EXPERIMENT :- 3. ROOT LOCUS.

AIM :-

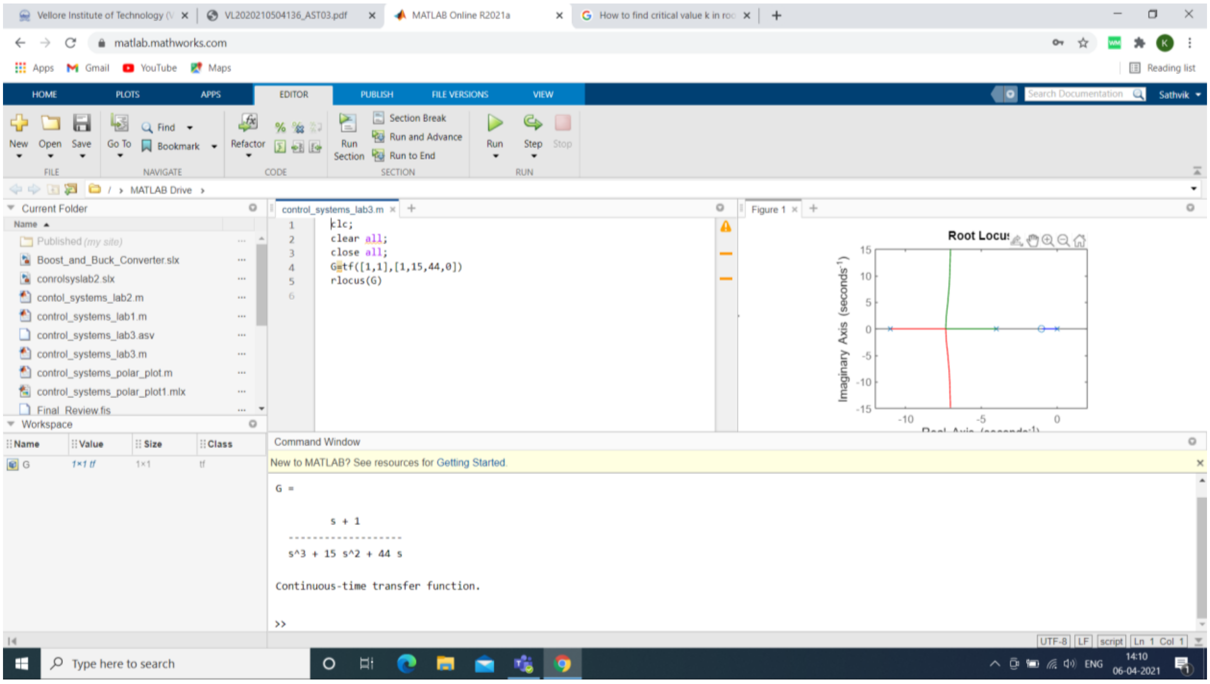
To find the root locus of the given Transfer function.

APPARATUS REQUIRED :-

Matlab, tf() → To write the Transfer function, rlocus() → To find the root locus of given Transfer function.

Given Transfer function $\frac{k*(s+1)}{s*(s+4)*(s+11)}$

MATLAB CODE :-



MANUAL CALCULATION :-

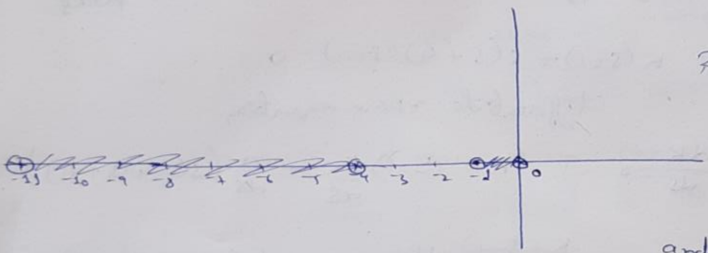
Given Transfer function

$$G(s) = \frac{K(s+1)}{s(s+4)(s+11)}$$

$$= \frac{K(s+1)}{s(s^2+15s+44)} = \frac{K(s+1)}{s^3+15s^2+44s}$$

The poles for the above Transfer function are 0, -4, -11 and zeroes are -1

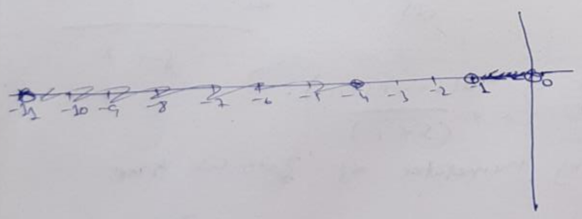
So the diagram is



Root locus is graphed as shown in figure

it exist between 0 & -1, -4 & -11.

and the pole zero tends to -1 as it is zeroes



and -4, -11 tends to zeroes at infinity

So the assymptode angles are

$$\frac{\pm 180(2q+1)}{n-m}$$

n → no. of poles = 3

m → no of zeroes = 1

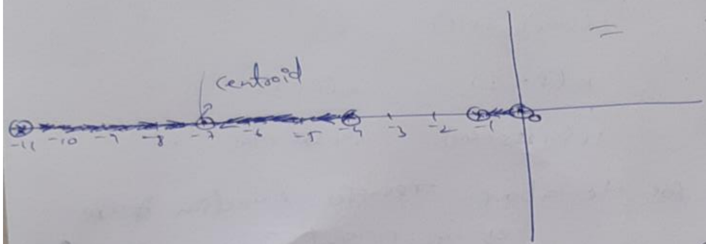
$$= \frac{\pm 180(2q+1)}{2} \quad \text{for } q = 0$$

$$= \pm 90$$

So the assymptode angles are ±90.

The centroid is $= \dfrac{(-4-11+0)-(-1)}{3-1}$

$= -\dfrac{14}{2} = -7$



~~So from -7 the poles tend to infinite~~

Then Differentiate the Characteristic equation to find out break away point as it exist between two poles

$\cancel{K=0}\quad K(s+1)+s(s+4)(s+11)=0$

differentiate above equation

$$\frac{dK}{ds}=0 \Rightarrow K+(s+1)\frac{dK}{ds}+\frac{d}{ds}\big(s(s+4)(s+11)\big)=0$$

$$\cancel{K+(s+1)}\frac{dK}{ds} = \frac{-\frac{d}{ds}\big(s(s+4)(s+11)\big)-K}{s+1}$$

$$\text{as } K = \frac{-s(s+4)(s+11)}{(s+1)}.$$

by making numerator as zero we have

$$-\left[(s+1)(3s^2+30s+44)-(s^3+15s^2+44s)(1)\right]=0$$

$$3s^3+30s^2+\cancel{44s}+3s^2+30s+44-s^3-15s^2-\cancel{44s}=0$$

$$2s^3+18s^2+30s+44=0$$

so we get $s = \cancel{-7.36}\ -7.37,$
$-0.8151+1.523j,$
$-0.8151-1.523j$

For the above values the value for which $K>0$ we take that as break away point as $K = \frac{-[s(s+4)(s+11)]}{(s+1)}$

for $s = -7.37$

$K = 14.1535$

for $s = -0.8151 + 1.525j$ we get

$K = -14.576 - 38.51j$

for $s = -0.8151 - 1.525j$

$K = -14.576 + 38.251j$

we take only the real values of K so the break away point is -7.37

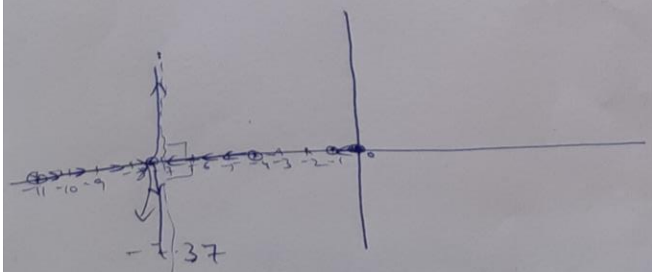
as there are no complex poles or zeroes angle of arrival or departure are not necessary.

