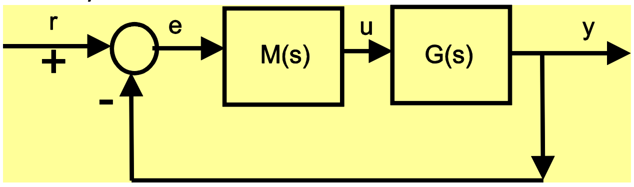
Modelling and control summaries

by Anthony Rossiter

Nyquist 15: Tutorial sheet

PREPARATION: Before you start, summarise the key observations and rules for Nyquist diagrams and stability criteria.  For the loop above, the full definition of a Nyquist diagram is the mapping of G(s)M(s) while s describes the D-contour. **Note**, using the loop transfer function GM and not GM/(1+GM)!	**Apply $n_q=n_c-n_o$ directly or $n_c=n_q+n_o$** n_o = number of open-loop RHP poles n_c = number of closed-loop RHP poles n_Q = number of clockwise encirclements of -1 With an integrator, as w →0, |G(jw)|→infinity! 1. D-contour has 2 right hand right angle turns so Nyquist has 2 right hand right angle turns. 2. s (that is D-contour) moves through 180 deg anti-clockwise so Nyquist (that is 1/s) must move through 180 deg clockwise (with infinite gain).
Always check against root-loci or other technique to ensure consistency.	**Closed-loop stable iff n_c=0!**

Apply the Nyquist stability criteria to assess the closed-loop stability and stability dependence on compensator gain (assume M(s)=K) for the following examples. Use MATLAB to test your answers. Compare your insights with those gained from root-loci and verify your results with the closed-loop step response plots.

$$G=\frac{10(s+0.1)}{(s-1)(s+2)}$$

$$G=\frac{400(s+4)(s+20)}{s^2(s+1)(s+100)}$$

$$G=\frac{14s+60}{s(s+1)(s+2)(s+5)}$$

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

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

$$G(s)=\frac{5}{(s-1)(s+2)(s+3)}$$

$$G(s)=\frac{100(s+2)}{(s+10)(s+6)(s+3)}$$

$$G=\frac{0.5}{(s-1)};\quad M=1\quad or\quad M=4\frac{(s+1)}{s}$$

$$G=\frac{1}{s(s+1)};\quad M=1\quad or\quad \frac{(s+1)}{(s+10)}\quad or\quad \frac{(s+10)}{(s+1)}$$