Experiment No:2 **Date:**

Aim:

Determine magnitude & phase plot of lag network.

Apparatus:

Luans make trainer kit,

Signal generator(0-1mhz)

Dual channel CRO

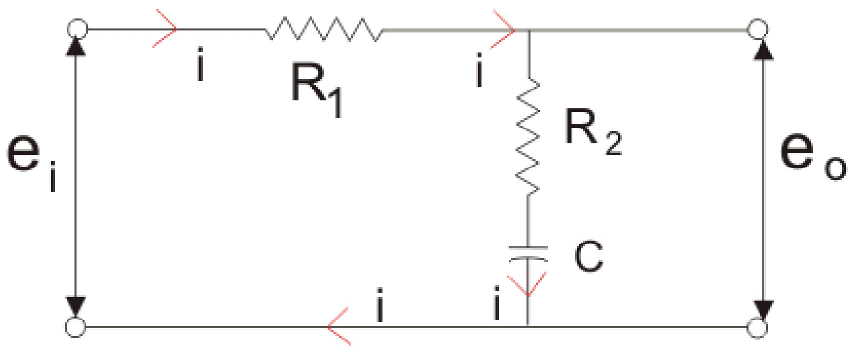
Patch cords, etc.

Theory:

A system which has one zero and one dominating pole (the pole which is closer to origin that all other poles is known as dominating pole) is known as lag network. If we want to add a dominating pole for compensation in control system then, we have to select a **lag compensation** network.

The basic requirement of the phase lag network is that all poles & zeros of the transfer function of the network must lie in (-)ve real axis interlacing each other with a pole located or on the nearest to the origin. Given below is the circuit diagram for the phase **lag compensation** network.

Circuit Diagram:



Circuit Description:

Phase Lag Compensating Network We will have the output at the series combination of the resistor R_2 and the capacitor C. From the above circuit diagram, we get

$$e_i = iR_1 + iR_2 + \frac{1}{C}\int idt$$
$$e_o = iR_2 + \frac{1}{C}\int idt$$

Now let us determine the transfer function for the given network and the transfer function can be determined by finding the ratio of the output voltage to the input voltage.

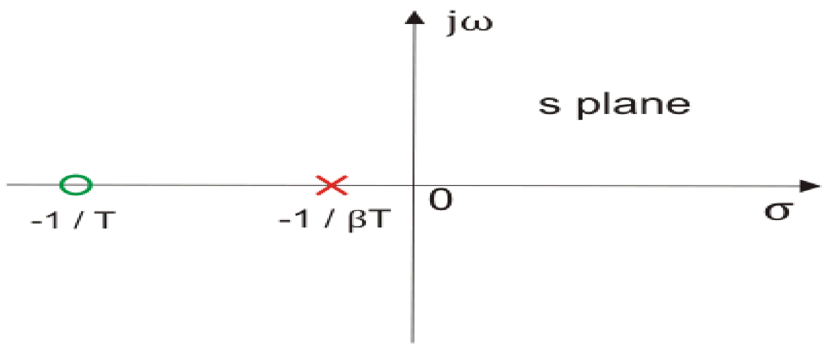
Taking Laplace transform of above two equation we get,

$$E_i(s) = R_1I(s) + R_2I(s) + \frac{1}{Cs}I(s)$$
$$E_o(s) = R_2I(s) + \frac{1}{Cs}I(s)$$
$$Transfer\ function,\ G_{lag}(s) = \frac{E_o(s)}{E_i(s)} = \frac{R_2 + \frac{1}{Cs}}{R_1 + R_2 + \frac{1}{Cs}}$$
$$\Rightarrow G_{lag}(s) = \frac{R_2Cs + 1}{(R_1 + R_2)Cs + 1}$$

On substituting the T = R_2C and β = {(R_2 + R_1) / R_1} in the above equation (where T and β are respectively the time constant and dc gain), we have

$$Transfer\ function,\ G_{lag}(s) = \frac{1 + Ts}{1 + \beta Ts}$$

The above network provides a high frequency gain of 1 / β. Let us draw the pole zero plot for the above transfer function.



Pole Zero Plot of Lag Network Clearly we have -1/T (which is a zero of the transfer function) is far to origin than the -1 / (βT)(which is the pole of the transfer function). Thus we can say in the lag compensator pole is more dominating than the zero and because of this lag network introduces negative phase angle to the system when connected in series.

Effect of Phase Lag Compensation

1. Gain crossover frequency increases.
2. Bandwidth decreases.
3. Phase margin will be increase.
4. Response will be slower before due to decreasing bandwidth, the rise time and the settling time become larger.

Advantages of Phase Lag Compensation

Let us discuss some of the advantages of phase lag compensation -

1. Phase lag network allows low frequencies and high frequencies are attenuated.
2. Due to the presence of phase lag compensation the steady state accuracy increases.

Disadvantages of Phase Lag Compensation

Some of the disadvantages of the phase lag compensation -

1. Due to the presence of phase lag compensation the speed of the system decreases.

<u>Procedure:</u>

1. Connect sine wave signal generator with amplitudes 5Vp-p at 1KHz as positive V_1 input terminal of lag network. Connect channel-1 of CRO at V_1 input while other channel at V_0 output.

2 .Keeping the input amplitude constant & vary the input frequency from 100Hz to 100 KHz & measure the output amplitude. Record your reading in observation table.

3. Measure the phase shift between I/p & O/p by using two channel CRO. Vary the I/p frequency & record the change on phase shift on dbs.

4. Repeat step 1 to 3 for different I/p voltages.

5. Plot the graph between frequency & phase shift & freq. Vs gain.

Observation Table:

Vin =5 V p-p at 1 KHz

Sr.No.	Frequency (Hz)	Vo	Y_1	Y_2	Phase Shift	Gain In (dB)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Calculations:

Result:

Conclusion: