11/21/07 move Nyquist
Preparation: manual construction
" add
Nyquist criterion

[Diagram of an open-loop system]
\[ R = A \cdot \sin(\omega t) \]
Varying $K$ moves $|F|$ up-down. See Fig 6.36

$\phi_{\text{margin}} = 180^\circ - \theta_{\text{crossover}}$
Let $\phi_{margin} = 45^\circ$

$\omega_c$

Plant $\times$ Lead

Gain = 1

-135° Plant $\times$ Lead

$\omega_c r = 4.5$
\[ X_{dB} = 20 \log x \quad 10 \Rightarrow 20 \quad 0.1 \Rightarrow -20 \]
Bode: Manual control of Lead:
\[
\frac{s/5 + 1}{s/50 + 1}
\]
Here is the actual Bode plot of \( \frac{1}{5s+1} \cdot \frac{1}{5s0+1} \).
$G = \frac{1}{s}$

Bode plot of Integrator

-20 dB/dec

-90°
Chapter 6.7.4

Lag comp. design

Lag is slow

Lag covers 

Place

lag zero

$0.1 \times \omega_c f$

$\frac{s/0.2 + 1}{s/0.02 + 1} = G_{lag}$
Bode Example of plant addition, gain adjusted, Plant x Lag

1. Plant
2. Plant x Lag
3. Final
4. Final phase margin is \( \approx 51 \text{ degrees} \)

- Phase (Plant x Lag)
- Phase (Lag)
- Phase (Plant)
- Gain raised 50 dB
- Gain after refining k
- Frequency (rad/sec)
- Magnitude (dB)