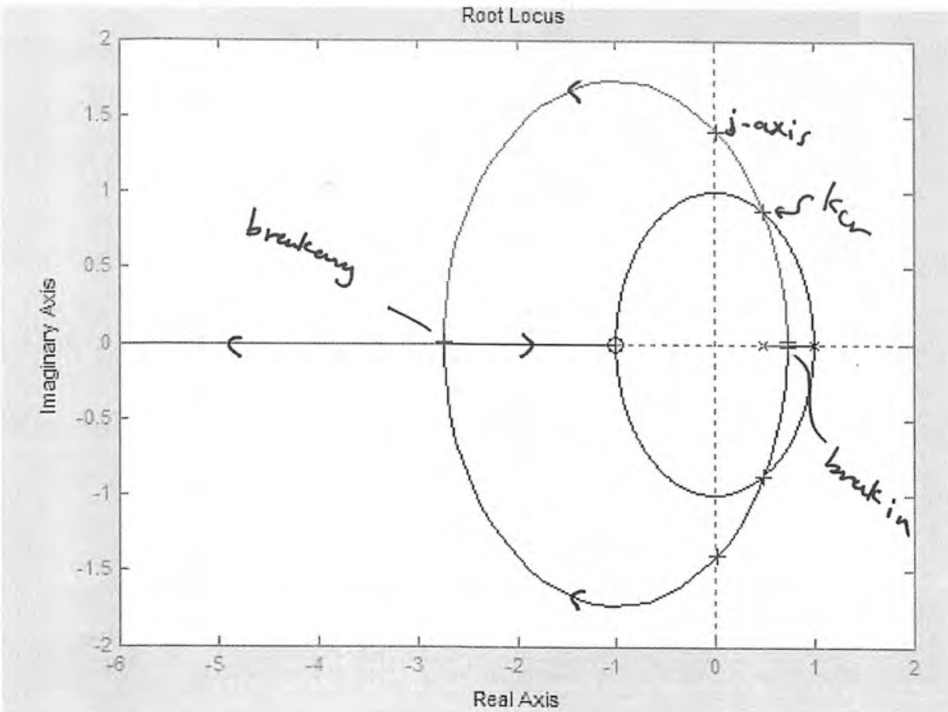
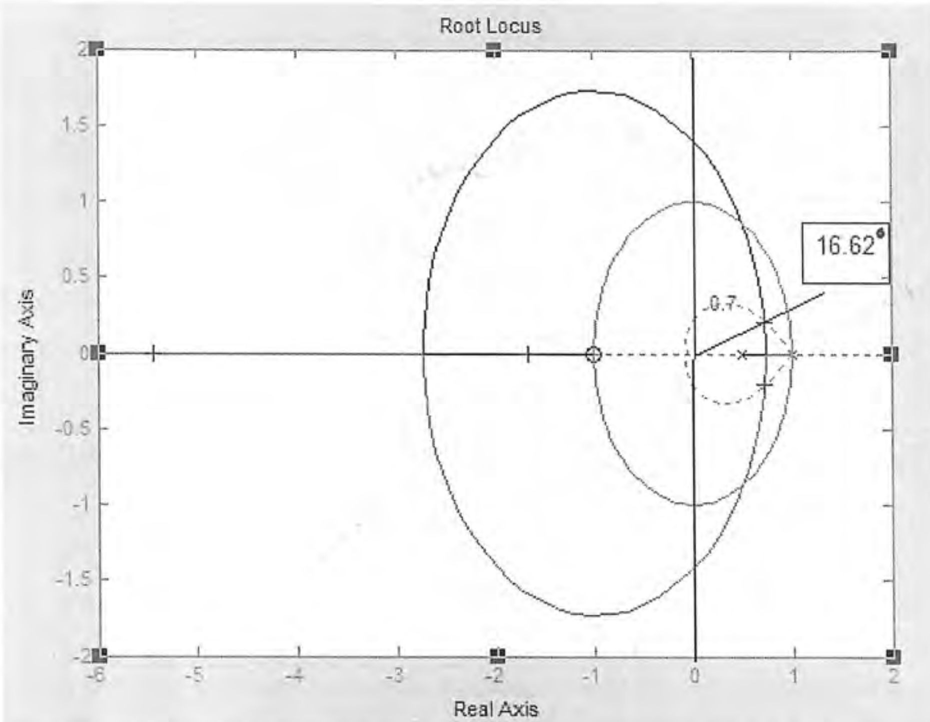
