ME2025 Digital Control

Gain and Phase Margins

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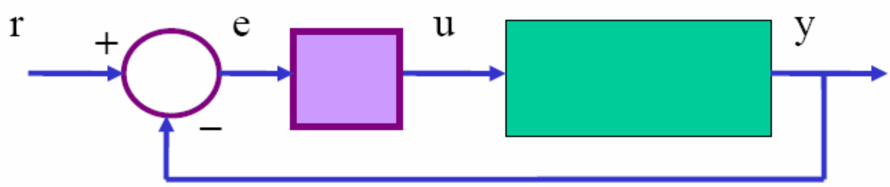
Gain and Phase Margins



This system is stable—but how close to being unstable is it?

- This is the "stability robustness" question
- The system's **Gain Margin** and **Phase Margin** are quantitative measures of the system's stability robustness

Loop Transfer function:

$$L(s) = \frac{s+5}{(s+2)s(s+1)}$$

Stability Margin

- Closed-loop transfer function is not usually known
- Would like to determine Closed-loop stability by evaluating the frequency response of open-loop transfer function *KG(jw)*
- This can be done without a math model of the system by experimentally determining the open-loop frequency response.

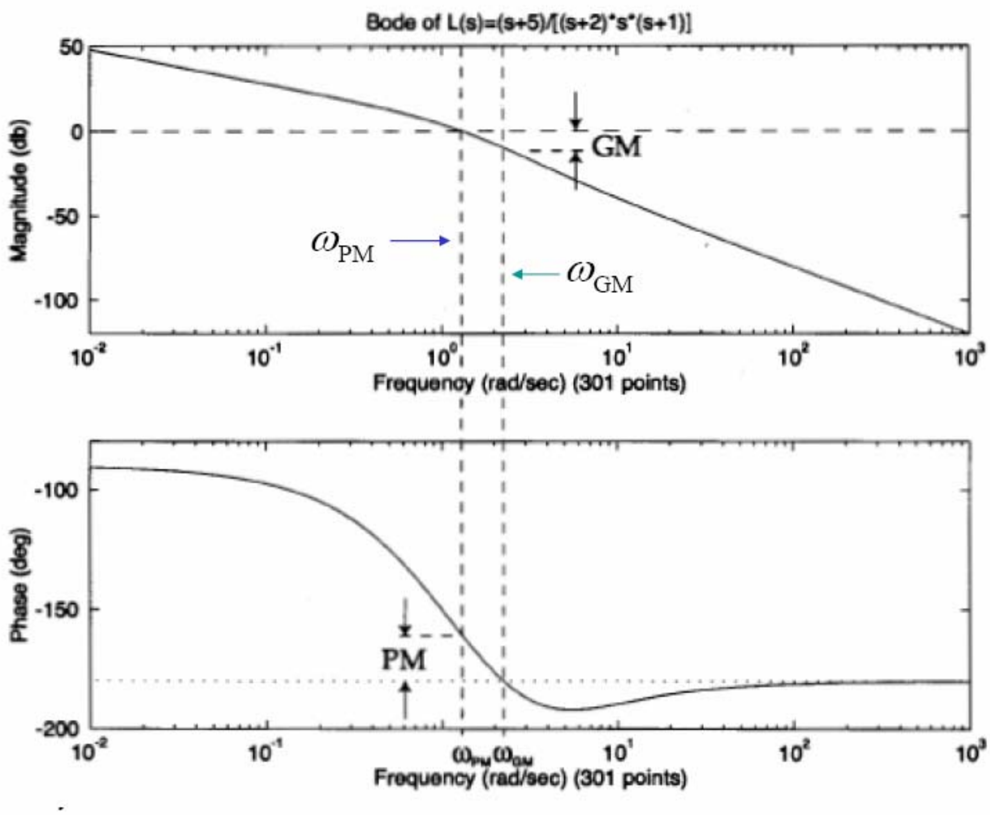
When pole is at imaginary axis

$$|KG(jw)| = 1 \quad \text{and} \quad \angle(KG(jw)) = -180^\circ$$

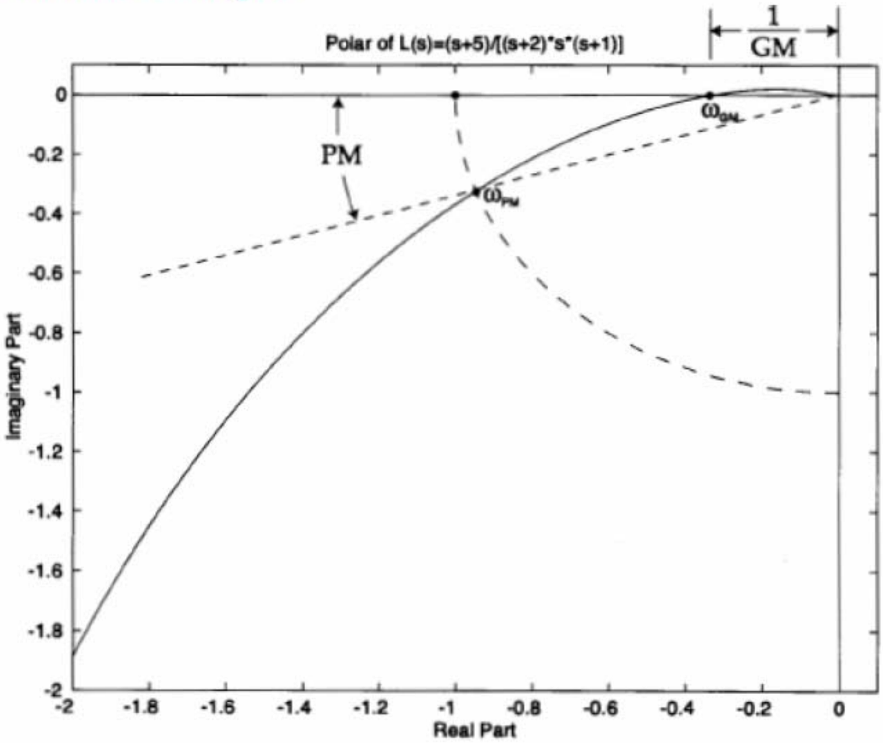
System become less stable as the gain increases

$$|KG(jw)| < 1 \quad \text{and} \quad \angle(KG(jw)) = -180^\circ$$

Bode Plot for this example



Polar Plot for this example



Now in discrete time….

- Replace s with z
- Plot the bode plot (or polar plot) of the system only up to the Nyquist frequency pi/T