Experiment 6

Study of Root Locus Plot in Matlab

Aim: To study following:

- Stabilty analysis of linear process by gain variation method and by root locus method of the given TF.

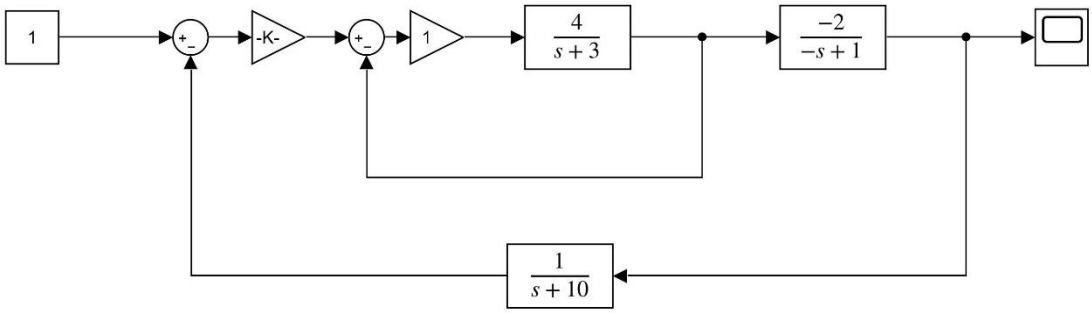


Fig 1: Given Transfer Function

- Stability analysis of linear process by gain variation on kit.

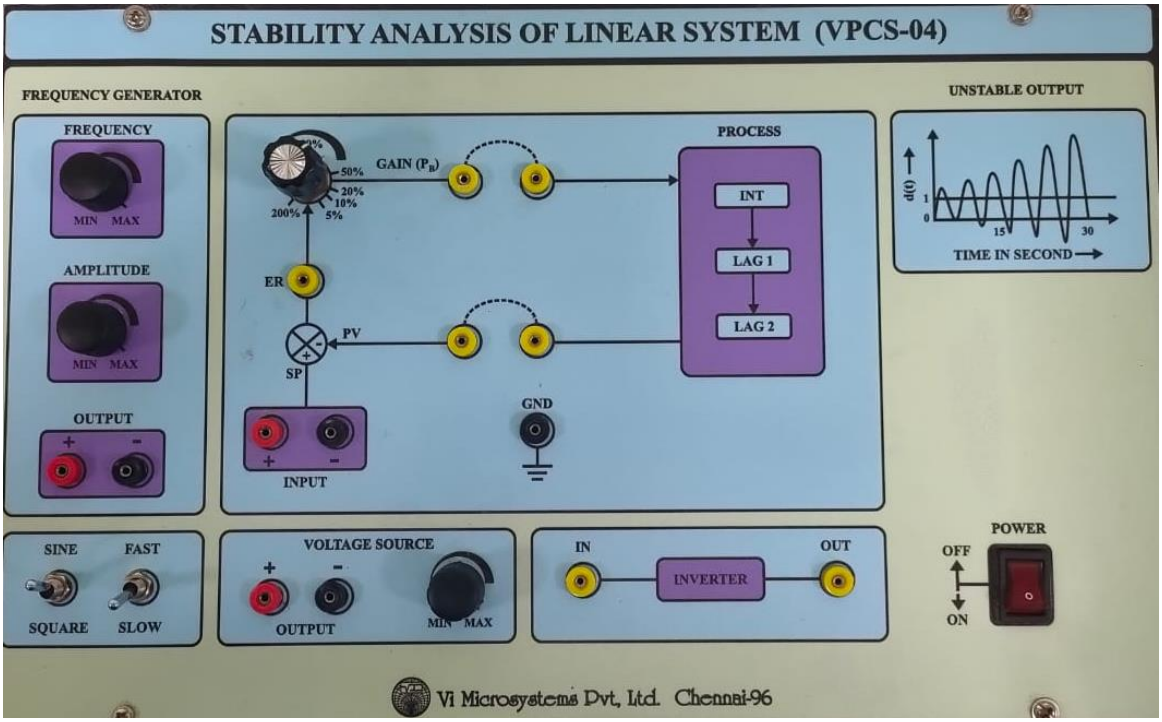


Fig 2: Controller box

Software: MATLAB 2018a

Theory:

Root Locus: The root locus of a feedback system is the graphical representation in the complex s-plane of the possible locations of its closed-loop poles for varying values of a certain system parameter. The root locus is a graphical representation in s-domain and it is symmetrical about the real axis. Because the open loop poles and zeros exist in the s-domain having the values either as real or as complex conjugate pairs. On a root-locus graph, all the poles move towards a zero. Only one pole may move towards one zero, and this means that there must be the same number of poles as zeros.

