# ECE 461/661 - Test #3: Name ____________________

Digital Control & Frequemncy Domain techniques - Fall 2021

## s to z conversion

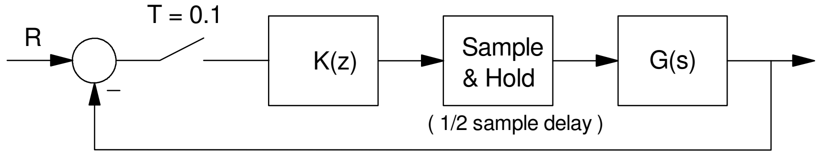
1) Determine the discrete-time equivalent for G(s). Assume a sampling rate of T = 0.1 second

$$G(s) = \left( \frac{100}{(s+3)(s+8)(s+12)} \right)$$

## Digital Compensators: K(z)

2) Assume a unity feedback system with a sampling rate of T = 0.1 second

$$G(s) = \left(\frac{100}{(s+3)(s+8)(s+12)}\right)$$

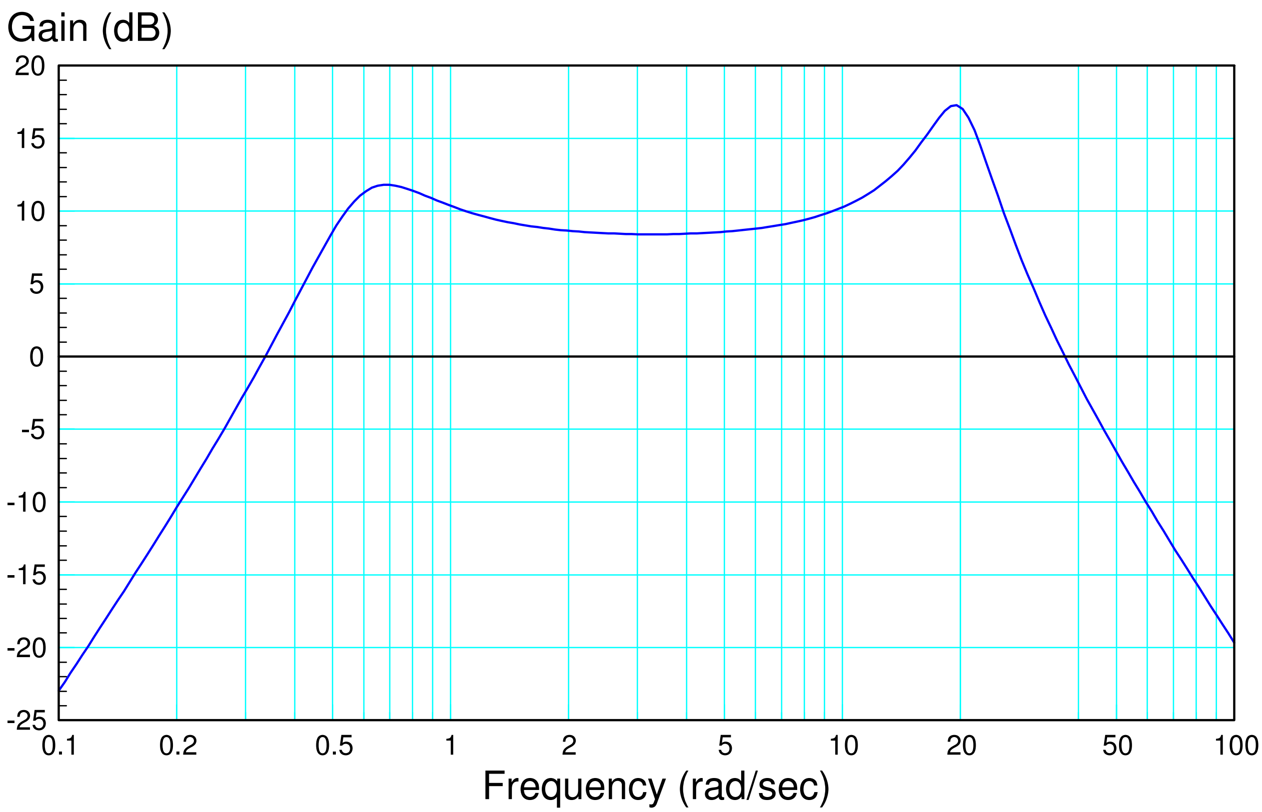



Design a digital compensator, K(z), which results in

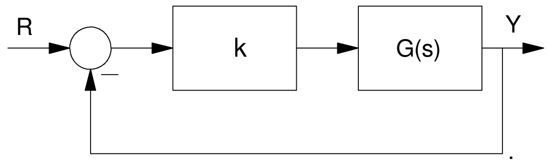
- No error for a step input
- 5% overshoot ($\zeta = 0.6901$), and
- A 2% settling time of 1.5 seconds

