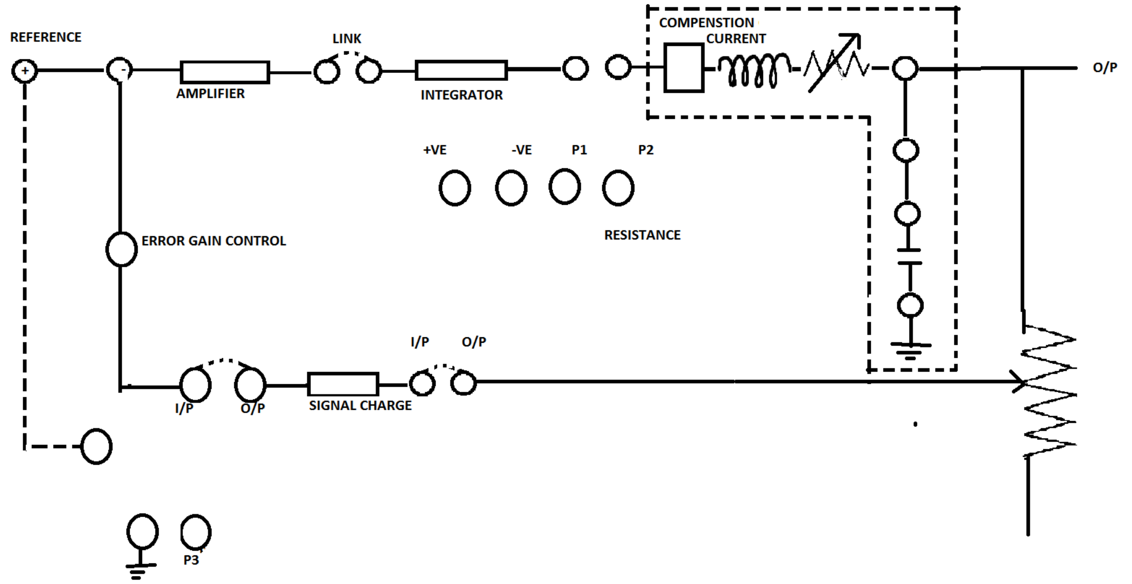
CIRCUIT DIAGRAM:



TIME RESPONSE OF SECOND ORDER SYSTEM

Exp No:01

Date:

TIME RESPONSE OF SECOND ORDER SYSTEM

AIM: To study the time response of closed loop second order system and to correlate the studies of theoretical result

APPARATUS REQUIRED:

1. Linear system simulator

2. Cathode ray oscilloscope

3. Insulated wires

THEORY:

TIME DOMAIN SPECIFICATIONS:

The transient response characteristics of a control system to a unit step input are specified in terms of the following time domain specifications.

1. Delay time (td)

2. Rise time (tr)

3. Peak time (tp)

4. Maximum overshoots (mp)

5. Setting time (ts)

Delay Time (td):- The delay time is the time required for the response to reach 50% of the final value the very first time.

Rise Time (tr):- The rise time is time required for the response to rise from 0 to 100% of the final value for under damped systems and from 10% to 90% of the final value for over damped systems.

Peak Time (tp):- The peak time is the time required for the response to reach the final peak of the overshoot.

Peak Overshoot (mp):- The Peak or Maximum overshoot is the maximum peak value of the response curve measured from unity.

Settling Time (ts):- The settling time is defined as the time taken by the response to reach and stay with in a specified error. It is usually expressed as percentage of final value.

TABULAR FORM:

K	**M_P(V)**		**td(ms)**		**tr(ms)**		**tp(ms)**		**ts(ms)**		ξ	**ω_n(rad/sec)**
	Theoritical	Practical	Theoritical	Practical	Theoritical	Practical	Theoritical	Practical	Theoritical	Practical		

PROCEDURE:

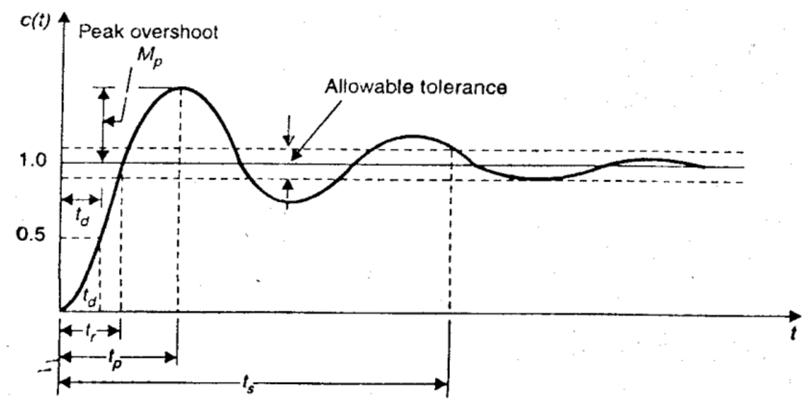
1. Patch the connections in front panel as shown in figure.
2. Switch ON the supply to the unit.
3. Square wave of amplitude V_{PP} is given as step input to the system at low frequency.
4. Adjust the value of proportional band such that there is a sustained oscillation for each step input.
5. At this instant note down the values of t_d ,t_r ,t_p, t_s,M_p.for different gain values
6. Draw the response of the system on graph.

Derivation:

Theoretical Calculation:

Formulaes to be listed

MODEL GRAPH:



PRECAUTIONS:

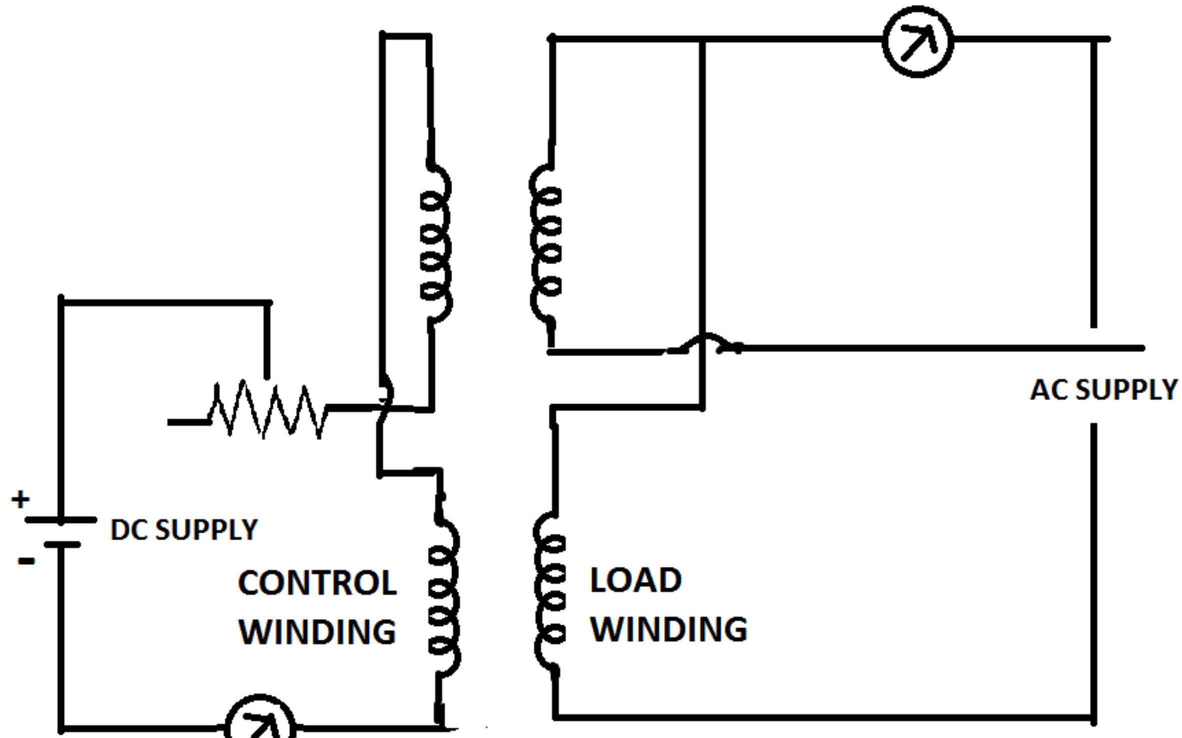
1. Avoid loose connections
2. Note the readings without parallax error

RESULT:

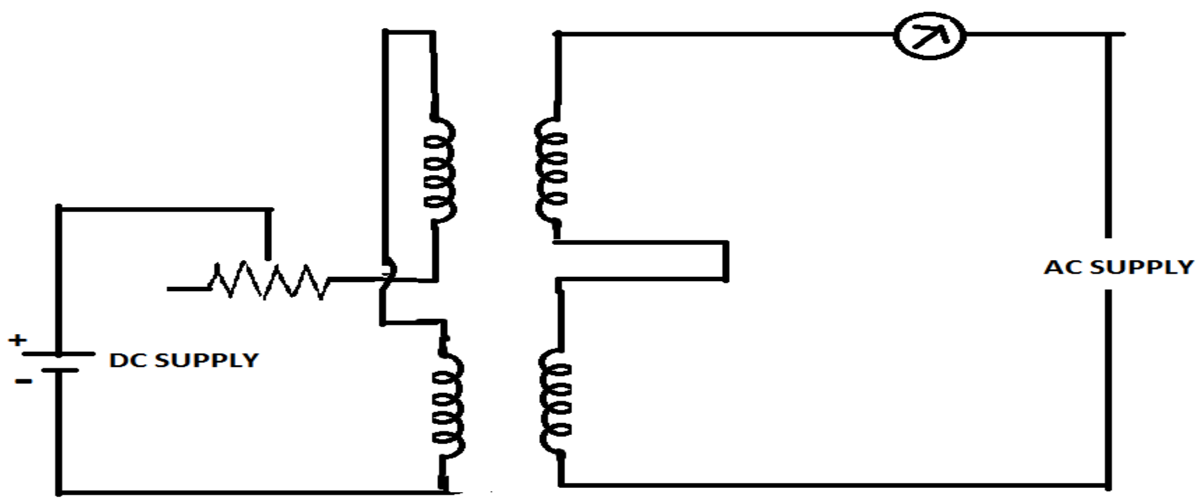
VIVA QUESTIONS:

1. What is time response?
2. What is transient and steady state response?
3. What is Importance of test signals?
4. Name the test signals used in the control systems?
5. Define step signal?
6. Define ramp signal?
7. Define parabolic signal?
8. What is the order of a system?
9. List the time domain specifications?
10. Define delay time, rise time, peak time, peak over shoot, settling time?

CIRCUIT DIAGRAM:



PARALLEL MAGNETIC AMPLIFIER



SERIES MAGNETIC AMPLIFIER

Exp.No:02

Date:

CHARACTERISTICS OF A MAGNETIC AMPLIFIER

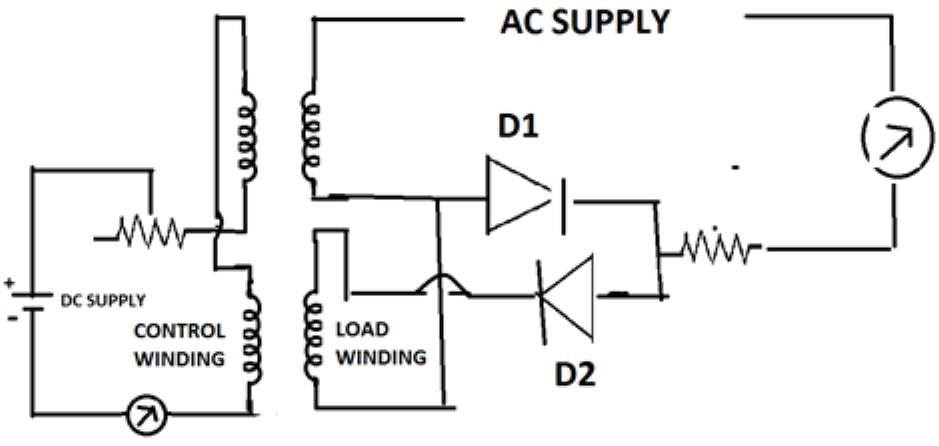
AIM: To plot the characteristics of series, parallel and self started magnetic amplifier

APPARATUS:

1. Magnetic amplifier
2. Low incandescent lamp
3.230V A.C supply
4.Ammeters (0- 500) Ma

THEORY: Refer text book by the student.

