

Test #3: ECE 461 / 661: Name _____

Closed Book. Closed Notes. Calculators Permitted.

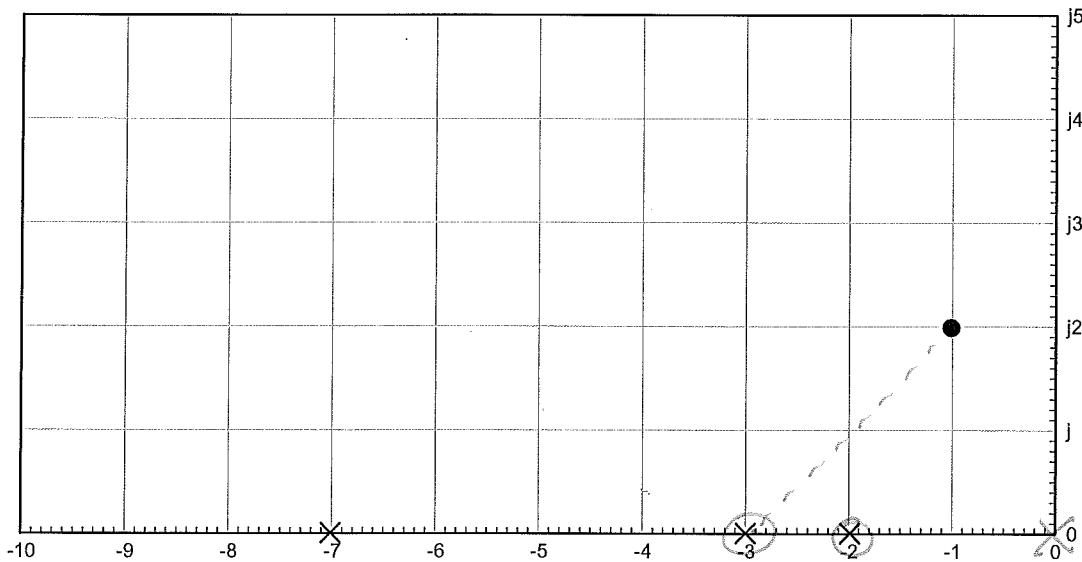
1) Given the following system

$$G(s) = \left(\frac{100}{(s+2)(s+3)(s+7)} \right)$$

Design a compensator, $K(s)$, which results in the closed-loop system having

- No error for a step input, (i.e. the open-loop system is type-1), and
- The closed-loop dominant poles are at $s = -1 + j2$

$$K(s) = 0.4 \frac{(s+2)(s+3)}{s(s+3)}$$



$$\frac{(s+2)(s+3)}{s(s+a)}$$

$$\frac{100}{s(s+7)} \Big|_{s=-1+j2} = 207 \angle -135^\circ$$

$$\angle s+a = 45^\circ$$

$$a = -3$$

2) Given the following system

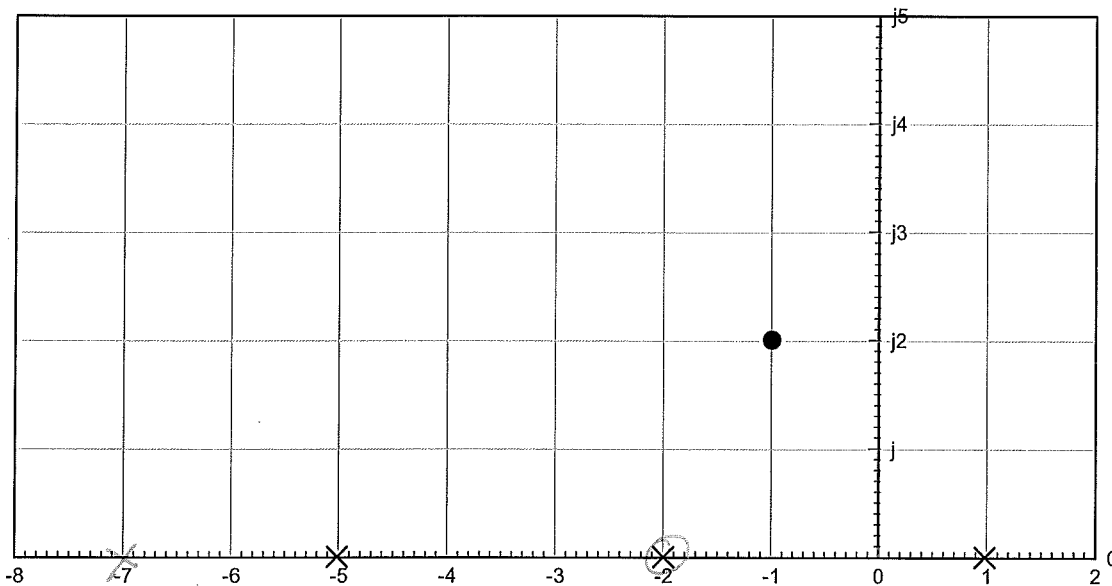
$$G(s) = \left(\frac{100}{(s-1)(s+2)(s+5)} \right)$$

Design a compensator, $K(s)$, which results in the closed-loop system being

- Stable,
- With a closed-loop dominant pole at $s = -1 + j2$

Non-zero steady-state error is OK (it doesn't have to be a type-1 system)

$K(s) =$ $\cdot 8 \left(\frac{s+2}{s+7} \right)$



$$\frac{s+2}{s+7}$$

$$\frac{100}{(s+1)(s+2)} \Big|_{s=-1+j2} = 7.9 \angle -161^\circ$$

$$\angle s+9 = 18.43^\circ$$

$$a = \frac{2}{\tan(18.43^\circ)} + 1 = 7$$

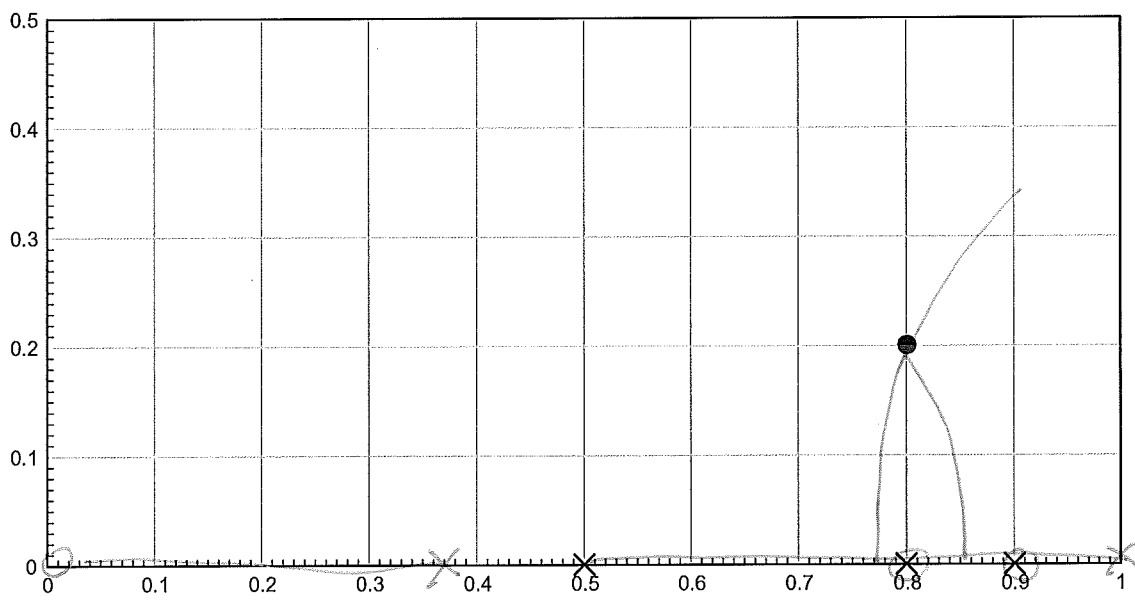
3) Given the following system with a sampling rate of $T = 0.1$ second

$$G(z) = \left(\frac{0.01z}{(z-0.9)(z-0.8)(z-0.5)} \right)$$

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

- No error for a step input, (i.e. the open-loop system is type-1), and
- The closed-loop dominant poles are at $z = 0.8 + j0.2$

$K(z) = 5.777 \frac{(z-0.9)(z-0.8)}{(z-1)(z-0.3778)}$



$$\frac{(z-0.9)(z-0.8)}{(z-1)(z-a)}$$

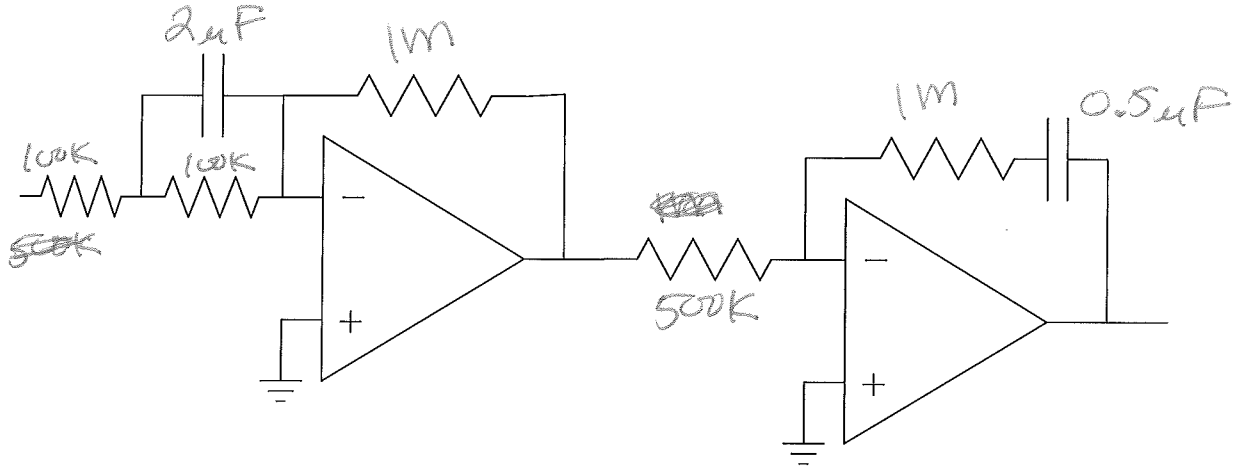
$$\left. \frac{0.01z}{(z-1)(z-0.5)} \right|_{z=0.8+j0.2} = 0.0809 \angle -154^\circ$$

$$\angle z-a = 25.34^\circ$$

$$a = -\frac{0.2}{\tan(25.34^\circ)} + 0.8 = 0.3778$$

4) Design a circuit to implement $K(s)$

$$K(s) = 20 \left(\frac{(s+2)(s+5)}{s(s+10)} \right)$$



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

$$10 \left(\frac{s+5}{s+10} \right)$$

$$10 \left(\frac{s+5}{s+10} \right)$$

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

Bonus - Bernie Trivia!!! Which of the following is a type of turkey and which is a U.S. Senator?

Avotte

Capito

Dindon de Sologne

Flake

Narragansett

Slate

turkeys