Modelling and control summaries

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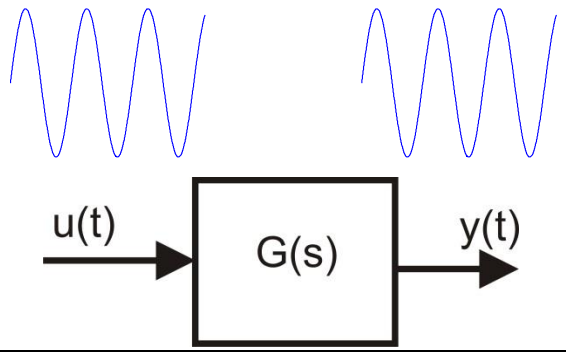
Bode 5: Interim tutorial sheet



SUMMARY of Frequency response

$$u = D\sin(wt) \quad \Rightarrow \quad y = DA\sin(wt + \phi)$$

1. Gain A(w) is the ratio of output amplitude of oscillation to that of the input.
2. Phase φ(w) is the phase difference between the input and output responses.

Gain and phase of single LHP factors of the form (s+a) or 1/(s+b)	$\angle(jw+a) = \tan^{-1}\frac{w}{a}; \quad \lvert jw+a\rvert = \sqrt{w^2+a^2}$ $\angle\frac{1}{jw+b} = -\tan^{-1}\frac{w}{b}; \quad \left\lvert\frac{1}{jw+b}\right\rvert = \frac{1}{\sqrt{w^2+b^2}}$
Phase of single RHP factors of the form (s-a) or 1/(s-b)	$\angle(a-jw) = -\tan^{-1}\frac{w}{a} \quad \angle(-a+jw) = 180 - \tan^{-1}\frac{w}{a}$ $\angle\frac{1}{a-jw} = \tan^{-1}\frac{w}{a} \quad \angle\frac{1}{-a+jw} = -180 + \tan^{-1}\frac{w}{a}$

Find the gain and phase expressions for the following transfer functions

$$\frac{0.2}{1+0.4s}; \quad \frac{0.4(s+1)}{(s+4)(s+2)}; \quad \frac{-3(s+6)}{(s+10)(s+1)(s+3)(s+4)};$$

$$\frac{5}{s(s+1)}; \quad \frac{8(1-s)}{(s+4)(s+2)}; \quad \frac{2(s+2)}{s(s+10)(s+1)(s-4)}$$

$$\frac{s+2}{s^2(s+1)}; \quad \frac{s+5}{s(s+2)^2}$$