Experiment No:1 **Date:**

Aim:

Determine magnitude & phase plot of lead network..

Apparatus:

Luans make trainer kit,

Signal generator(0-1mhz),

Dual channel CRO

Patch cords, etc.

Theory:

Necessary of Compensation

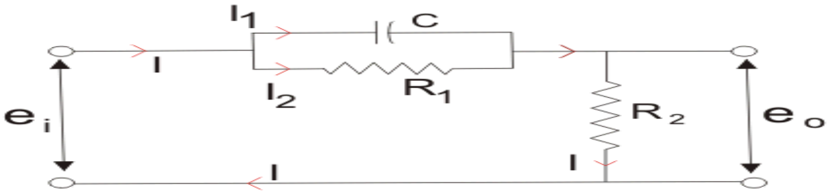
1. In order to obtain the desired performance of the system, we use compensating networks. Compensating networks are applied to the system in the form of feed forward path gain adjustment.
2. Compensate a unstable system to make it stable.
3. A compensating network is used to minimize overshoot.
4. These compensating networks increase the steady state accuracy of the system. An important point to be noted here is that the increase in the steady state accuracy brings instability to the system.
5. Compensating networks also introduces poles and zeros in the system thereby causes changes in the transfer function of the system. Due to this, performance specifications of the system change.

Lead Compensation:

A system which has one pole and one dominating zero (the zero which is closer to the origin than all over zeros is known as dominating zero.) is known as lead network. If we want to add a dominating zero for compensation in control system then we have to select lead compensation network.

The basic requirement of the phase lead network is that all poles and zeros of the transfer function of the network must lie on (-)ve real axis interlacing each other with a zero located at the origin of nearest origin.

Circuit Description:



Phase Lead Compensation Network

From above circuit we get,

$$I_1 = C\frac{d}{dt}(e_i - e_o)$$
$$I_2 = \frac{e_i - e_o}{R_1}$$
$$I = I_1 + I_2 = C\frac{d}{dt}(e_i - e_o) + \frac{e_i - e_o}{R_1}$$
$$Again, I = \frac{e_o}{R_2}$$

Equating above expression of I we get,

$$\frac{e_o}{R_2} = C\frac{d}{dt}(e_i - e_o) + \frac{e_i - e_o}{R_1}$$

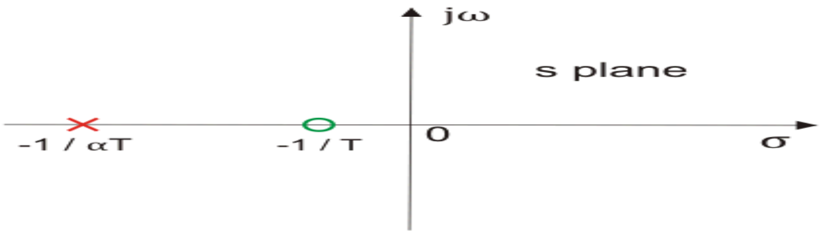
Now let us determine the transfer function for the given network and the transfer function can be determined by finding the ratio of the output voltage to the input voltage. So taking Laplace transform of both side of above equations,

$$\frac{1}{R_2}E_o(s) = \frac{1}{R_1}[E_i(s) - E_o(s)] + Cs[E_i(s) - E_o(s)] \quad (neglecting\ initial\ condition)$$
$$\Rightarrow \frac{1}{R_2}E_o(s) + \frac{1}{R_1}E_o(s) + CsE_o(s) = \frac{E_i(s)}{R_1} + CsE_i(s)$$
$$\Rightarrow \frac{E_o(s)}{E_i(s)} = \frac{\frac{1+sCR_1}{R_1}}{\frac{R_1+R_2+sR_1R_2C}{R_2R_1}}$$
$$\Rightarrow \frac{E_o(s)}{E_i(s)} = \frac{R_2}{R_1 + R_2}\left[\frac{1 + sCR_1}{1 + \frac{sR_1R_2C}{R_1+R_2}}\right]$$

On substituting the $\alpha = (R_1 + R_2)/ R_2$ & $T = \{(R_1R_2) /(R_1 + R_2)\}$ in the above equation. Where T and α are respectively the time constant and attenuation constant, we have

$$Transfer\ function\ ,\ G_{lead}(s) = \frac{E_o(s)}{E_i s} = \frac{1}{\alpha}\left[\frac{1 + \alpha sT}{1 + sT}\right]$$

The above network can be visualized as an amplifier with a gain of 1/α. Let us draw the pole zero
plot for the above transfer function.



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

Procedure:

1) Connect sine wave signal generator with amplitudes 5Vp-p at 1KHz as positive V_1 input terminal of lead 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 1KHz to 1MHz & 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						

Result:

Conclusion: