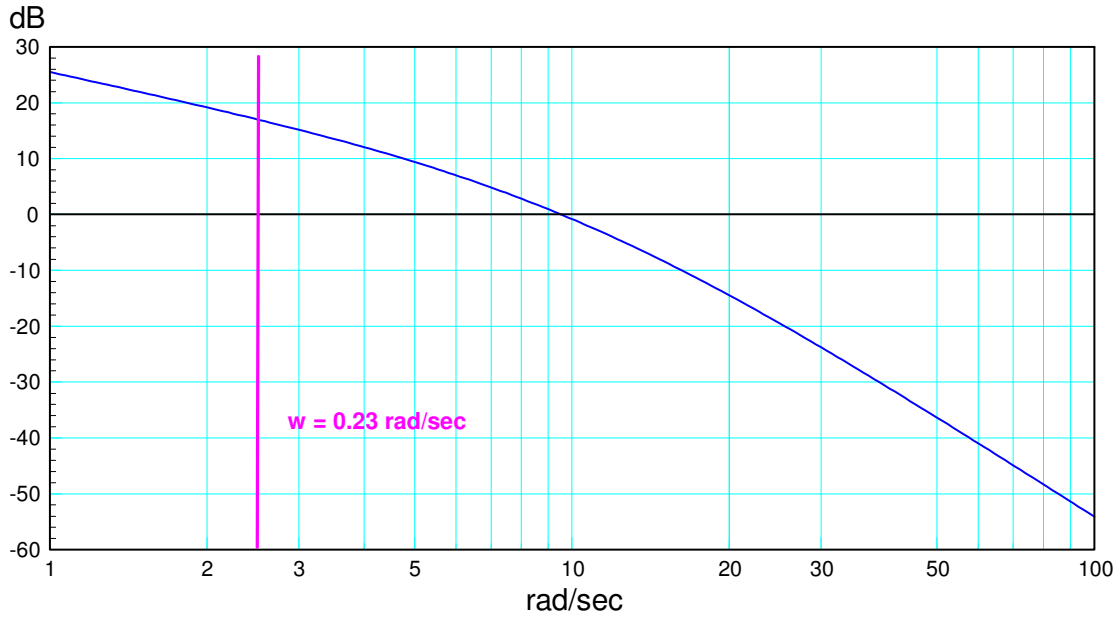
From the phase plot, ω = 2.3 rad/sec. This tells you

$$zero = \frac{2.3}{5} = 0.46$$

$$K(s) = k\left(\frac{s+0.46}{s+0.046}\right)$$



Next, refer to the gain plot.



Find the gain, k, so that

$$GK(j2.3) = 1\angle -130^0$$

From the gain plot

$$G(j2.3) = +17dB = 7.08\angle -119.83^0$$

$$K(j2.3) = k\left(\frac{s+0.46}{s+0.046}\right)_{s=j2.3} = 1.0196k\angle -10.16^0$$

$$GK(j2.3) = 7.219k\angle -130^0$$

meaning

$$k = \frac{1}{7.219} = 0.1385$$

$$K(s) = 0.1385\left(\frac{s+0.46}{s+0.046}\right)$$

The error constant is the DC gain. As s goes to zero

$$G(s) \approx \frac{+26dB}{s} = \frac{20}{s}$$

$$GK_{s\to 0} = \left(\frac{20}{s}\right)\left(0.1385\left(\frac{s+0.46}{s+0.046}\right)\right)_{s\to 0}$$

$$GK(s \to 0) = \left(\frac{20}{s}\right)(1.385) = \left(\frac{27.7}{s}\right)$$

$$K_v = 27.7$$