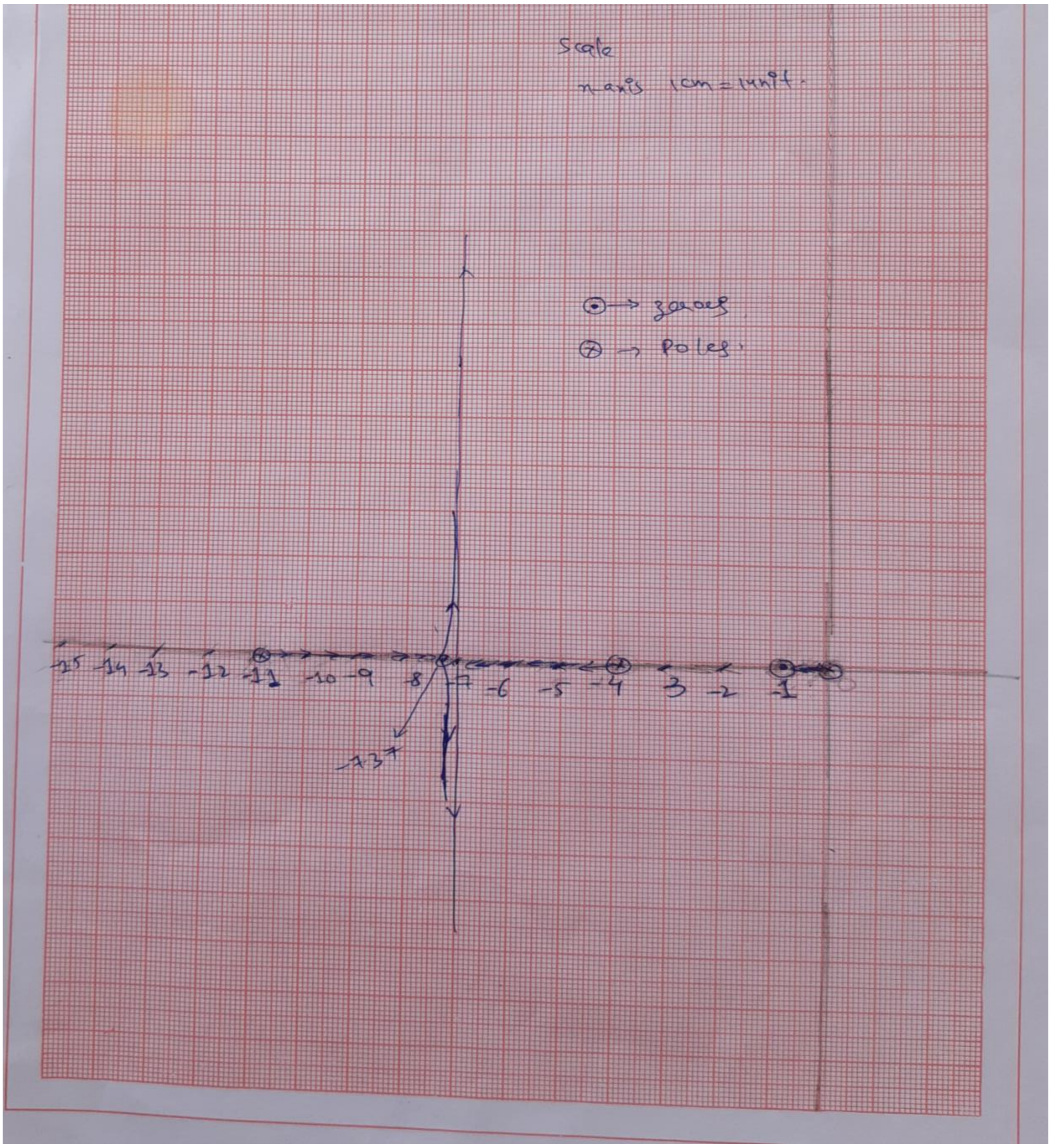
The critical value of K is for $s = j\omega$

given $K = \frac{-s(s+4)(s+11)}{s+1}$

$= \frac{-j\omega(4+j\omega)(j\omega+11)}{(j\omega+1)}$

Here we don't get $K > 0$ so it doesn't ~~touch~~ cross imaginary axis so the graph will be





Result :-

The experiment is verified under matlab as well as calculated it manually.

Inference :-

From the above graph we see that the pole -2 is moving towards 0 and the poles -4, -11 are moving towards zeroes at infinite.