Controller Box: A proportional–integral–derivative controller (PID controller. or three-term controller) is a control loop mechanism employing feedback that is widely used in industrial control systems and a variety of other applications requiring continuously modulated control. A PID controller continuously calculates an *error value* e(t) as the difference

between the desired setpoint (SP) and a measured process variable (PV) and applies a correction based on proportional , integral , and derivative terms (denoted *P* , *I* , and *D* respectively)

Matlab Code:

```
clc; clear all; close all;
s = tf('s');
g1 = 0.5;
g2 = 4/(s+3);
g3 = -2/(-s+1);
h = 1/(s+10);
Y = series(feedback(series(g1,g2),1),g3);
rlocus(Y*h);
```

Results:

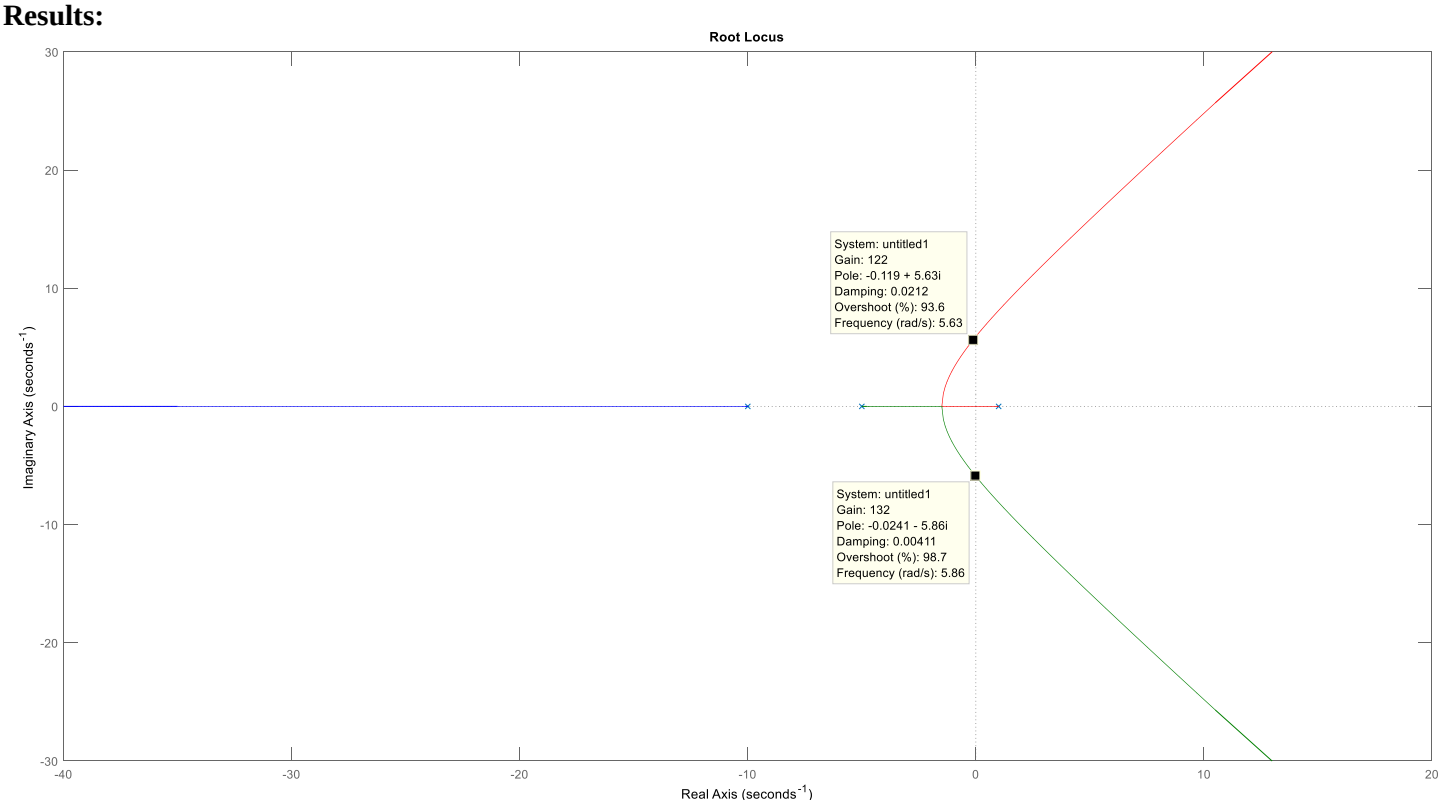


Fig 3: Root Locus

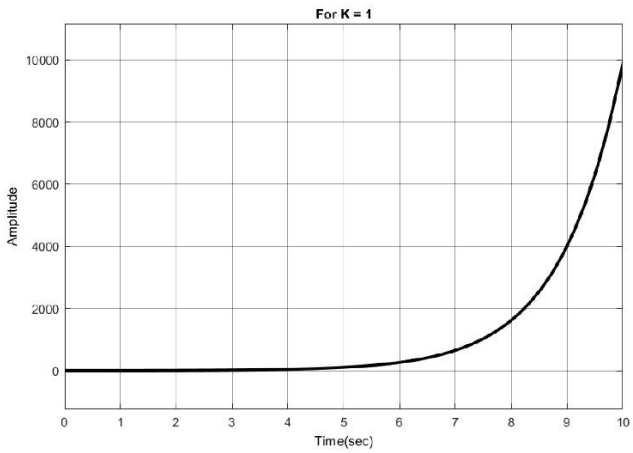


Fig 4: For k not in root locus

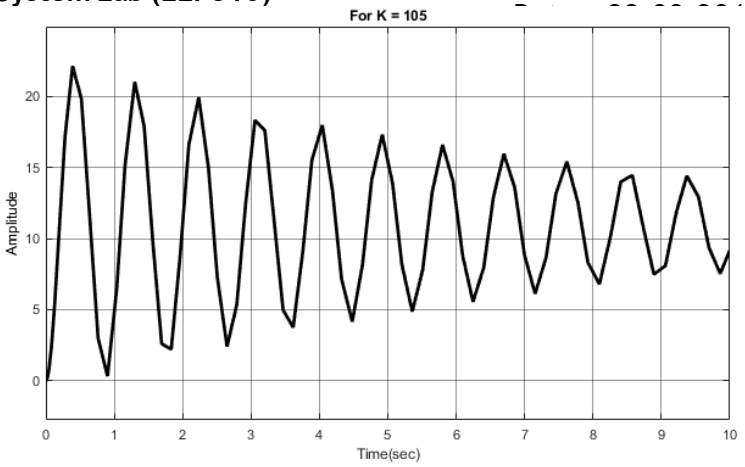


Fig 5: For K in root locus

Conclusion:

For Root Locus

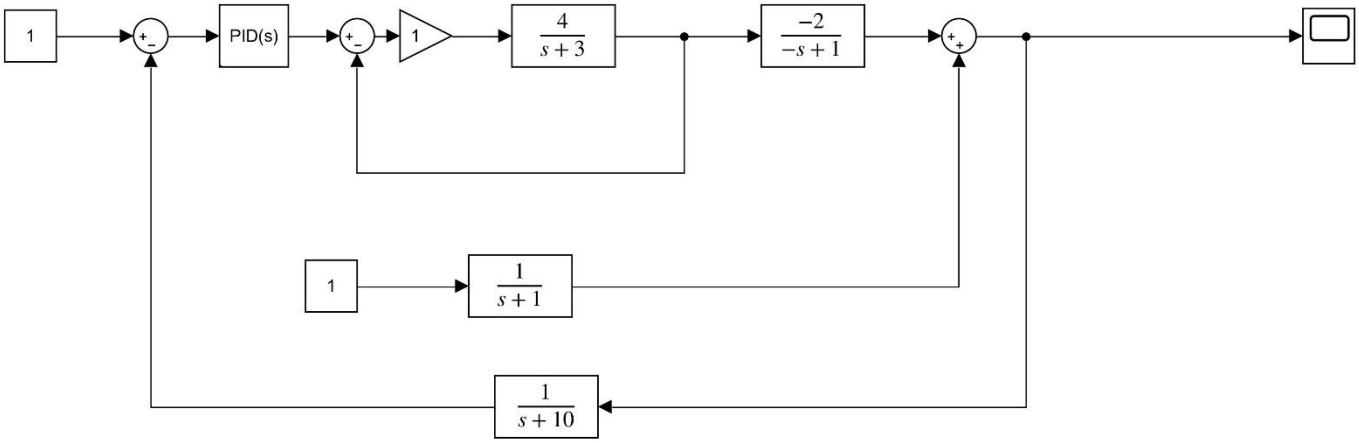
- After locating k on the Root Locus, the system stabilizes, and stable response is obtained
- On a root-locus graph, all the poles move towards a zero. Only one pole may move towards one zero, and this means that there must be the same number of poles as zeros.
- Range of k for stability = (1-105)

For Controller Box

- On increasing k, the systems tends to get unstable.
- Response of such a system shows increasing amplitude.

Assignment 6a

Aim: To Study Root Locus of a system with PID controller in MATLAB.



