Zeros and Poles of Transfer Function

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1. Introduction :-

- Zeros of Transfer Function are the frequencies (values of s) for which the numerator of the transfer function becomes zero.
- Poles of Transfer Function are the frequencies (values of s) for which the denominator of the transfer function becomes zero.

2. Example :

Find the transfer function of the system given by:

$$\frac{d^2}{dt^2}y(t) + 7\frac{d}{dt}y(t) + 12y(t) = \frac{d}{dt}x(t) + 2x(t)$$

where $x(t)$ is the input and $y(t)$ is the output.

Solution: Taking laplace transform both sides:

$$s^2Y(s) - sy(0^-) - y'(0^-) + 7[sY(s) - y(0^-)] + 12Y(s) = sX(s) - x(0^-) + 2X(s)$$

Assuming all initial conditions to be zero:

$$s^2Y(s) + 7sY(s) + 12Y(s) = sX(s) + 2X(s)$$
$$Y(s)[s^2 + 7s + 12] = X(s)[s + 2]$$

$$H(s) = \frac{Y(s)}{X(s)} = \frac{s+2}{s^2+7s+12}$$

$$\boxed{H(s) = \frac{s+2}{(s+3)(s+4)}}$$

* Zeros of TF :-

$$(s+2) = 0$$
$$\boxed{s = -2}$$ → System has only 1 zero which is -2.

* Poles of TF :

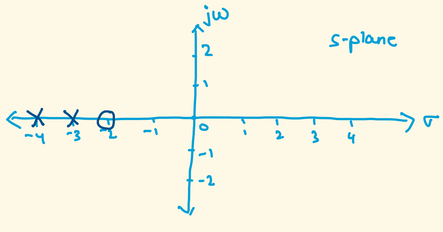
$$(s+3)(s+4) = 0$$
$$\boxed{s = -3, -4}$$ → System has 2 poles which are -3 & -4.

* Pole-Zero Diagram :-

Pole-Zero diagram is the plot on s-plane which represents the locations of poles and zeros of a transfer function.

poles are represented by X

zeros are represented by O



3. General form of Transfer Function:

$$\boxed{T.F. = \frac{(s-z_1)(s-z_2)(s-z_3)\cdots(s-z_n)}{(s-p_1)(s-p_2)(s-p_3)\cdots(s-p_n)}}$$

Zeroes: $s = z_1, z_2, z_3, \cdots, z_n$

Poles: $s = p_1, p_2, p_3, \cdots, p_n$

4. References:

1. Neso Academy

THE END