Modelling and control summaries

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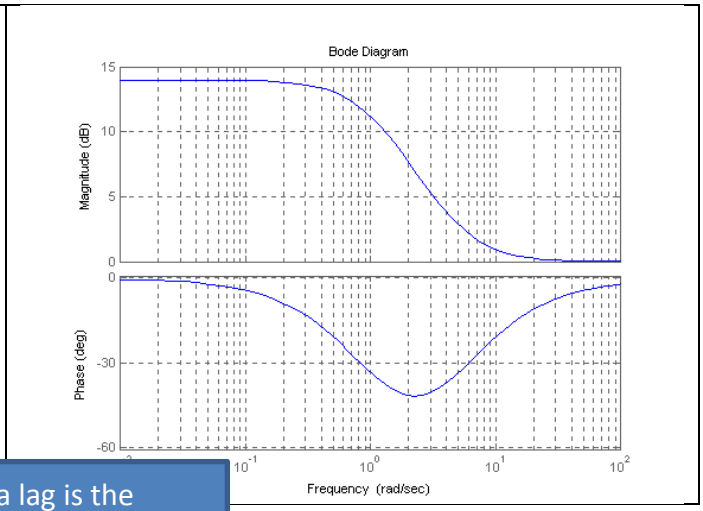
Margins 9: Simple lag compensation

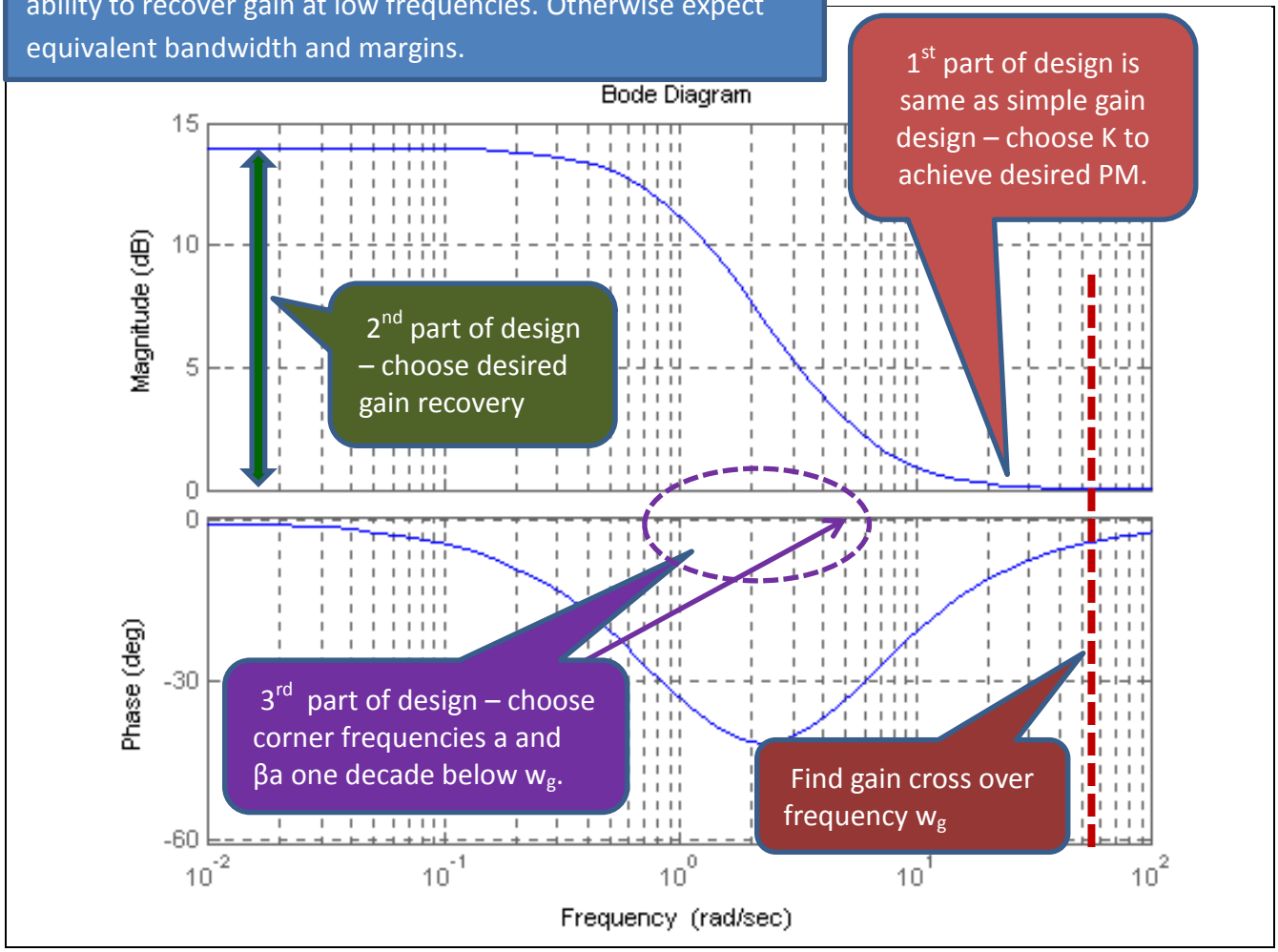
LAG COMPENSATOR SUMMARY:

