Nyquist 4: Sketching with integrators

Asymptotic methods give a rough Bode plot using simple trends: i) as \( w \) tends to zero; ii) as \( w \) tends to infinity; iii) how do gain and phase change in between.

Some key points should be noted when an integrator is present.

- As \( w \to 0 \), gain tends to infinity (typically phase tends to \(-90^\circ\))
- As \( w \to \infty \), gain tends to zero.

A simple Nyquist sketch is acquired by transcribing this information into an Argand diagram.

**NOTE:** Accuracy is important near to \(-1\) (0dB and -180 degrees).

### SKETCHING NYQUIST OF DIFFERENT \( G(s) \) USING TRENDS

Note how initial/final values and trends can be used to form a reasonable sketch.

\[
\frac{3}{s(s+2)}
\]

**2nd example**

\[
\frac{3}{s(s+1)(s+2)}
\]

- **1st example**
  - \( w \to 0 \), Gain to 0, Phase to -180
  - \( w \to \infty \), Gain to \( \infty \), Phase to -90
  - Gain moves smoothly from \( \infty \) to zero, phase from -90 to -180

- **2nd example**
  - \( w \to 0 \), Gain to 0, Phase to -270
  - \( w \to \infty \), Gain to \( \infty \), Phase to -90
  - Gain moves smoothly from \( \infty \) to zero, phase from -90 to -270
REMARKS:
1. Trends can be very useful for seeing the impact of different pole/zero positions on the resulting shapes of the Nyquist diagram.
2. This insight is invaluable later!
3. Always a good idea to use MATLAB to check your answers

NOTE HOW CHANGING ZERO CHANGES TREND HUGELY

\[
G_1 = \frac{9s + 3}{s(s + 1)(s + 2)}; \quad G_2 = \frac{2s + 3}{s(s + 1)(s + 2)}; \quad G_3 = \frac{0.3s + 3}{s(s + 1)(s + 2)}
\]

Published with Creative Commons License by J.A. Rossiter, University of Sheffield