### 3) Bode Plots

Determine the system, G(s), which has the following gain vs. frequency



### 4) Nichols Charts

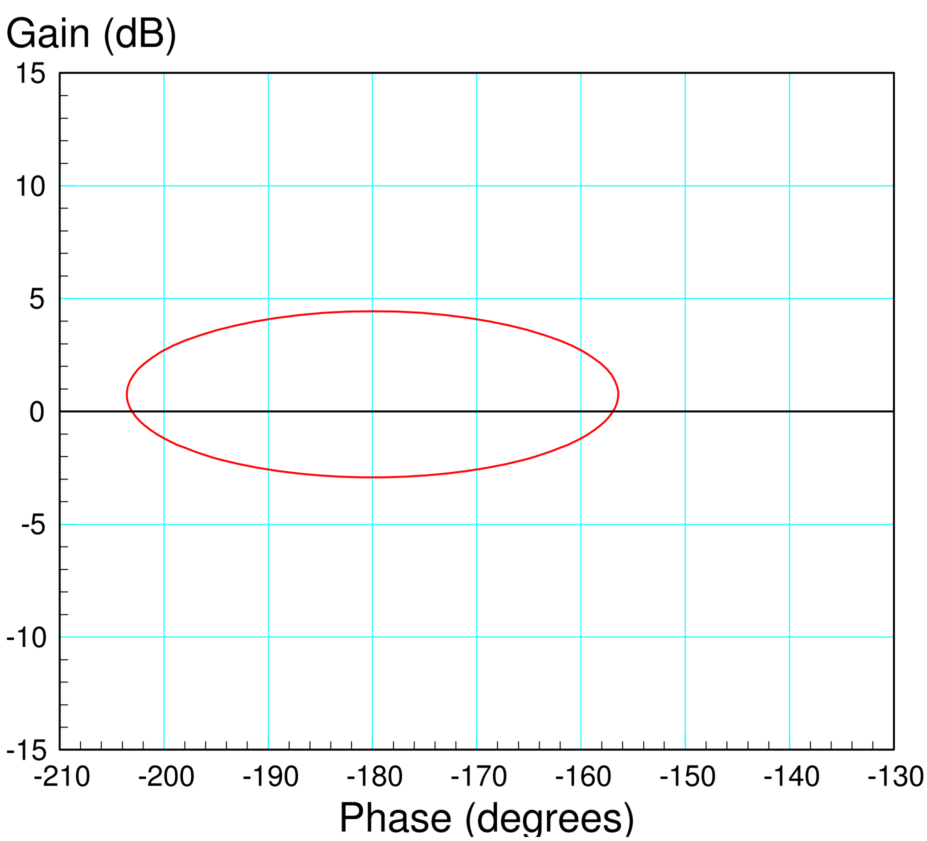



Assume a unity feedback system where the gain of G(s) is as follows:

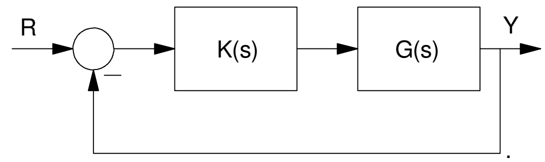
Determine

- The maximum gain, k, for stability
- k that results in a resonance of Mm = 2.5

| frequency (rad/sec) | 7 | 8 | 9 | 10 | 12 | 15 |
|---|---|---|---|---|---|---|
| Gain | 10dB | 2dB | -3dB | -8dB | -15dB | -22dB |
| Phase (degrees) | -130 deg | -145 deg | -160 deg | -175 deg | -190 deg | -205 deg |



## 5) Analog Compensator (Bode Plots)




Assume a unity feedback system with

$$G(s) = \left( \frac{10}{(s+3)(s+8)(s+12)} \right)$$

Determine a compensator, K(s), which results in

- No error for a step input
- A phase margin of 60 degrees
- A 0dB gain frequency of 3 rad/sec

## Compensator Design in the Frequency Domain

4) Assume a unity feedback system with

$$G(s) = \left(\frac{10}{s(s+2)(s+10)}\right)$$

Determine a compensator, K(s), which results in

- No error for a step input (closed-loop gain at DC = 1.000)
- A 60 degree phase margin, and
- A 0dB gain frequency of 2 rad/sec