ME3210

Control Systems

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ME21BTECH11001

Mid Sem

Bonus Question

Note: Below are the graphs for every question for the Bonus Portion only

Question 9

Taking Laplace of: $y'' - 3y' + 4y = 6t$

Initial Conditions of y (0) = -1 & y(0) = 1

Taking Laplace Inverse :

$$\mathcal{L}_s^{-1}\left[\frac{6 + 4\,s^2 - s^3}{s^2\left(s^2 - 3\,s + 4\right)}\right](t)$$

$$\frac{1}{56}\left(84\,t + 43\sqrt{7}\;e^{(3\,t)/2}\sin\left(\frac{\sqrt{7}\;t}{2}\right) - 119\,e^{(3\,t)/2}\cos\left(\frac{\sqrt{7}\;t}{2}\right) + 63\right)$$

Graph:

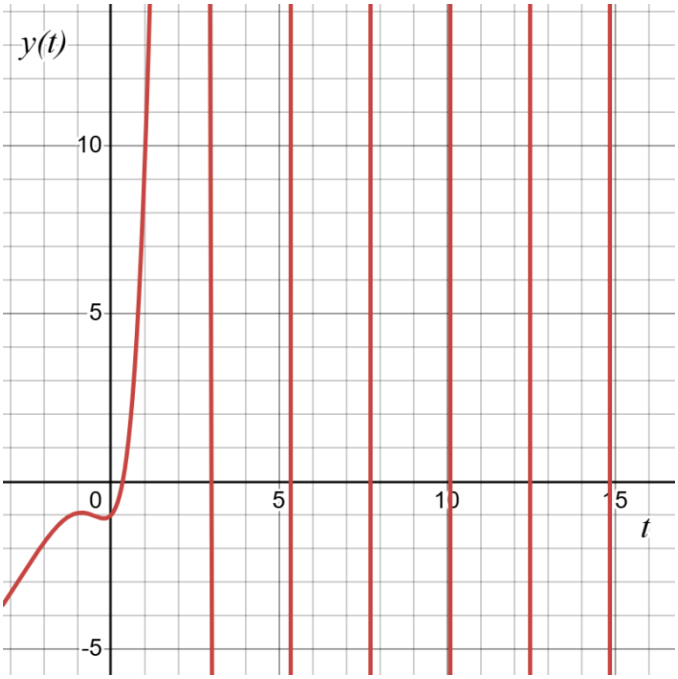


Fig: Zoomed In Plot

