Fourth Year Mechatronics Department
CSE-473 Control Systems (2)
Sheet #06: Digital Control System Design
Spring 2014

Ain Shams University
Faculty of Engineering

1- Sketch the z-domain root locus, and find the critical gain for the following systems:-
   a. $G(z)=\frac{K}{(z-0.4)}$
   b. $G(z)=\frac{K}{(z+0.9)(z-0.9)}$
   c. $G(z)=\frac{Kz}{(z-0.2)(z-1)}$
   d. $G(z)=\frac{K(z+0.9)}{(z-0.2)(z-0.8)}$

2- Determine the stable range of the parameter a for the closed-loop unity feedback systems with loop gain:-
   a. $G(z)=\frac{1.1(z-1)}{(z-a)(z-0.8)}$
   b. $G(z)=\frac{1.2(z+0.1)}{(z-a)(z-0.9)}$

3- Design a proportional controller for a system described by $G(z)=\frac{1}{(z-1)(z-0.5)}$ with a sampling period T = 0.1 s to obtain (a) A damped natural frequency of 5 rad/s, (b) A time constant of 0.5 s, and (c) A damping ratio of 0.7.

4- Consider a vehicle position control system with the transfer function$G_p(s)=\frac{1}{(s)(s+5)}$. Design a proportional controller for the unity feedback digital control system with analog process and a sampling period T = 0.04 s to obtain (a) A steady-state error of 10% due to a ramp input and (b) A damping ratio of 0.7.

5- Consider a process control system with the transfer function$G_p(s)=\frac{1}{(s)(s+1)}$. Design a suitable controller. The design specifications are that the damping ratio of the dominant closed-loop poles be 0.5 and that there will be at least 8 samples per cycle of damped sinusoidal oscillation. Assume that the sampling period is 0.1 Sec. Determine the static velocity error constant. Also, determine the system response to a unit step input.

6- Consider a process control system with the transfer function$G_p(s)=\frac{10}{(s+5)(s+1)}$. Design a suitable controller. The design specifications are that the damping ratio of the dominant closed-loop poles be 0.5 and that there will be at least 8 samples per cycle of damped sinusoidal oscillation. Assume that the sampling period is 0.2 Sec. Determine the static velocity error constant. Also, determine the system response to a unit step input.

7- Consider a process control system with the transfer function$G_p(s)=\frac{e^{-5s}}{(s+0.4)}$. Design a PI controller. The design specifications are that the damping ratio of the dominant closed-loop poles be 0.5 and that there will be at least 10 samples per cycle of damped sinusoidal oscillation. Assume that the sampling period is 1 Sec. Determine the system response to a unit step input.

8- Consider a process control system with the transfer function$G_p(s)=\frac{1}{s^2}$. Design a PD controller. The design specifications are that the damping ratio of the dominant closed-loop poles be 0.5 and that the un-damped natural frequency be 4 rad/sec. Assume that the sampling period is 0.1 Sec. After the controller is designed, determine the number of samples per cycle of damped sinusoidal oscillation.

9- Consider a process control system with the transfer function $G_p(s) = \frac{1}{(s)(s+1)(s+10)}$. Design a suitable controller for the unity feedback digital control system with analog process and a sampling period T = 0.02 Sec. to obtain (a) A settling time of 1Sec. and (b) A damping ratio of 0.7.

10- Consider a process control system with the transfer function $G_p(s) = \frac{5}{(s+2)(s+1)}$. Design a digital controller such that the system output will exhibit a response to a unit step with the settling time the minimum as possible and zero steady state error. It is required that the system will have a static velocity error constant of 10 Sec^{-1}. Also, there will be no ripples in the output after the settling time is reached.

11- Consider a process control system with the transfer function $G_p(s) = \frac{1}{(s)(s+1)(s+10)}$. Design a digital controller such that the system output will exhibit a response to a unit step with the settling time the minimum as possible and zero steady state error. Also, it is required that a steady-state error of 5% or less is obtained due to a unit ramp input. Also, there will be no ripples in the output after the settling time is reached.