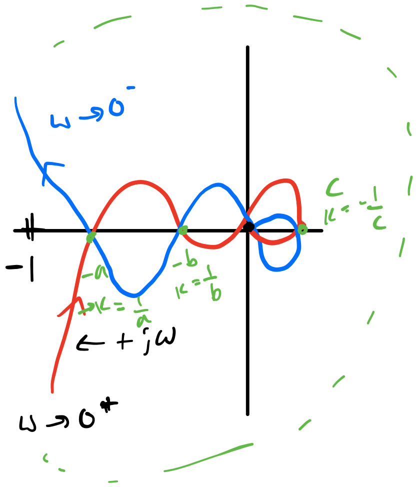
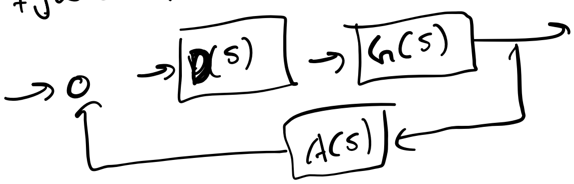


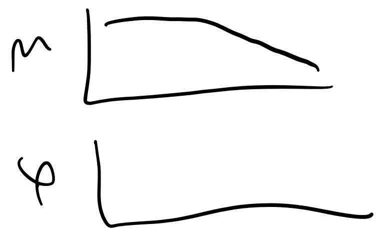
+jω ← F.R. OL system



→ # poles @ origin

→ # unstable OL poles (P)

$Z = N + P$



stability margins $G(s) = Me^{j\varphi}$

- increasing gain moves everything away from origin
  - → can cause encirclements
  - → leads to instability

Gain stability condition: $|KG(j\omega)| < 1$ when $\angle G(j\omega) = -180°$

stable system: $GM > 1$, $GM > 0\,dB$

phase stability condition $\angle G(j\omega) > (-180°)$ when $|KG(j\omega)| = 1$

$$\frac{1}{GM} = |KG(j\omega)|_{\varphi = -180°}$$

$$PM = \angle G(j\omega)_{M=1} + 180°$$

exceptions

$$\frac{\sim (s-5)}{\sim} \quad \text{zeros in RHP}$$

$$\frac{\sim}{\sim (s-4)} \quad \text{unstable OL poles}$$

→ Need to check nyquist in RHS plane

System bandwidth (describes speed of response)

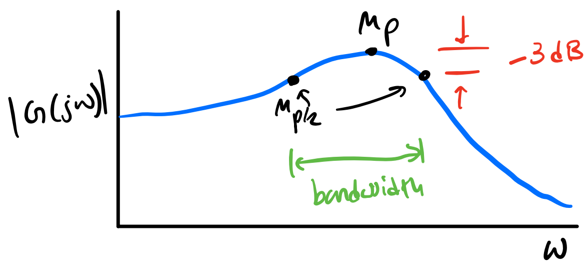
- Range of forcing frequencies where system is most responsive
- output power > half of peak output power

output power: $P = aM^2$ → $\frac{1}{2}P_{peak} = aM_{p/2}^2$

e.g. $P = IV = I^2R = \frac{V^2}{R}$

peak power: $P_{peak} = aM_p^2$

$$\frac{M_{p/2}}{M_p} = \frac{\sqrt{2}}{2} \cong -3\,dB$$



Alternative definition: