Parameter design by the root locus method

Example: Laser Manipulator Control System

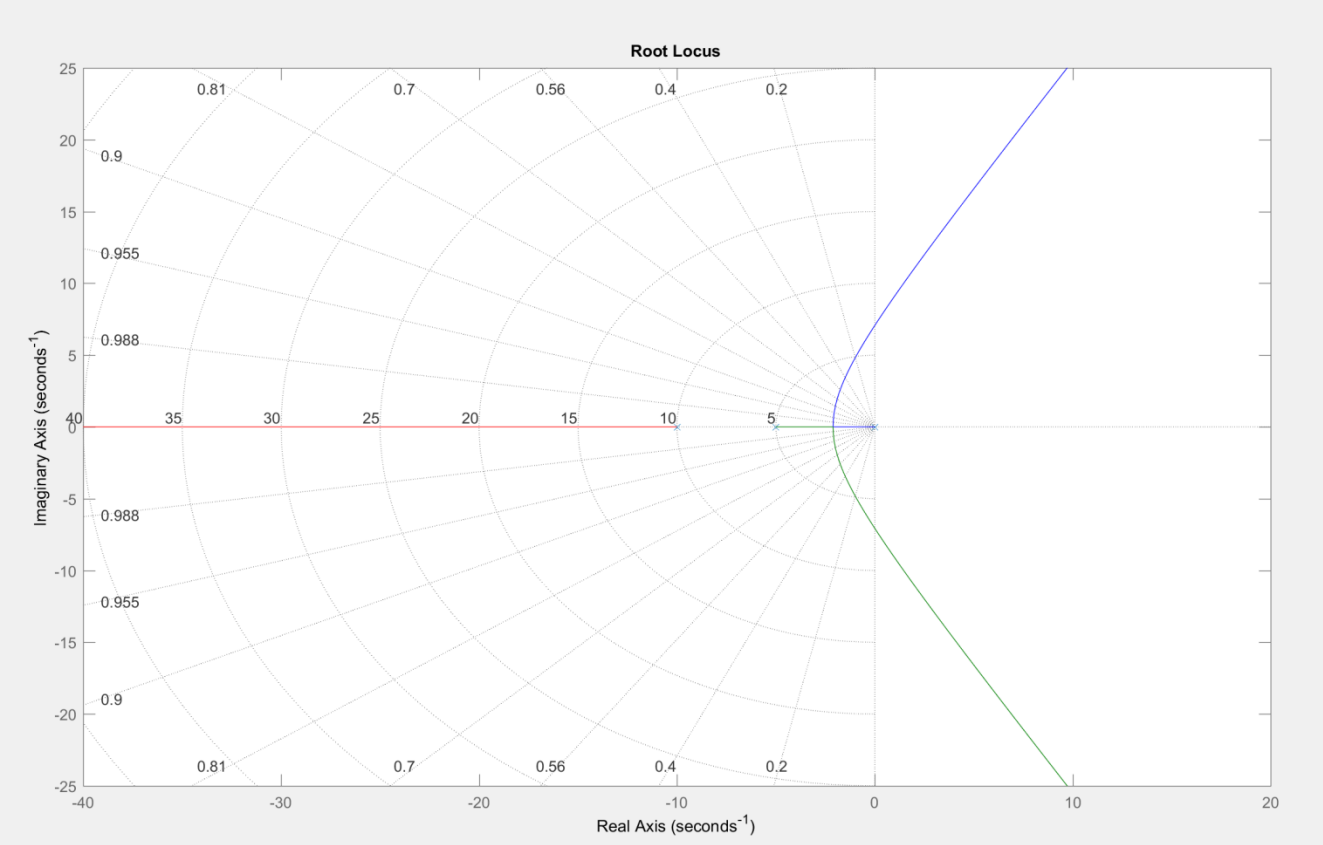
1. Establish transfer function

```
>> s = tf([1 0],[0 1]);
>> sysG = 1 / (s*(0.1*s+1)*(0.2*s+1))

sysG =

            1
  ----------------------
  0.02 s^3 + 0.3 s^2 + s

Continuous-time transfer function.
```

Parameter design by the root locus method

2. Draw root locus

```
>> rlocus(sysG)
>> grid
```



Parameter design by the root locus method

3. rlocfind

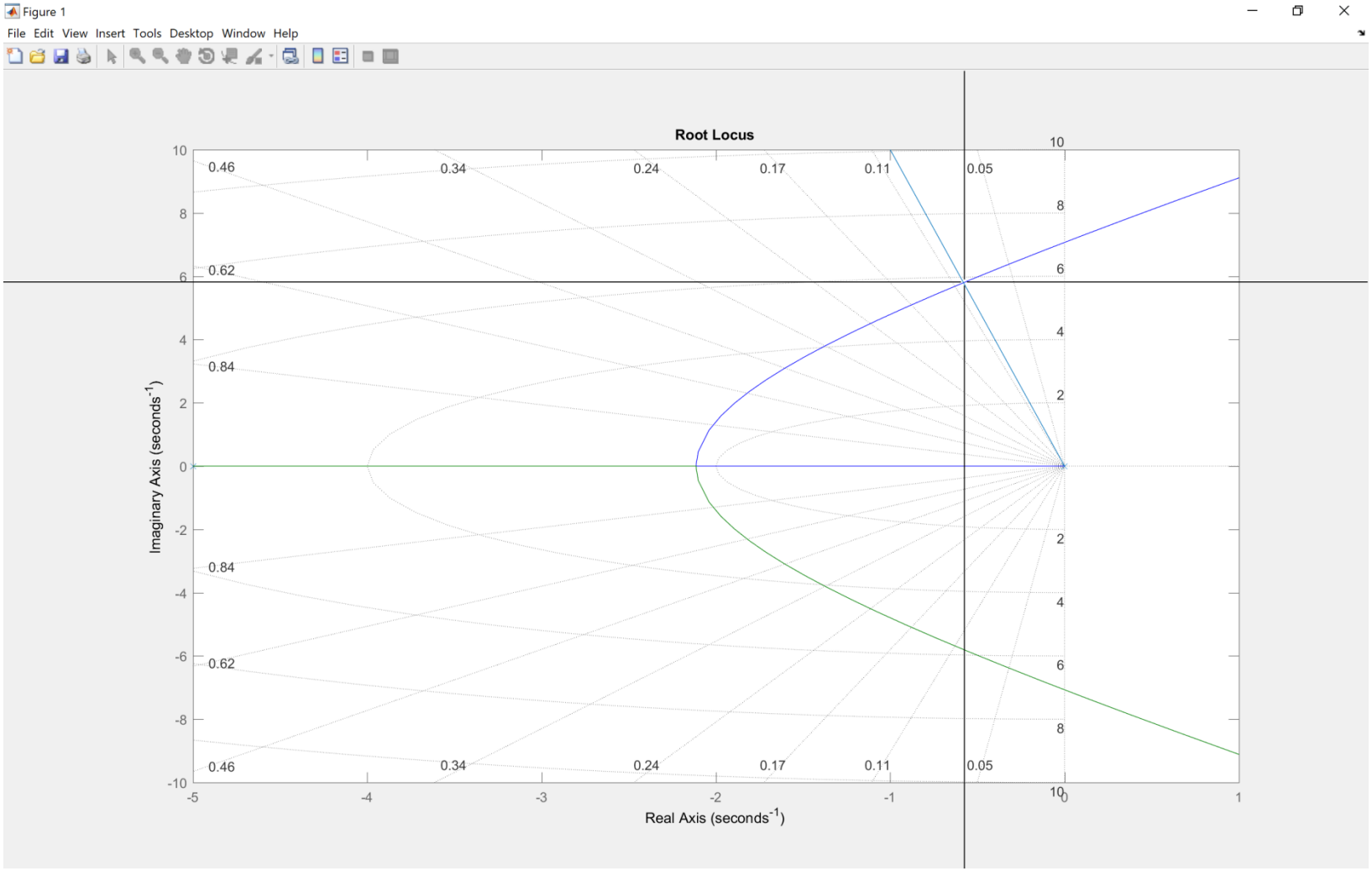
```
>> help rlocfind
 rlocfind  Find root locus gains for a given set of roots.

    [K,POLES] = rlocfind(SYS)  is used for interactive gain
    selection from the root locus plot of the SISO system SYS
    generated by RLOCUS.  rlocfind puts up a crosshair cursor
    in the graphics window which is used to select a pole location
    on an existing root locus.  The root locus gain associated
    with this point is returned in K and all the system poles for
    this gain are returned in POLES.

    [K,POLES] = rlocfind(SYS,P)  takes a vector P of desired root
    locations and computes a root locus gain for each of these
    locations (i.e., a gain for which one of the closed-loop roots
    is near the desired location).  The j-th entry of the vector K
    gives the computed gain for the location P(j), and the j-th
    column of the matrix POLES lists the resulting closed-loop poles.
```

Parameter design by the root locus method

move the mouse and click the root locus to see the corresponded gain K

```
>> axis([-5 1 -10 10])
>> [k,p] = rlocfind(sysG)
Select a point in the graphics window

selected_point =

  -0.4356 + 6.1120i


k =

   10.6109


p =

 -14.1200 + 0.0000i
  -0.4400 + 6.1140i
  -0.4400 - 6.1140i
```