$$K\frac{s+\beta a}{s+a};\quad 1\le\beta\le 10$$

1. Steady state gain larger than high frequency gain (by factor of β).
2. Shifts low frequency up by Kβ and high freq. by K.
3. Phase is zero at high and low freq.
4. Phase is negative around corner freq.



The difference between a simple K design and a lag is the ability to recover gain at low frequencies. Otherwise expect equivalent bandwidth and margins.



For $G=K/(s+1)^4$, use a phase lag which gives a PM=60 and recovers a factor of 5 gain at low frequency.

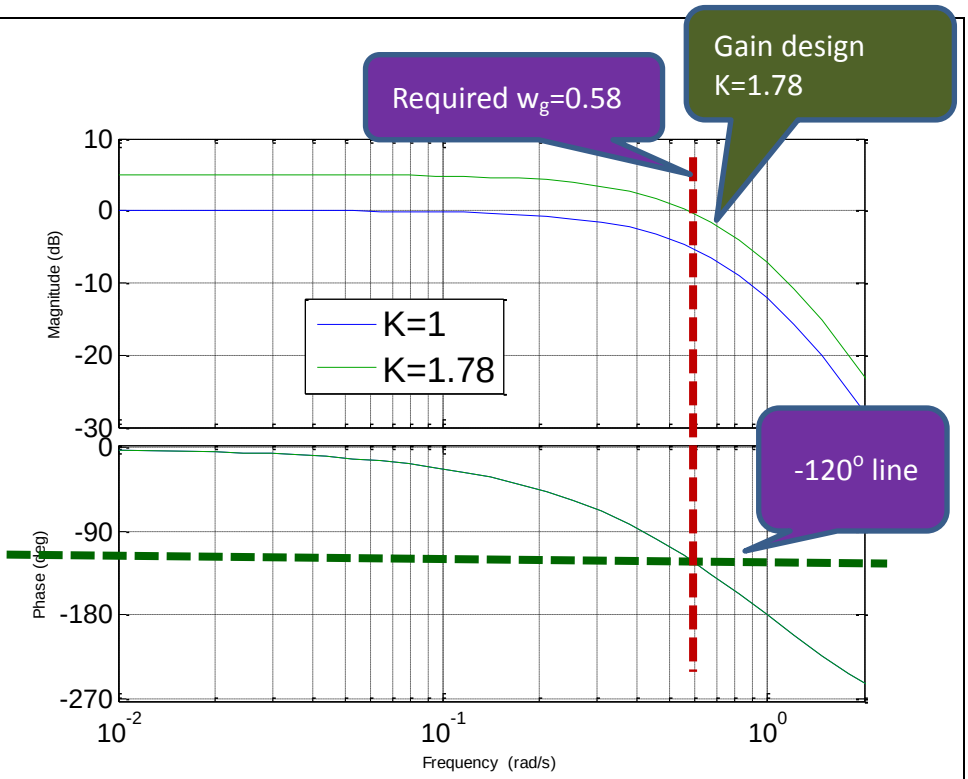
STEP 1: Do a simple gain design to get a 60^o PM.

STEP 2: Determine w_g.

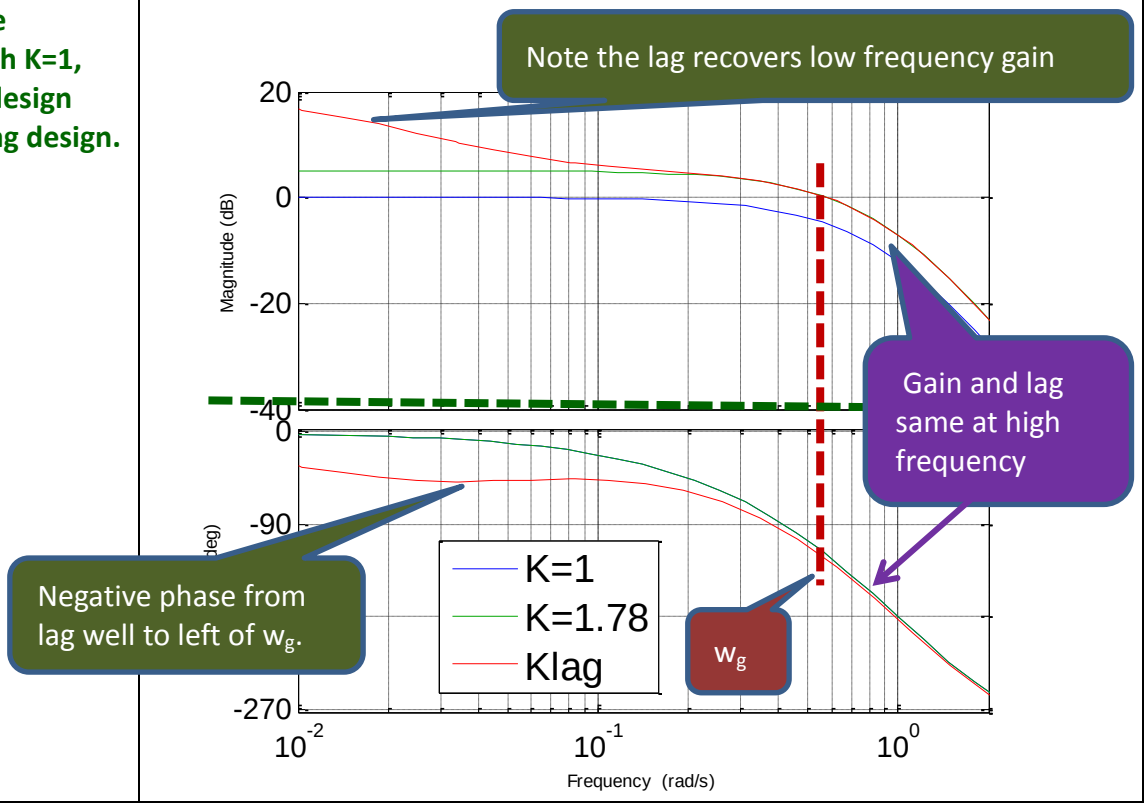
STEP 3: Define lag using specified K, w_g and gain recovery β=5.

$$K_{lag}(s) = K\frac{s + w_g/10}{s + w_g/10\beta}$$

$$K_{lag} = 1.78\frac{s+0.058}{s+0.0116}$$



Overlay Bode diagrams with K=1, simple gain design and simple lag design.



1. **A lag is only useful if there exists a suitable simple gain design to begin with!**
2. **The lag introduces negative phase which gives a small loss in PM compared to the simple gain design, but increases low frequency gain by β.**
3. **Implicit that the corner frequencies must be at least a decade below gain cross over frequency to avoid the negative phase having a significant impact on margins.**
4. **Low gain design as improves margins by gain reduction at high frequency.**