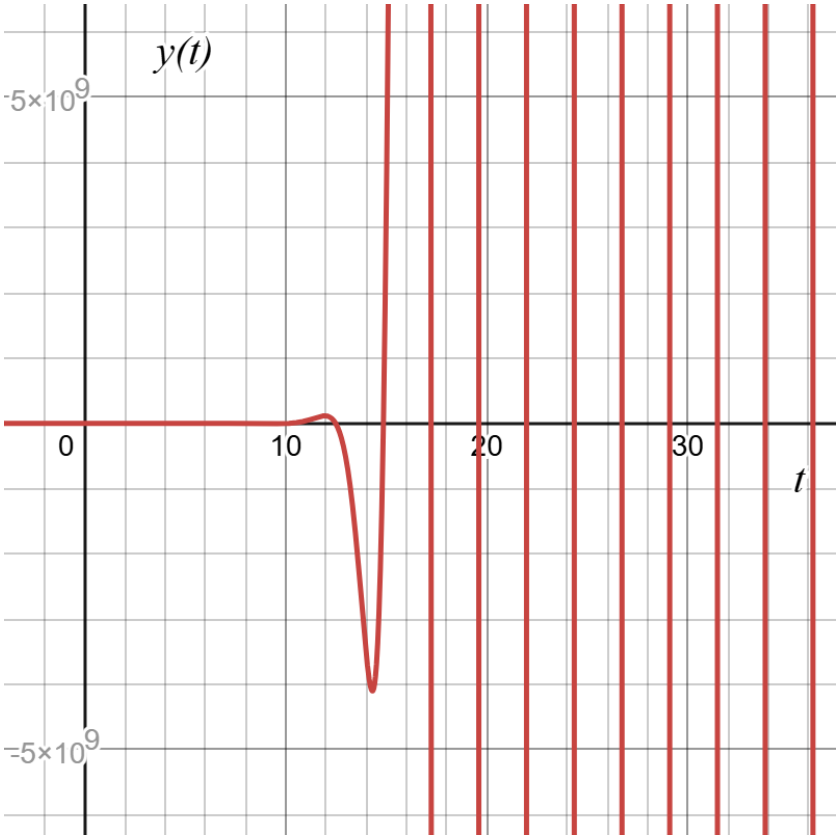


Fig: Zoomed Out Plot

Oscillations are observed as graph tends to infinity therefore it is unstable

Question 10

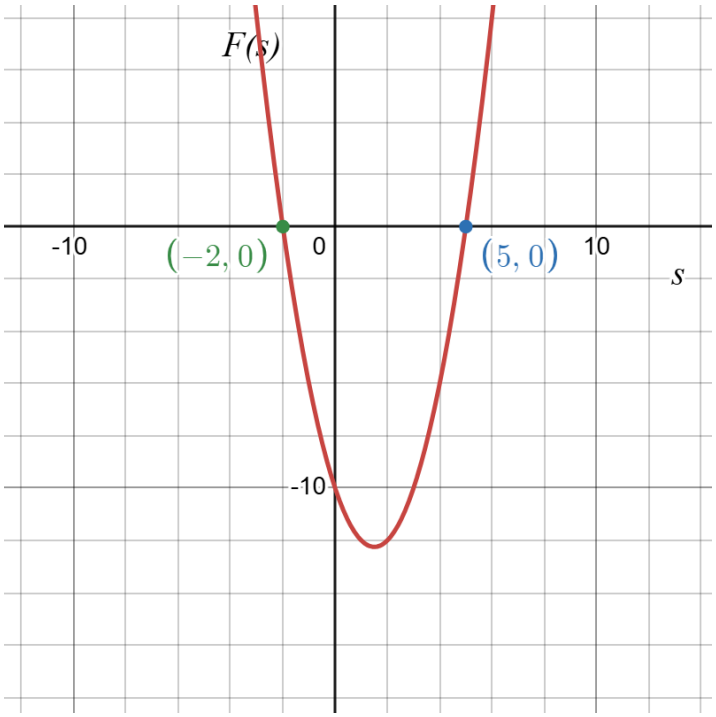
System:

$y'' - 3y' - 10y = u(t)$

Taking Laplace and finding Transfer Function:

$P(s) = \frac{1}{(s^2-3s-10)}$

Poles => $(s^2-3s-10) = 0$ => $(s-5)*(s+2) = 0$ => $s = 5,-2$



One pole in RHP => therefore from BIIBO stability criteria we conclude the system is unstable

Question 11

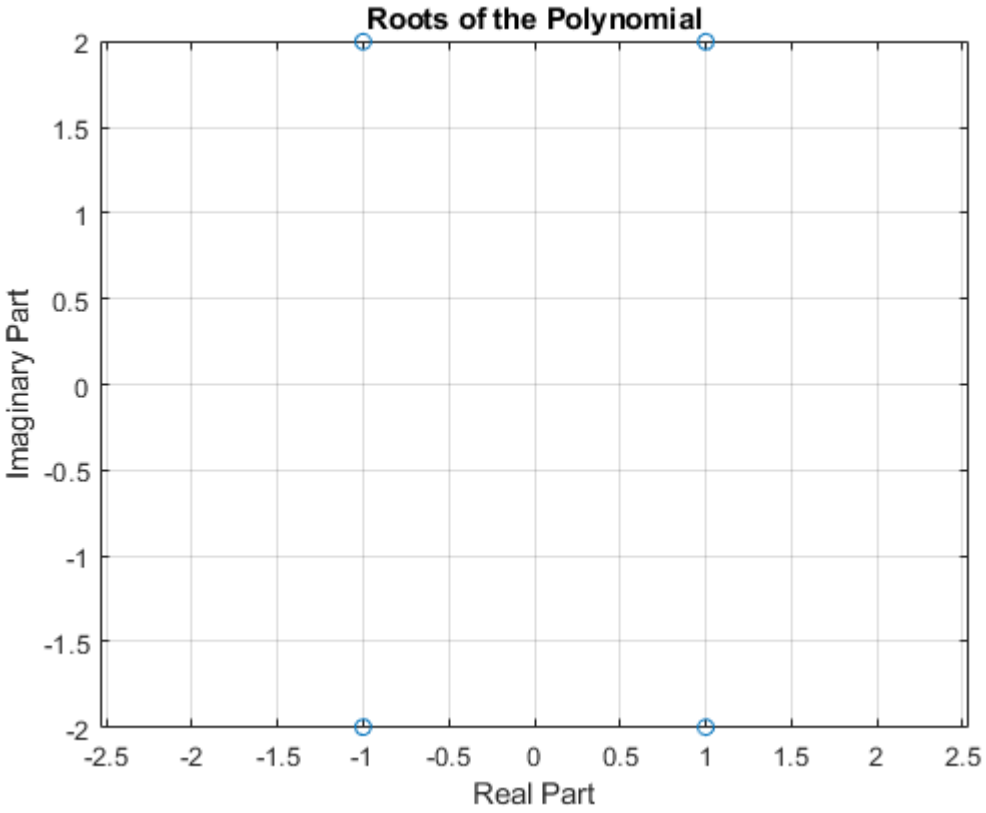
From the Routh's array we found out that roots are radially opposite (because one full row became zero)

