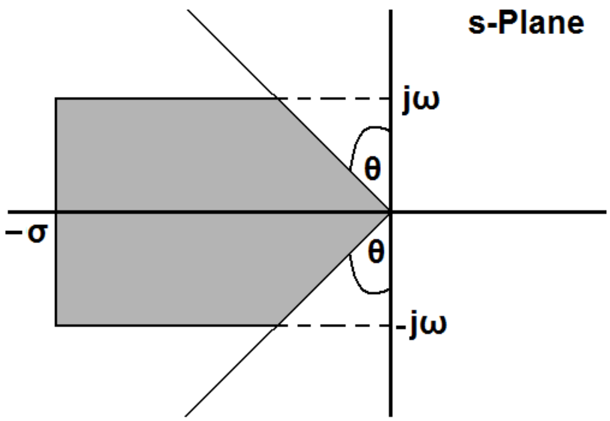
Fourth Year Mechatronics Department
CSE-473 Control Systems (2)
Sheet #05: System Time Response Characteristics
Spring 2014

Ain Shams University
Faculty of Engineering

1- Write a computer program (MATLAB/C++) to map the shaded region in the figure below from s-plane to z-plane. Consider the parameters $\boldsymbol{\theta}, \boldsymbol{\sigma}, \boldsymbol{and}\ \boldsymbol{\omega}$ as inputs to your program.



2- Determine the stability of the roots of the following characteristic equations:-
   a- $z^4 - z^3 + 2.1z^2 + 1.44z - 0.32 = 0.$
   b- $z^5 + 0.2z^4 + z^2 + 0.3z - 0.1 = 0.$
   c- $z^5 - 0.25z^4 + 0.1z^3 + 0.4z^2 + 0.3z - 0.1 = 0.$

3- Use the Jury-Stability criterion to find the stable range of K for the closed loop unity feedback systems with loop gain:-
   a. $G(z) = \frac{K(z-1)}{(z-0.1)(z-0.8)}$
   b. $G(z) = \frac{K(z+0.1)}{(z-0.7)(z-0.9)}$

4- 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. $G(z) = \frac{1.2(z+0.1)}{(z-a)(z-0.9)}$

5- Write a computer program that determines the stability of the roots of a given characteristic equation.

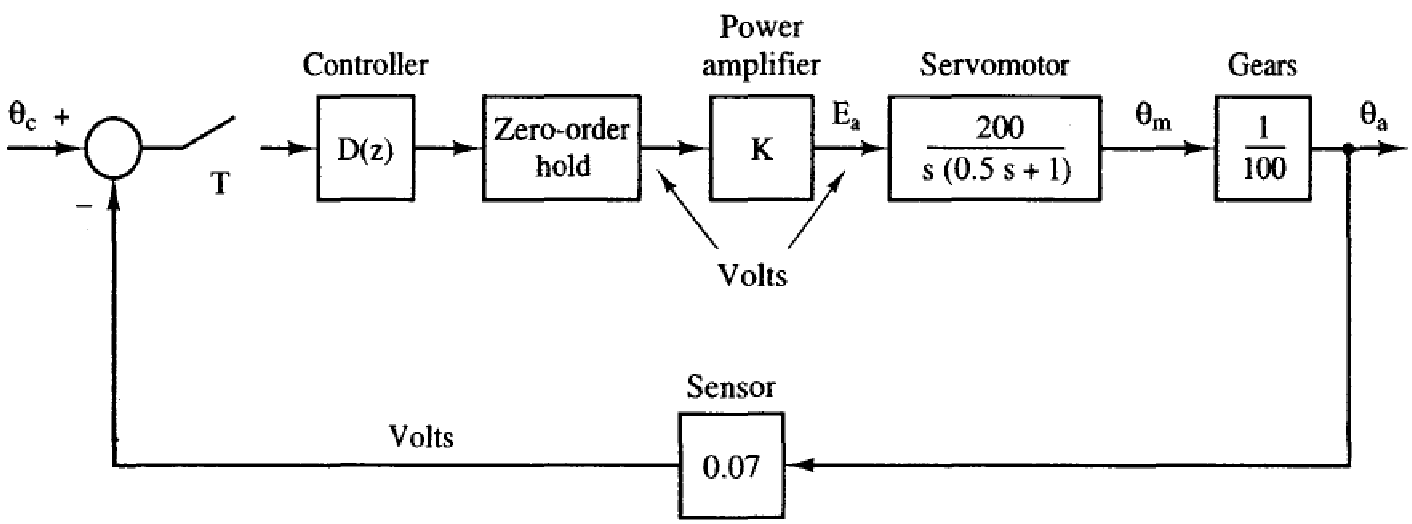
6- Consider the following characteristic equation where a, b, and c are real numbers:-

$$z^3 + az^2 + bz \quad + c = 0.$$

   a. The above equation can be decomposed into $(z-r_1)(z-r_2)(z-r_3)= (z-r_1)(z^2+dz+f)=0$. At least, the equation has one real root (assume r_1). Write a computer program to compute the root r_1 given a, b, and c. (Hint: Try Newton-Raphson Method or any other root finding method)

b. Given the root r_1, a direct division cane used to compute the coefficients d and f. Write a computer program to compute d and f given r_1.
c. Use the programs developed in parts (a) and (b) to determine the stability of the characteristic equation given a, b, and c.

7- Consider the robot arm control system shown below. The power amplifier gain is given by K=10, sampling period is T=0.1 Sec., and D(z)=1.



a- Find the damping ration, natural frequency, and time constant of the open loop system.
b- Find the damping ration, natural frequency, and time constant of the closed loop system.

8- Find the steady state error for a unit step disturbance input for the system shown below.