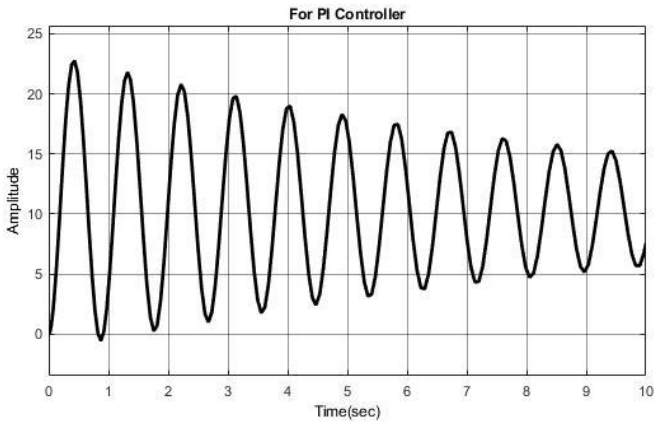
Software: Matlab 2018a

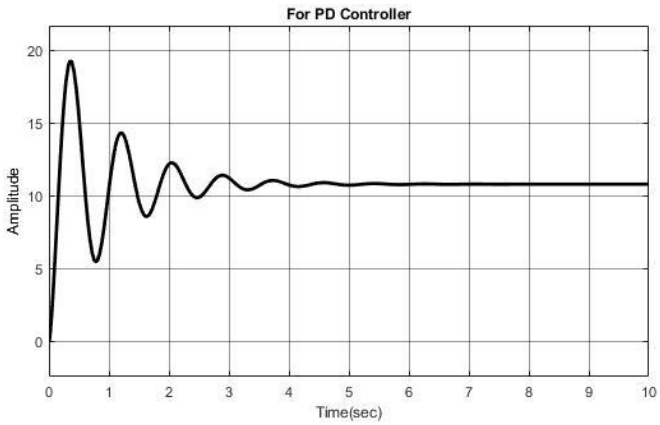
Theory: In control system theory, the Routh–Hurwitz stability criterion is a mathematical test that is a necessary and sufficient condition for the stability of a linear time-invariant (LTI) control system. Stability can be characterized by considering a sign of real parts of the roots of the characteristic polynomial of a linear system. If all entries in the routh array are positive, implies a stable system, negative entry implies instability, 0 implies threshold condition.

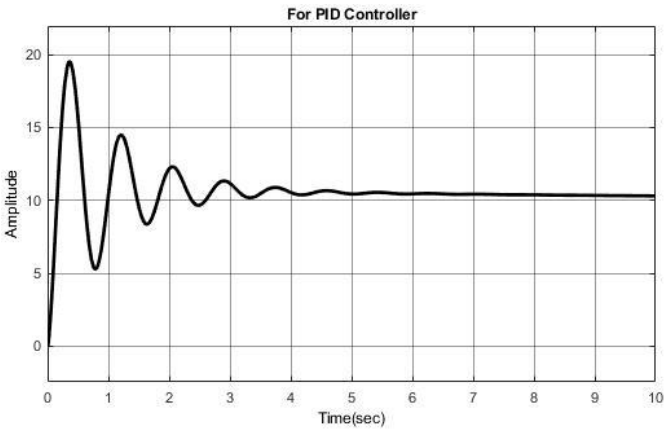
Matlab Code:

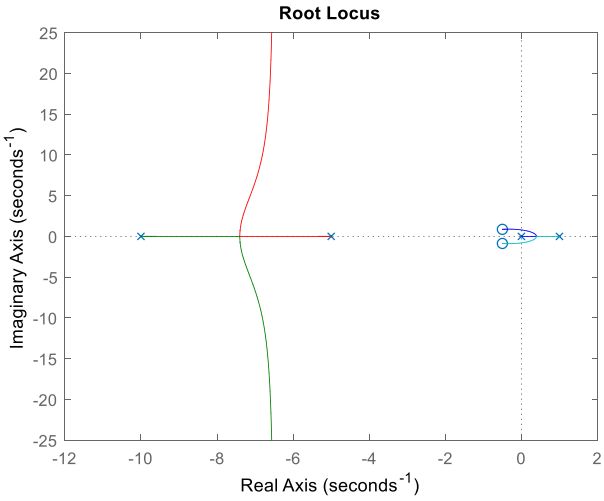
```
close all;
clear; clc;
Gp = series(tf([1 1 1],[1 0]), series(feedback(tf(2,[1 3]), 1), tf(-2,[-1
1])));
H = tf(1, [1 10]);
rlocus(Gp*H);
```

Results:









Conclusion:

- After locating k on the Root Locus, the system stabilizes, and stable response is obtained**.**
- Step response was studies for different values of disturbances.