Parameter design by the root locus method



Parameter design by the root locus method

Example 8.8 Third order system gain design

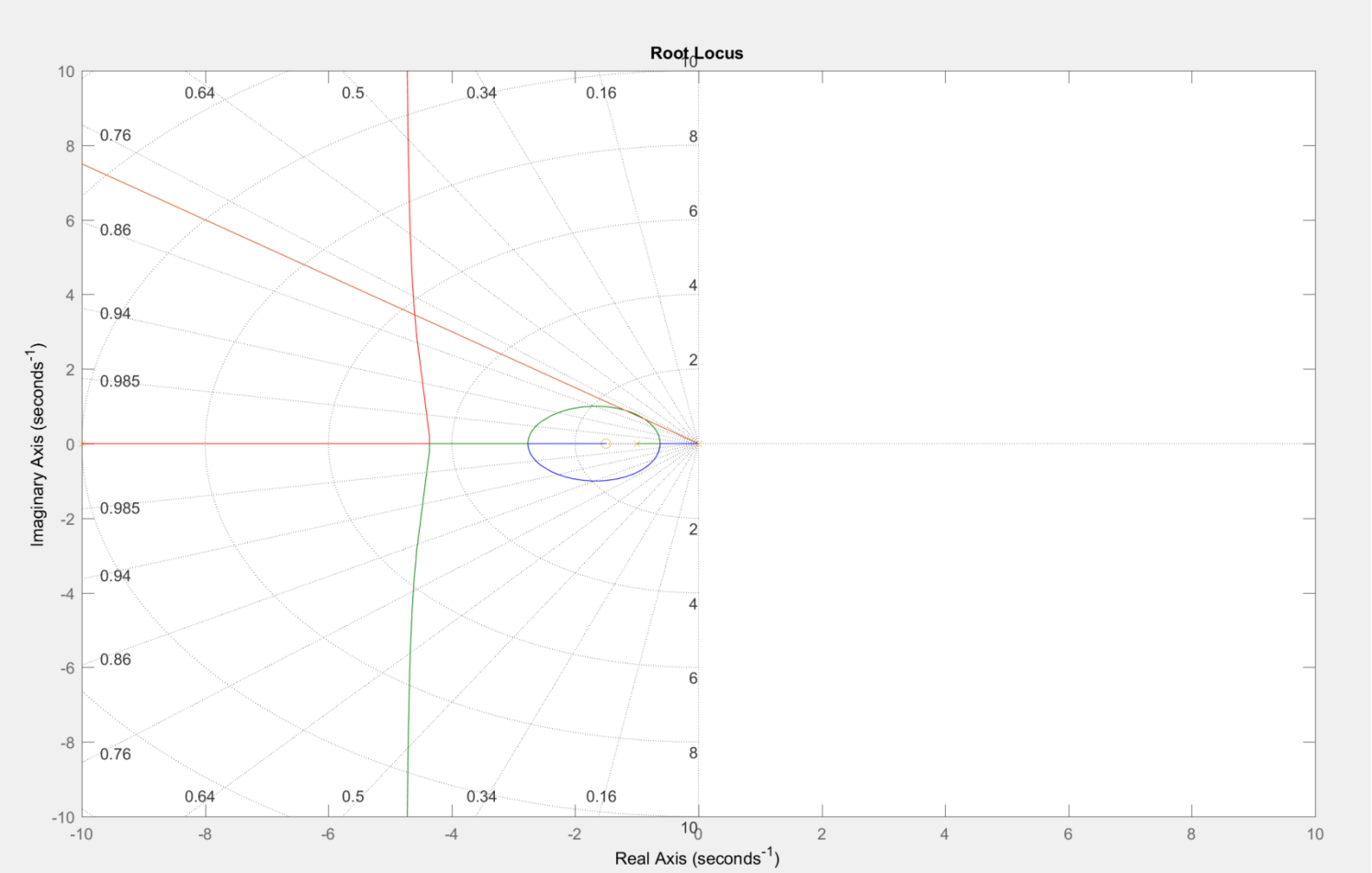
Establish transfer function

```
s = tf([1 0],[0 1]);
sysG = (s+1.5) / (s*(s+1)*(s+10));
rlocus(sysG)
hold on
grid
axis([-10 10 -10 10])
hold on
plot([-10 0],[10*0.75 0])
```

Parameter design by the root locus method

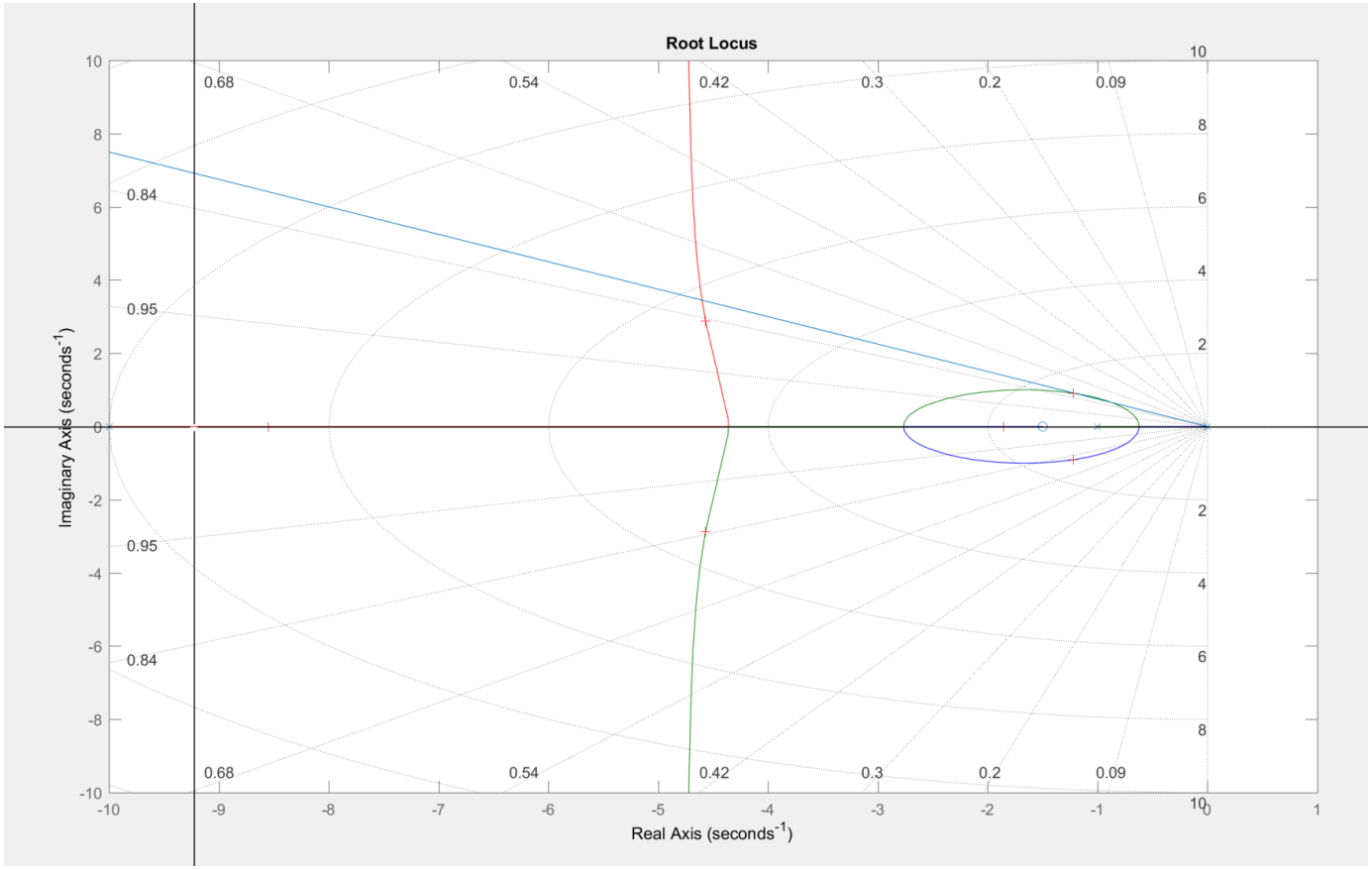
Assumption of second order system:
find roots and gain corresponded with desired damping ratio by rlocfind

```
>> [k,p] = rlocfind(sysG)
```



Parameter design by the root locus method

To test our assumption of second order system
→ calculate the location of the third pole
→ Search along the negative extension of the real axis for points that match the value of gain found at the second order dominant poles



Parameter design by the root locus method

Location of the third pole and corresponded gain & dominant poles

```
>> [k,p] = rlocfind(sysG)
Select a point in the graphics window

selected_point =

  -1.7999 - 0.0237i


k =

   39.2680


p =

  -4.5993 + 3.3977i
  -4.5993 - 3.3977i
  -1.8014 + 0.0000i
```

```
>> [k,p] = rlocfind(sysG)
Select a point in the graphics window

selected_point =

  -8.6119 - 0.0394i


k =

   12.8000


p =

  -8.6112 + 0.0000i
  -1.1944 + 0.8961i
  -1.1944 - 0.8961i
```

```
>> [k,p] = rlocfind(sysG)
Select a point in the graphics window

selected_point =

  -9.2521 - 0.0079i


k =

    7.3659


p =

  -9.2521 + 0.0000i
  -0.8739 + 0.6561i
  -0.8739 - 0.6561i
```