SELF SATURATED



TABULAR FORMS:

1)SERIES:-

SNO	Control current (Ic) mA	Load current (IL)mA

2)PARALLEL:-

SNO	Control current (Ic) mA	Load current (IL)mA

PROCEDURE:

Series:

1. Keep toggle switch in position D on from panel

2. Keep control current setting knob at its extreme left position, whichensures zero control current.

3. With the help of patch cords connect the fallowing terminals.

   i. Connect AC to A1

   ii. Connect B1 to A2

   iii. Connect B2 to L

4. Now put 100W lamp in its provided position

5. Now once again check connections

6. Switch on the unit

7. Now by increasing the control current gradually note down the corresponding control current

8. Plot the graph between load current Vs control current

Parallel:

1. Keep toggle switch in position D On from panel

2. Keep control current setting knob at its extreme left position..

3. With the help of patch cords connect the fallowing terminals.

   1. Connect A1 to AC

   2. Connect A1 to A2

   3. Connect B2 to L

   4. Connect B2 to B1

4. Now put 100W lamp in its provided position.

5. Now once again check connections

6. Switch on the unit

7. Now by varying the load current note down the corresponding control current

8. Plot the graph between control current Vs load current.

Self saturated:

1. Keep toggle switch in position E on from panel

2. Keep control current setting knob at its extreme left position.

3. With the help of patch cords connect the following terminals.

    1. Connect AC to C1

    2. Connect A3 to B3

    3. Connect B3 to L

4. Now put 100W lamp in its provided position.

5. Now once again check connections.

6. Switch on the unit

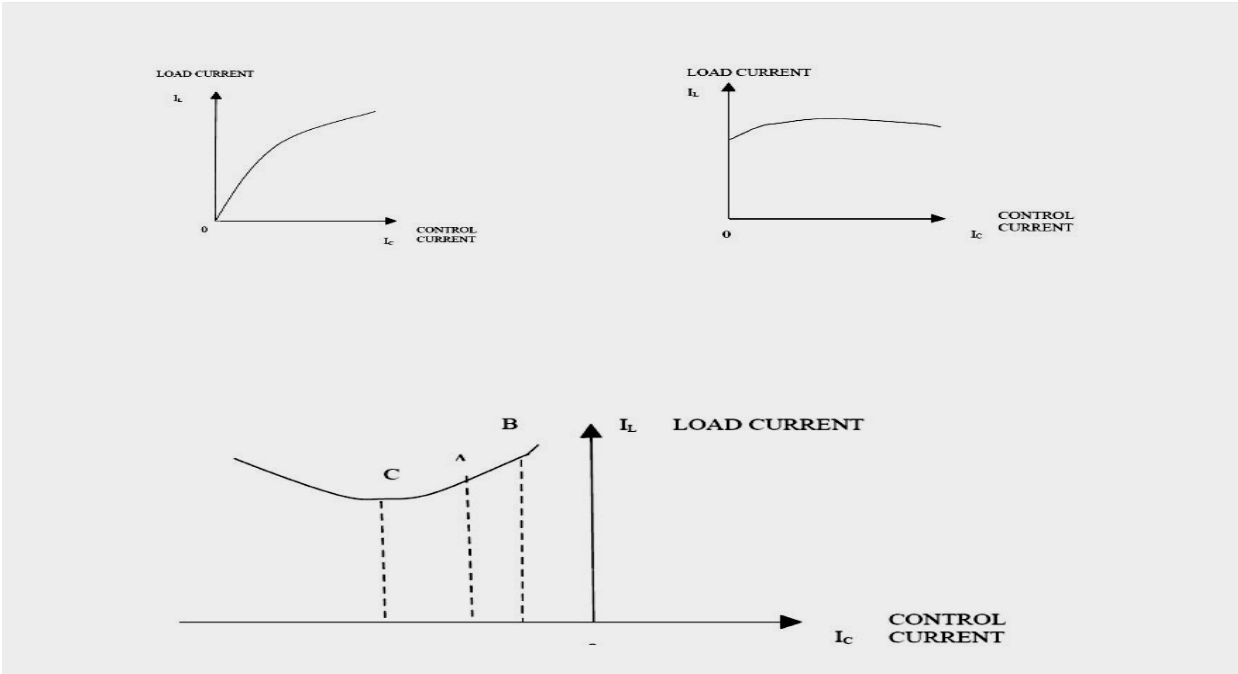
7. Now by varying the control current seating knob and note down the Corresponding load current.

8. Plot the graph between load current Vs control current.

3.Self-magnetic:

SNO	Control current (Ic) mA	Load current (IL)mA

MODEL GRAPHS:



PRECAUTIONS:

1. Position of toggle switch is to be checked before switching the unit.
2. Control current knob is to be in minimum position before switching the unit.

RESULT:

VIVA QUESTIONS:

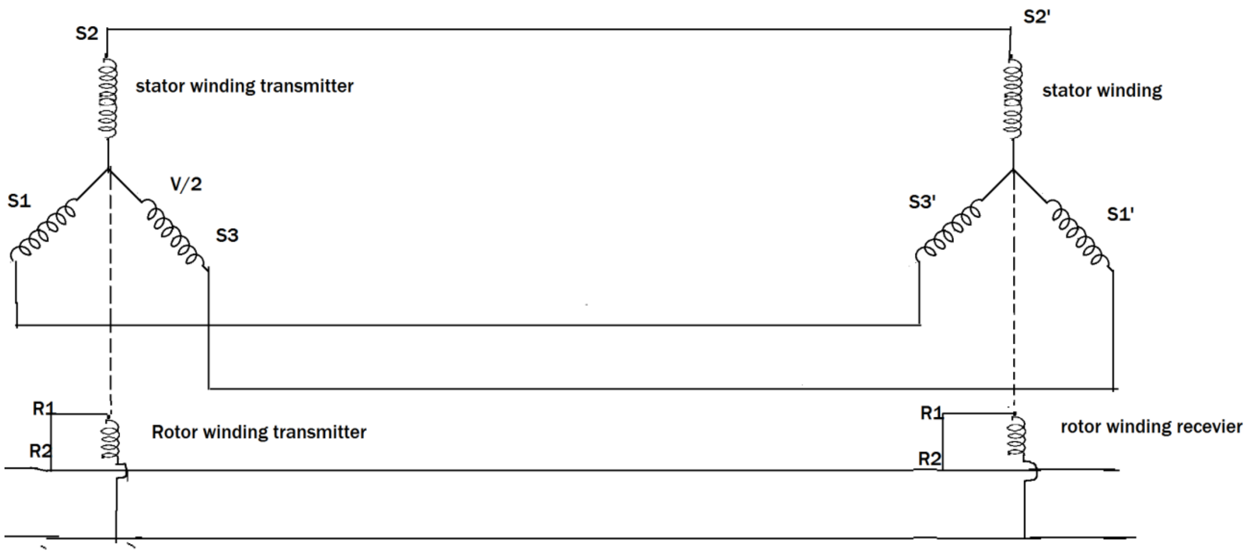
1. Explain the operation of Series magnetic amplifier?