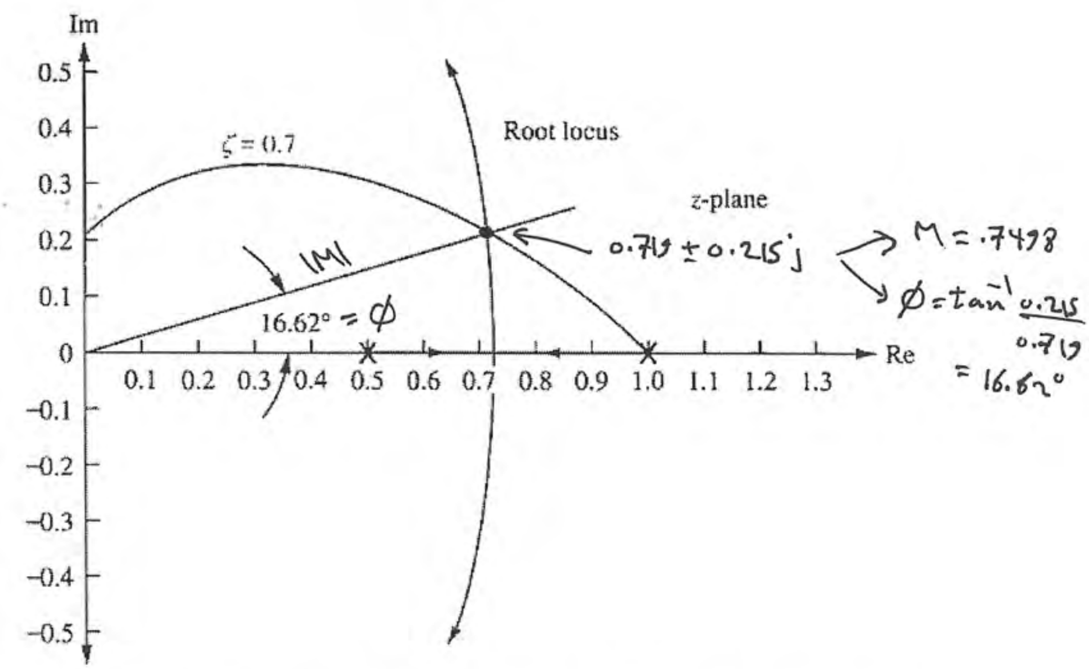


Note that

Repeat this Ex. For design by proportional gain (Kp) only to yield a damping ratio=0.7

Draw:- radial line from the origin to the intersection of the root locus with the 0.7 damping



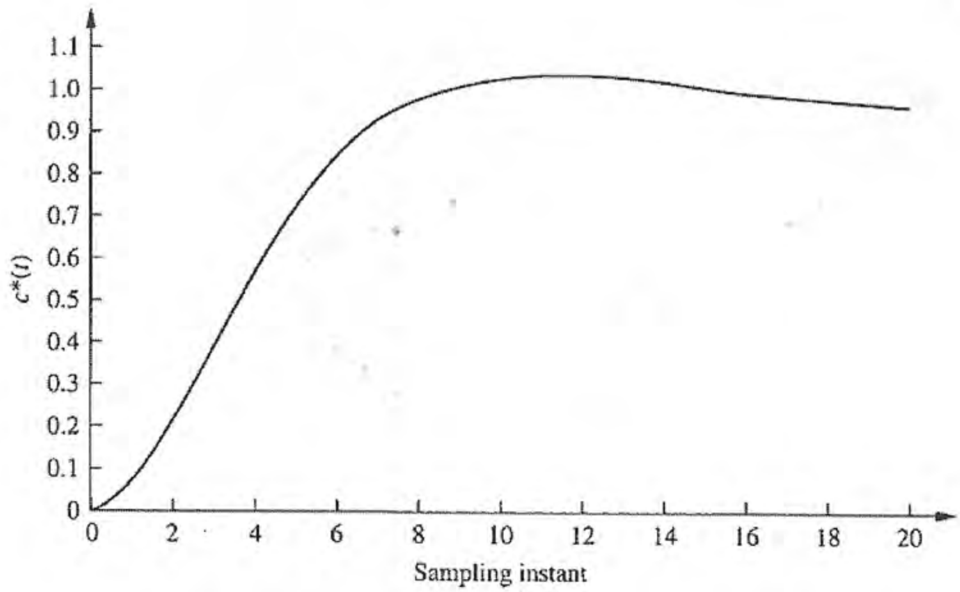


show that the gain, K, is 0.0627 at $0.719 + j0.215$, the point where the 0.7 damping ratio curve intersects the root locus.

We can now check our design by finding the unit sampled step response of the system of Figure below. Using our design, $K = 0.0627$, along with $R(z) = z/(z-1)$, a sampled step input, we find the sampled output to be

$$C(z) = \frac{R(z)G(z)}{1+G(z)} = \frac{0.0627z^2 + 0.0627z}{z^3 - 2.4373z^2 + 2z - 0.5627}$$

Since the overshoot is approximately 5%, the requirement of a 0.7 damping ratio has been met.



<u>**Example17**</u>

find the value of gain, K, to yield a damping ratio of 0.5.

$$G(z) = \frac{K(z+0.5)}{(z-0.25)(z-0.75)}$$

Apply all the R-L rules.

<u>**Use the MATLAB**</u>**:-**

```
gz=zpk(-0.5,[0.25 0.75],1,[])

rlocus(gz)
```

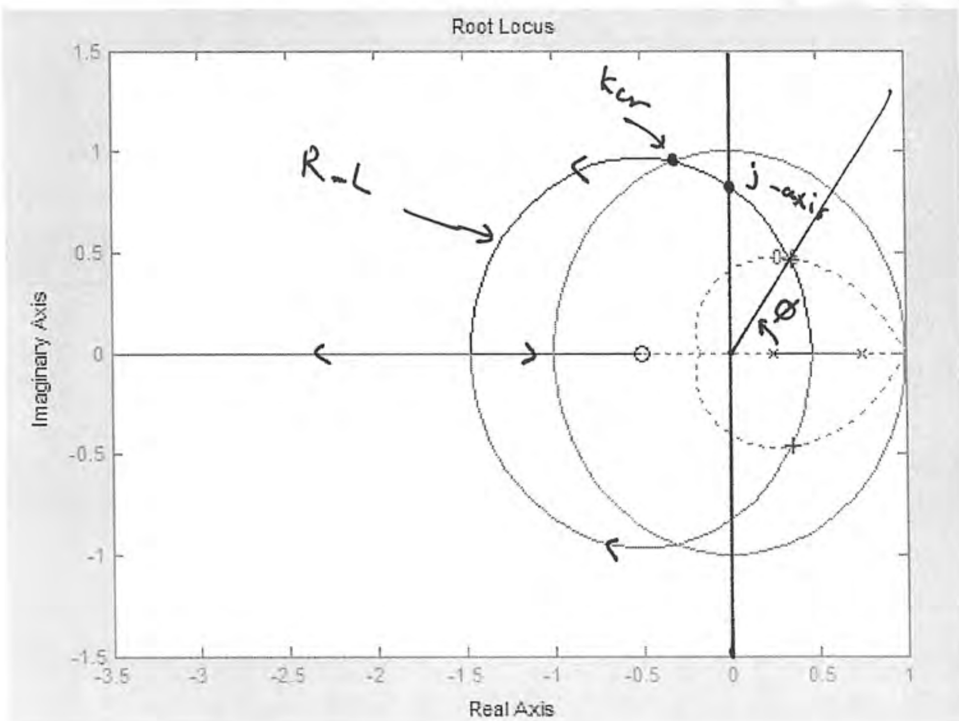
zgrid(0.5,[])

[k, p]=rolcfind(gz)

Ans:-

selected_point = 0.3442 ∓ 0.4612i (point of intersection R-L with the radial line of zeta=0.5)

kp = 0.31



or to find (kp) mathematically, sub the c.L. poles (.3442+0.4612j) in the c/cs eqn to calculate kp = 0.31

Example18

or lag compensator

Draw the R-L after design (PI) controller for:-

The continuous-time process is given by

$$= \frac{e^{-s}}{(1+10s)(1+5s)}$$

Observe that the system has a delay term of 1 sec. The sampling time is 1 sec.

Add the time-delay to the process by multiplying with z^{-1}, since $Z\{e^{-s}\} = z^{-1}$.

So that G(z) is:-

$$= 0.00905 \frac{(z+0.9048)}{(z-0.9048)(z-0.8187)z}$$

Design (PI) controller to make Ess=0

Sol

. The PI can be calculated similarly to the continuous system. T_i is the largest time constant of the system **(special direct method)**

PI : break frequency at 0.1 $\Rightarrow e^{-\frac{T_s}{T_i}} = e^{-\frac{1}{10}} = e^{-0.1} = 0.9048$

So that C(z) is:-

$$C(z) = k_c \frac{z - 0.9048}{z - 1}$$

Let

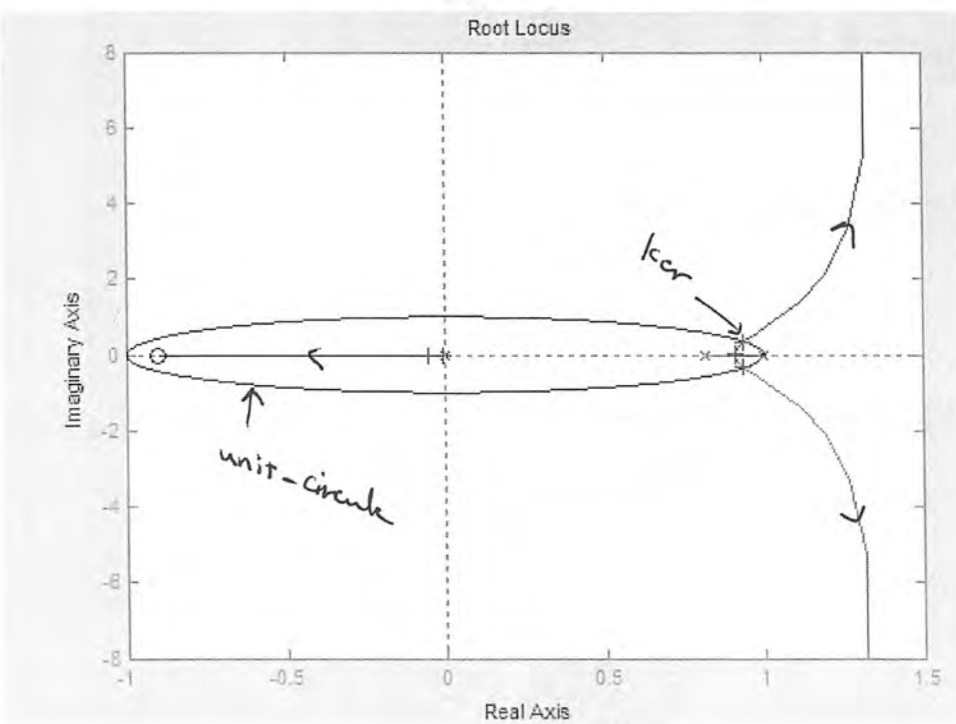
The gain of the discrete-time controller is $k_c = 16$

$$G(z)C(z) = \frac{0.00905 * 16(z + 0.9048)}{z(z-1)(z-0.8187)}$$

So that the system became type one , Ess=0, but there is problem in T.R, we need (PD) controller also.

Apply all the R-L rules:-

Kcr=0.41, breakaway=0.91, no intersection with j-axis



Example19

Sketch the root locus of the following system:

$$G_{OL}(z) = K\frac{z-0.5}{z(z-1)^2}$$

Solution:

1. Poles: $p_1 = 0$; $p_2 = p_3 = 1$ $(n = 3)$
   Zeros: $z_1 = 0.5$ $(m = 1)$.
2. Root loci on the real axis:
   $0 \le z \le 0.5$
3. Asymptotes:

$$\sigma_a = \frac{(1+1+0)-0.5}{3-1} = 0.75$$

$$\Phi_a = \frac{\pm 180^\circ(2k+1)}{3-1} = \pm 90^\circ$$

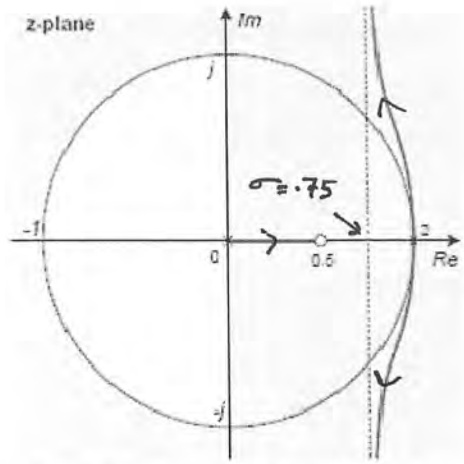
4. Break-away / break-in points:

K=[z(z-1)^2]/(z-0.5)

dK/dZ=0

The points are

$z_1 = 1$
$z_{2,3} = 0.375 \pm j0.7806$ (nonsense)



NOT POSSIBLE TO STABILIZE!

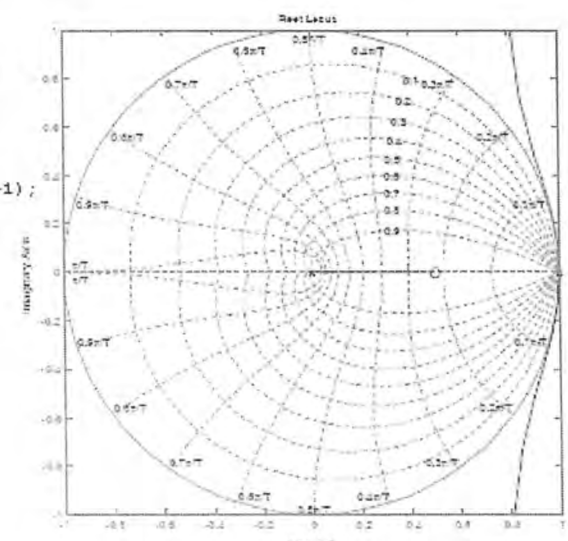
Breakaway=1, but there is no break in.

Also there is no intersection with j-axis.

5. Branches depart from poles 1 with ±90°
6. Locus does not cross the unit circle.

Let us verify this result with Matlab again:

```
% define open-loop TF of DTS
G = tf([1 -.5],poly([0 1 1]),-1);
% plot root locus
rlocus(G);
zgrid;
```



6.3 Root-locus of digital control System by using MATLAB