Modelling and control summaries

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Margins 10: Lag compensation tutorial

1. For the questions given here, use the mechanistic lag compensation rules to find a lag compensator.
2. Use MATLAB to compare the responses with a simple gain design and comment on what you find.
3. Also practice using sisotool to do the simple gain design and then to enter your Lag compensator.

For simplicity, use a target phase margin of 60^o for the gain design, but you might like to investigate how behaviour varies if you use other values such as 50 or 70.

Find a lag compensator with a low frequency gain recovery of 4.

What do you notice as the gain recovery is increased to 10?

What differences do you see between systems with and without integrators?

$$G(s) = \frac{40}{s(s+2)};$$

$$G = \frac{10(s+2)}{s(s+1)(s+4)^2}$$

$$G(s) = \frac{8}{s(s^2+3s+2)}$$

$$G(s) = \frac{0.001}{(s+0.2)(s+0.1)(s^2+0.4s+0.2)}$$

When introducing a lag compensator, then compared to the simple gain design, the phase margin changes? Why is this and would could you do?

MECHANISTIC RULES FOR LAG DESIGN

1. Specify the desired PM as ϕ (this is designer choice but typically ϕ =50-70).
2. Find the frequency w where argument of G(jw) is ϕ -180.
3. Choose the gain K so that K|G(jw)|=1, thus w becomes the gain cross over frequency.
4. Choose the required gain recovery at low frequency, say β, then

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

WARNING: More advanced and systematic lag design procedures do exist. These rules are simple guidelines to give an approximate result.

POSSIBLE ANSWERS:

$$G(s)=\frac{40}{s(s+2)};\quad K=0.0665,\ w_g=1.15;\quad K=0.0665\frac{s+0.115}{s+0.0287}$$

$$G=\frac{10(s+2)}{s(s+1)(s+4)^2};\ K=0.515,\ w_g=0.57;\quad K=0.515\frac{s+0.057}{s+0.0142}$$

$$G(s)=\frac{8}{s(s^2+3s+2)};\quad K=0.097;\quad w_g=0.359;\quad K=0.097\frac{s+0.0359}{s+0.00898}$$

$$G(s)=\frac{0.001}{(s+0.2)(s+0.1)(s^2+0.4s+0.2)};\quad K=9.35;\quad w_g=0.167;\quad K=9.35\frac{s+0.0167}{s+0.00417}$$