EXPERIMENT No 4 : MINIMUM, MAXIMUM AND MIXED PHASE SYSTEM.

AIM :- To classify the systems as minimum, maximum, mixed phase based on zero location of transfer function.

SOFTWARE USED :- Spyder Python 3.8.

THEORY :-

Linear Phase System : It is one in which phase response is linear function of frequency.

1. **Minimum phase system:** A system is said to be minimum phase system if difference in the phase at $\omega = \pi$ and $\omega = 0$ is 0, then system is minimum phase.

$$\angle H(\omega)\big|_{\omega=\pi} - \angle H(\omega)\big|_{\omega=0} = 0$$

With reference to poles and zeros of system function. If all Os of system function lies inside unit circle system is minimum phase system.

2. **Maximum phase system:** — A system is said to be maximum phase if the difference in $\angle$ at $\omega = \pi$ and $\omega = 0$ is $M\pi$. Then system is called to be maximum phase.

$$\angle H(\omega)\big|_{\omega=\pi} - \angle H(\omega)\big|_{\omega=0} = M\pi$$

In other words if all zeros of the Transfer function $H(z)$ lie outside unit circle then it is maximum phase system.

3. **Mixed Phase system:** — If the difference in $\angle H(\omega)$ at $\omega = \pi$ and $\omega = 0$ is not 0 and not $M\pi$. System is mixed phase system. In other words some Os of $h(z)$ lie inside unit circle and some lie outside.

Identify the following system as min, max or mixed phase

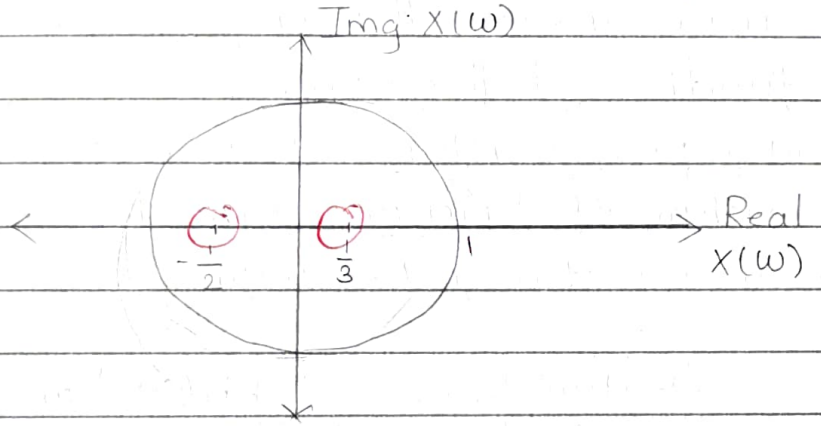
1. $H_1(z) = 6 + z^{-1} - z^{-2}$

$= \frac{6z^2 + z - 1}{z^2} = \frac{z^2 + \frac{1}{6}z - \frac{1}{6}}{z^2}$

$= \frac{(z - \frac{1}{3})(z + \frac{1}{2})}{z^2}$

$= z = \frac{1}{3}, \quad z = -\frac{1}{2}$

As both zeros lie inside the unit circle system is minimum phase system.

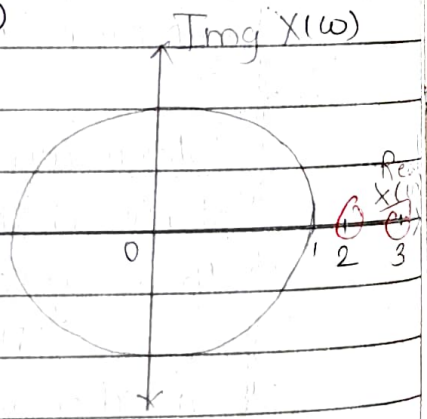


2. $H_2(z) = 1 - z^{-1} - 6z^{-2}$

$= \frac{z^2 - z - 6}{z^2} = \frac{(z-3)(z-2)}{z^2}$

$z = 3, \quad z = 2.$

As both zeros lie outside unit circle system is maximum phase system.

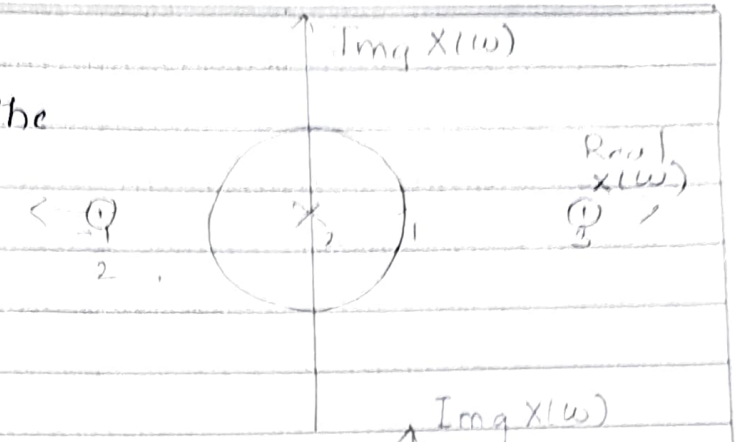


3. $H_3(z) = 1 - \frac{5}{2}z^{-1} - \frac{3}{2}z^{-2}$

$= \frac{z^2 - \frac{5}{2}z - \frac{3}{2}}{z^2} = \frac{(z-3)(z+1/2)}{z^2}$

$= z = 3, \quad z = -1/2$

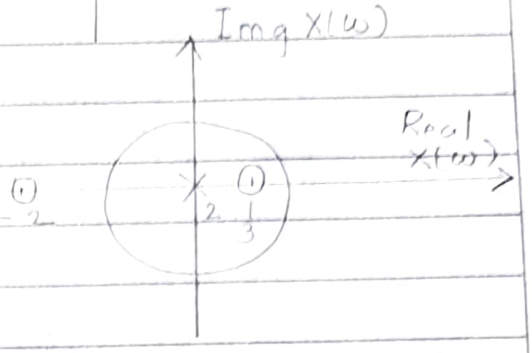
As both the zeros lie outside the unit circle the system is maximum phase system.



4. $H(z) = 1 + \frac{5}{3}z^{-1} - \frac{2}{3}z^{-2}$

$= \frac{z^2 + \frac{5}{3}z - \frac{2}{3}}{z^2}$

$= z = \frac{1}{3}, \quad z = -2$



System A: one zero lies inside and outside the unit circle the system is mixed phase system.

STEPS OF PROGRAM:

step 1: Import numpy, scipy and matplotlib libraries.
step 2: Define function for plot pole zero plot in zplane.
step 3: setting font size to 10.
step 4: Define Transfer Functim H(z)
step 5: Call function of pole zero.
step 6: Def Display zeros, poles and gain of Transfer Function H(z).

CONCLUSION:

In this experiment, we have learned the classification of systems as minimum, maximum and mixed phase system based on locations of zero of system transfer functim. Plotted the pole zero diagram of each system.