The graph proves the same:

Also there are roots in RHP therefore not stable.

```
p = [1 0 6 0 25]

r = roots(p)

real_parts = real(r);

imag_parts = imag(r);

plot(real_parts, imag_parts, 'o');

axis equal;
grid on;
xlabel('Real Part');
ylabel('Imaginary Part');
title('Roots of the Polynomial');
```

```
p =

     1     0     6     0    25

r =

  -1.0000 + 2.0000i

  -1.0000 - 2.0000i

   1.0000 + 2.0000i

   1.0000 - 2.0000i
```



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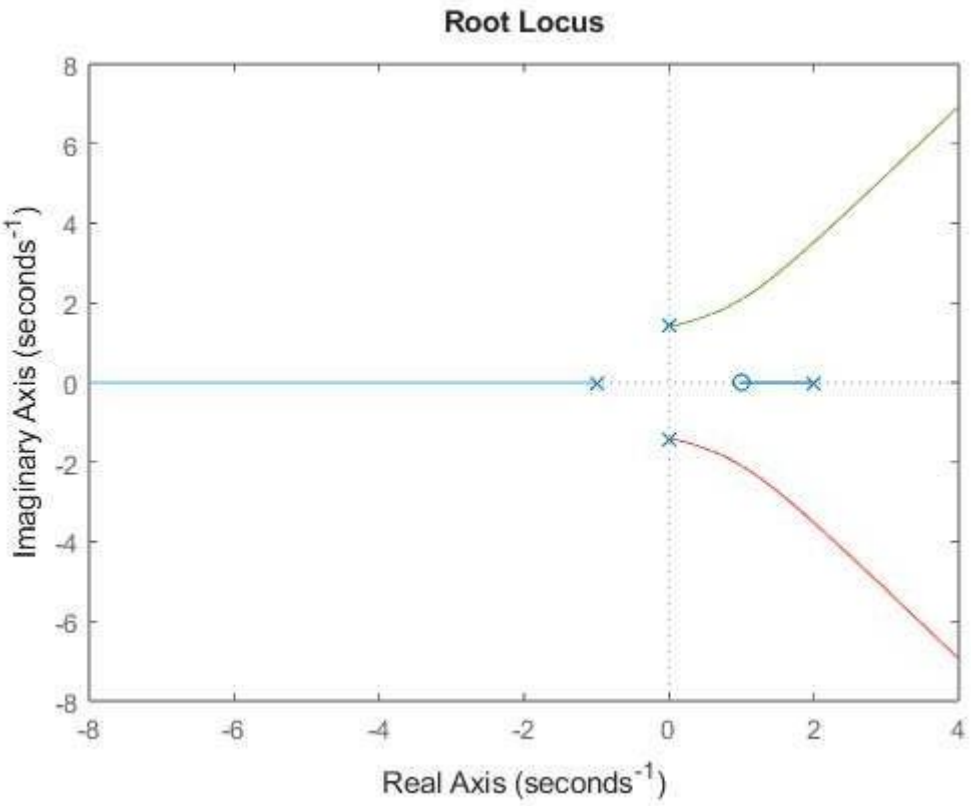
Question 14

```
sys = tf([1 -1], [1 -1 0 -2 -4])
rlocus(sys)
```

```
sys =

      s - 1
-------------------
s^4 - s^3 - 2 s - 4
```

C



The root locus has been plot using the rlocus command using control system toolbox in MATLAB.

Part B: Question 14 2nd part:

Performance criteria so that settling time is less than 2s: