Modelling and control summaries
by Anthony Rossiter
Nyquist 7: Self-study tutorial sheet

This is primarily for students to practise. Attempt questions by hand and only after completion, use MATLAB to test your solutions.

**QUESTION 1. Sketch Nyquist of the following**

\[
G = \frac{4}{s(s+5)}; \quad H = \frac{10(s+2)}{(s+5)^2}; \quad N = \frac{0.0005(s+0.02)}{(0.008-s)(0.06+s)}
\]

\[
M = \frac{2(s+10)}{s(s+1)(s+4)}; \quad P = \frac{3}{(s-1)(s+6)} \quad L = \frac{s+2}{s^2(s+4)}
\]

\[
G = \text{tf}(4,[1 5 0]); \quad H = \text{tf}([10 20],[1 10 25]) \quad P = \text{tf}(3,\text{poly}([1 -6]))
\]

\[
M = \text{tf}([20],[\text{poly}([0 -1 -4])]) \quad N = \text{tf}(0.0005*[1 0.02],\text{poly}([0.008,-0.06])*(-1)) \quad L = \text{tf}([1 2],[1 4 0 0])
\]

**QUESTION 2. Match systems to the Nyquist plots**

\[
G_1 = \frac{s+1}{s(s+4)(s+3)}
\]

\[
G_2 = \frac{s+1}{s^2(s+4)}
\]

\[
G_3 = \frac{s+2}{s(s-1)}
\]
Sketch the Bode/Nyquist diagrams with and without compensation

\[
G(s) = \frac{0.3(s+10)}{s(s+1)(s+2)}; \quad K_1(s) = \frac{2s+0.5}{s+2};
\]

\[
G(s) = \frac{6(s+1)}{s(s-1)(s+3)}; \quad K_1 = \frac{4(s+2)}{s+5}; \quad K_2 = \frac{4(s+0.1)}{(s+0.04)}
\]

\[
G(s) = \frac{0.001(s+4)}{s(s+0.1)^2(s+2)}; \quad K_1 = \frac{2s+0.06}{s+0.18}; \quad K_2 = \frac{1.18}{s+0.006}
\]

\[
G(s) = \frac{10(s+1)}{s(s+4)(s-2)}; \quad K = 4; \quad K_1(s) = \frac{8s+3}{s+12}; \quad K_2 = \frac{s+12}{s+3}
\]

\[
G(s) = \frac{4-4s}{s(s+2)(s+3)}; \quad K_1(s) = 1; \quad K_2(s) = 0.5; \quad K_3(s) = 0.25 \frac{(s+0.1)}{(s+0.05)}
\]

You can overlay Bode/Nyquist plots on MATLAB as follows

\[
>> \text{nyquist}(G,G*K1,G*K2); \text{legend('G','GK1','GK2')}
\]

By computing the initial quadrant carefully, sketch Nyquist diagrams of the following.

\[
G_1(s) = \frac{4.5s+3}{s^2(s+1)(s+2)}; \quad G_2(s) = \frac{6s+3}{s^2(s+1)(s+2)}; \quad G_3(s) = \frac{2s+3}{s^2(s+1)(s+2)}
\]

\[
G(s) = \frac{s+10}{(s+1)(s+2)}
\]

Give an explanation of how dead-time affects Bode and Nyquist diagrams. Illustrate with several examples.