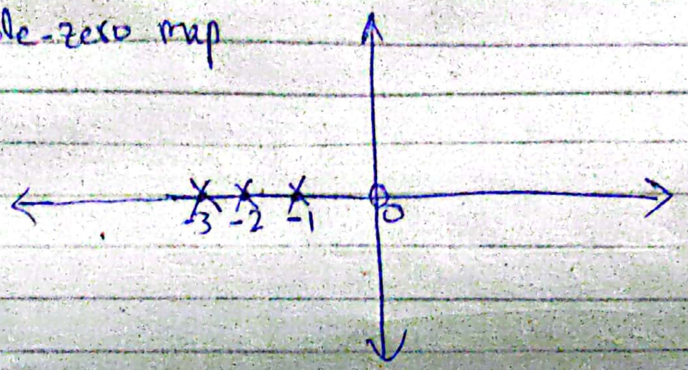
Q1 (a) $G(s) = \dfrac{s}{(s+1)(s+2)(s+3)}$

(i)
- poles $= -1, -2, -3$
- zeros $= 0$

(ii)
- pole-zero map



(iii)
- stability

  system is stable

(b) $G(s) = \dfrac{(s+3)^2}{s+10}$

$\cancel{9 = 18+9}$

$s^2 + 6s + 9$

$s = \dfrac{-6 \pm \sqrt{6^2 - 4(1)(9)}}{2(1)}$

$s = \dfrac{-6 \pm \sqrt{36-36}}{2}$

$s = \dfrac{-6}{2} = -3$

- poles

  $s + 10 = 0$

  $\boxed{s = -10}$

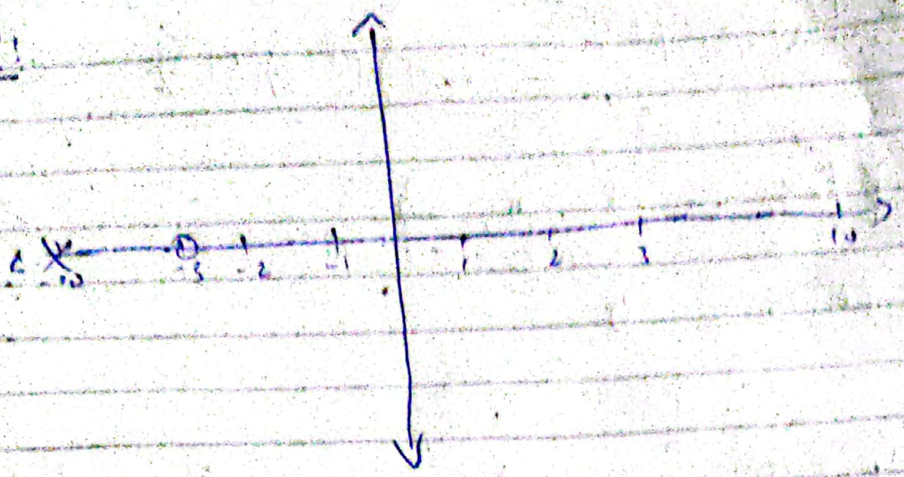
- zeros

  $(s+3)^2 = 0$

  $s + 3 = 0$

  $s = -3$

PZMaP:



Stability: The system is stable since all poles are negative.

(c) $G(s) = \dfrac{s(s-3)}{(s-10)(s-1)}$

Poles:- $(s-10)(s-1) = 0$

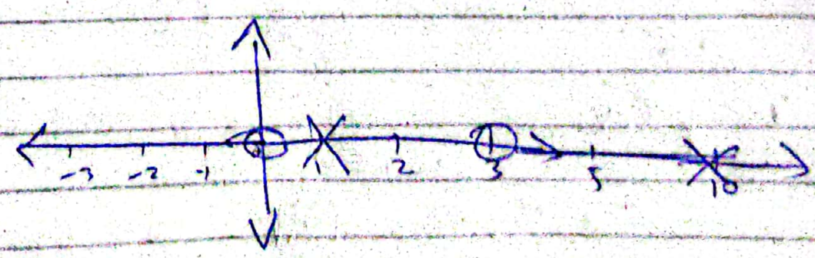
$s - 10 = 0$; $s - 1 = 0$

$\boxed{s = 10}$; $\boxed{s = 1}$

Zeros:- $s(s-3) = 0$

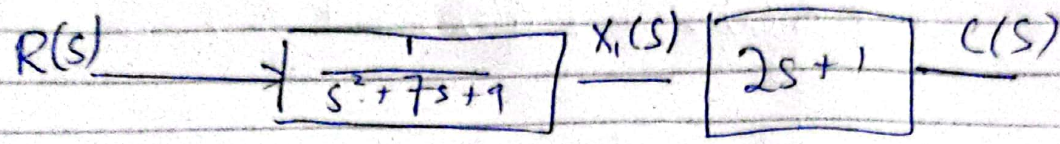
$\boxed{s = 0}$, $\boxed{s = 3}$

PZMaP:



Stability:- The system is unstable since one of the pole is positive.

$$G(s) = \frac{1}{s^2+7s+9}\cdot(2s+1)$$



$$\frac{X_1(s)}{R(s)} = \frac{1}{s^2+7s+9}$$

$$X_1(s)s^2 + 7X_1(s).s + 9X_1(s) = R(s)$$

$$\ddot{x}_1 + 7\dot{x}_1 + 9x_1 = r$$

$$x_1 = x_1$$
$$x_2 = \dot{x}_1$$

$$\dot{x}_1 = x_2$$

$$\dot{x}_2 = \ddot{x}_1 = -7\dot{x}_1 - 9x_1 + r$$

$$\dot{x}_2 = -7x_2 - 9x_1 + r$$

$$\boxed{\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ -9 & -7\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}r}$$

$$\frac{C(s)}{X_1(s)} = \frac{2s+1}{1}$$

$$\boxed{C = \begin{bmatrix}1 & 2\end{bmatrix}}$$

$$c(s) = X_1(s).2s + X_1(s)$$

$$c = 2\dot{x}_1 + x_1 \Rightarrow c = 2x_2 + x_1$$