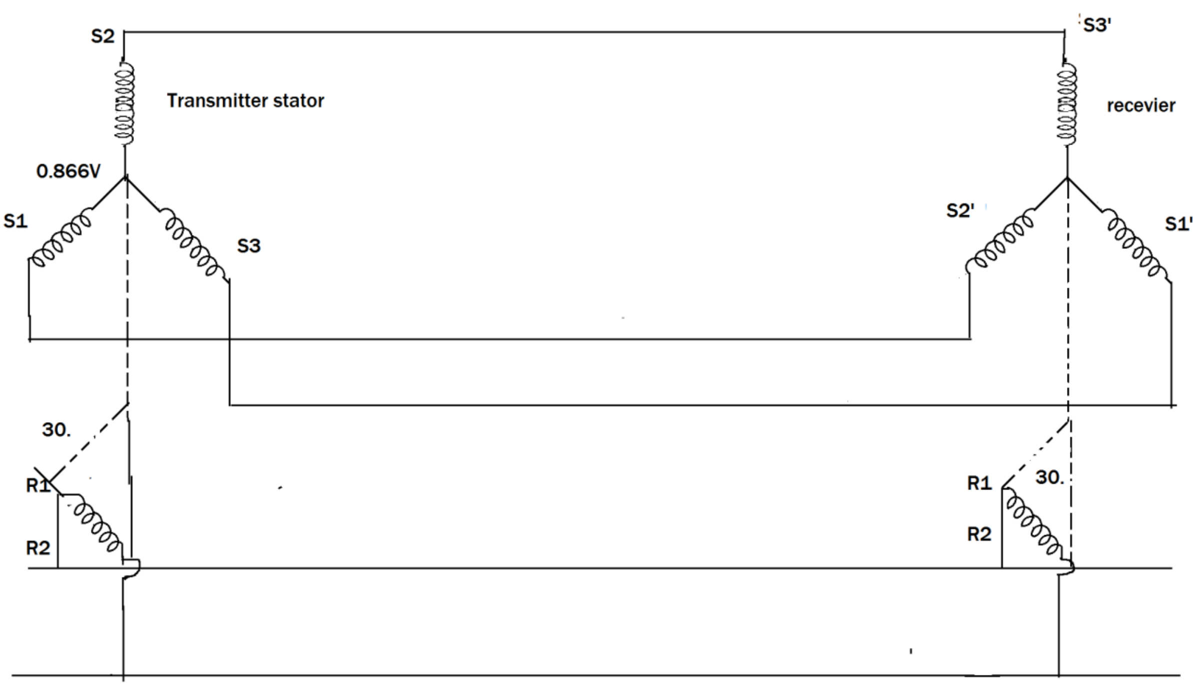
2. Explain the operation of Parallel magnetic amplifier?

3. Explain the operation of Self Saturated magnetic amplifier?

4. Give applications of Magnetic Amplifier?

CIRCUIT DIAGRAM:





SYNCHROS TRANSMITTER AND RECEIVER

Exp.No:03

Date:

CHARACTERSTICS OF SYNCHROS

AIM: To study the characteristics of synchros as transmitter and synchro transmitter- receiver pair.

APPARATUS:

1. Synchro's pair unit
2. Multimeter.
3. Patch cords.

THEORY: Refer text book by the student.

PROCEDURE:

TRANSMITTER:

1. Connect the main supply cables. Connect s_1,s_2&s_3 of synchro receiver by patch cards provided respectively

2. Switch on main supply.

3. Starting from zero position, note down the voltages between stator winding terminals V_{S1S2}, VS2S3&V_{S3S1} in tabular form by rotating angular position of Transmitter and plot graph.

RECEIVER

1. Connect the main supply cables

2. Connect s_1, s_2&s_3 of synchro receiver by patch cards provided respectively

3. Switch on sw_1, sw2 and switch on main supply.

4. Move the pointer i.e is rotor position of synchro transmitter Tx is step of 30deg and observe the new rotor position observe that Tr rotor is rotated, the Tr motor follows it with the direction of rotation &their position are in good arrangement.

5. Enter the i/p signal angular position & adjustment o/p position in tabular form and plot graph.

TABULAR FORMS:

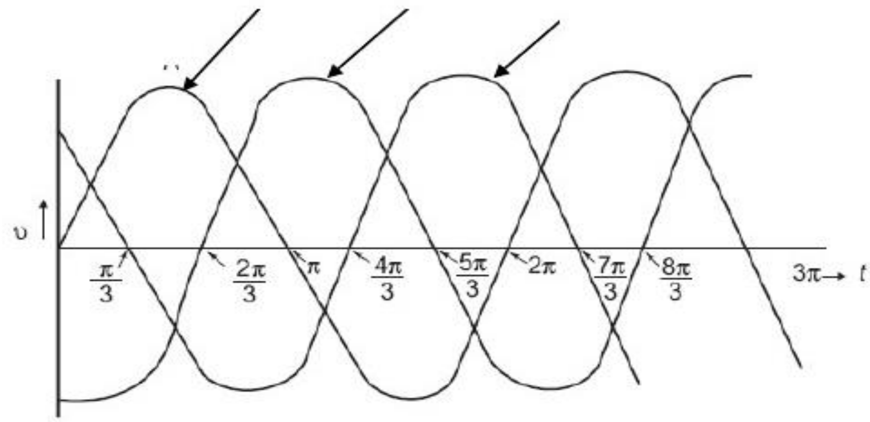
TRANSIMITTER:

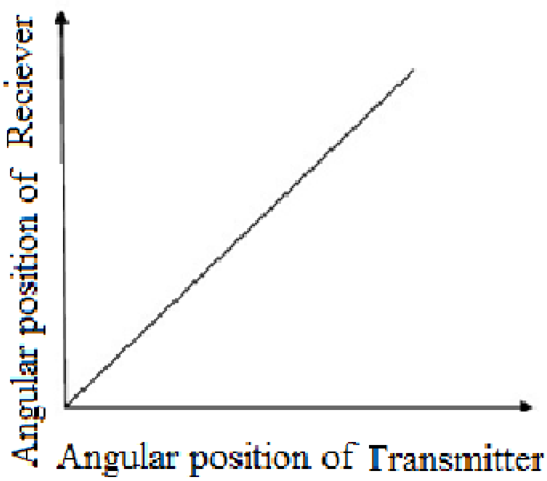
S.No	Position of Rotor	STATOR TERMINAL VOLTAGE		
		V_{S1S2}(V)	V_{S1S3}(V)	V_{S2VS3}(V)

RECEIVER:

S.No	Angular position of Transmitter	Angular position of Receiver

MODEL GRAPH:





PRECAUTIONS:

1. Handle the pointer for both rotors in gentle manner.

2. Don't attempt to pull out the pointer.

3. Don't short rotor or stator terminals.

RESULT:

VIVA QUATIONS:

1. Define synchros?

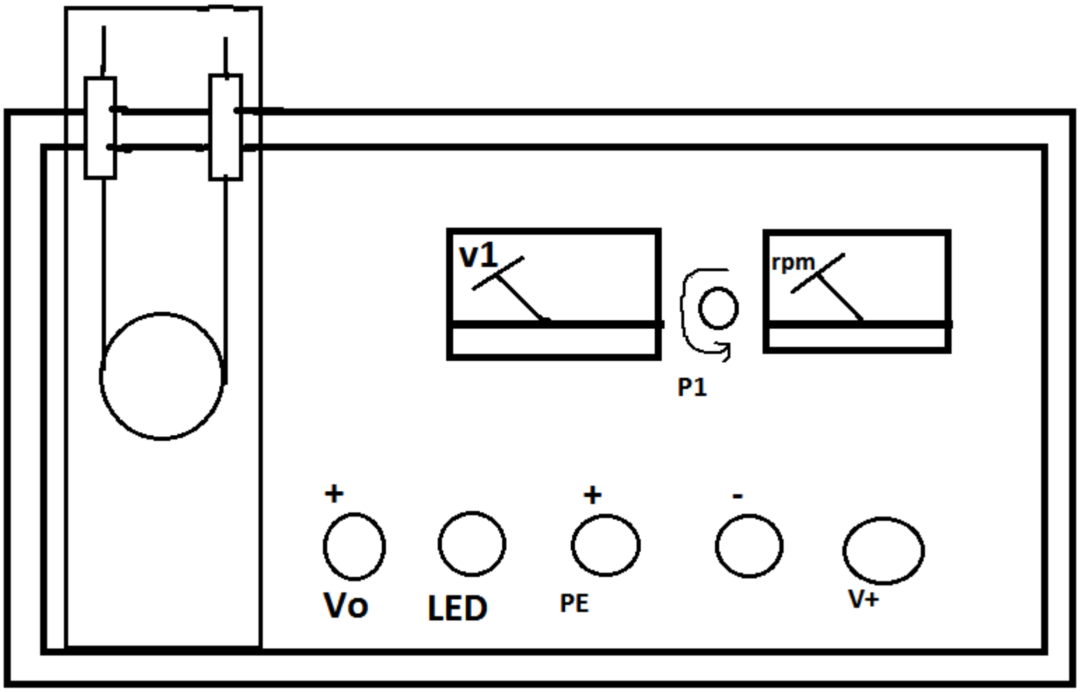
2. What do you understood by this experiment?

3. Write principal how angular position is converted to voltage?

4. Write the applications of synchro transmitter?

5. Write the applications of synchro receiver?

CIRCUIT DIAGRAM:



CHARACTERISTICS OF DCSERVO MOTOR

Exp No:04

Date :

EFFECT OF FEEDBACK ON DC SERVO MOTOR

AIM: To study the characteristics of dc servo motor

APPARATUS:

1. DC Servo motor kit
2. Patch cards
3. Multimeter
4. Connecting wires.

THEORY: Refer text book by the student.

TABULAR FORMS:

Radius of Pulley R =0.017m

Keeping Field Voltage Constant

S.NO	Field voltage v_f =			Armature voltage v_a=		
	T_1(gm)	T_2(gm)	$t = T_1 - T_2$	T= t*R	N(rpm)	I_a(A)

S.NO	Field voltage v_f =			Armature voltage v_a=		
	T_1(gm)	T_2(gm)	$t = T_1 - T_2$	T= t*R	N(rpm)	I_a(A)

S.NO	Field voltage v_f =			Armature voltage v_a=		
	T_1(gm)	T_2(gm)	$t = T_1 - T_2$	$T = t*R$	N(rpm)	I_a(A)

Keeping Armature Voltage Constant

S.NO	Field voltage v_f =			Armature voltage v_a=		
	T_1(gm)	T_2(gm)	$t = T_1 - T_2$	$T = t*R$	N(rpm)	I_a(A)

S.NO	Field voltage v_f =			Armature voltage v_a=		
	T_1(gm)	T_2(gm)	$t = T_1 - T_2$	$T = t*R$	N(rpm)	I_a(A)

S.NO	Field voltage v_f =			Armature voltage v_a=		
	T_1(gm)	T_2(gm)	$t = T_1 - T_2$	$T = t*R$	N(rpm)	I_a(A)

PROCEDURE:

Armature Control:

1. Adjust spring balance so that there is minimum load on the servo motor. Note that you have to pull the knob k1 in the upward direction to apply load on the servo motor. You may make use of holes to apply a fixed load on the system by using a locking screw.

2. Ensure the pot P_1 (Speed control) is in Max. anti-clockwise position .switch on the supply and slightly press the control knob in anticlockwise direction so that soft start relay is turned on and armature voltage is applied to the armature from zero onwards.

3. Connect a digital or analog multimeter across the terminals marked armature to measure armature voltage in the range 0-35 volts.

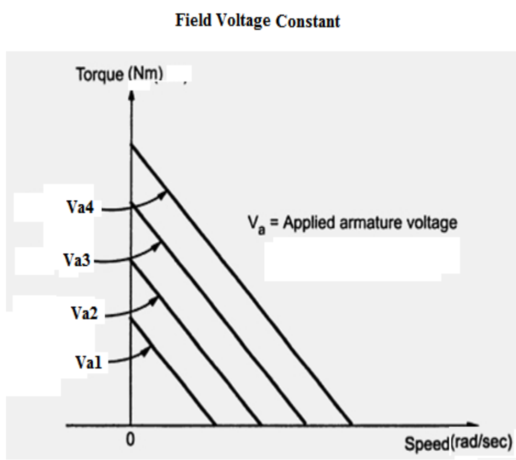
4. Armature controlis varied by fixing values of field voltage to a desired value.

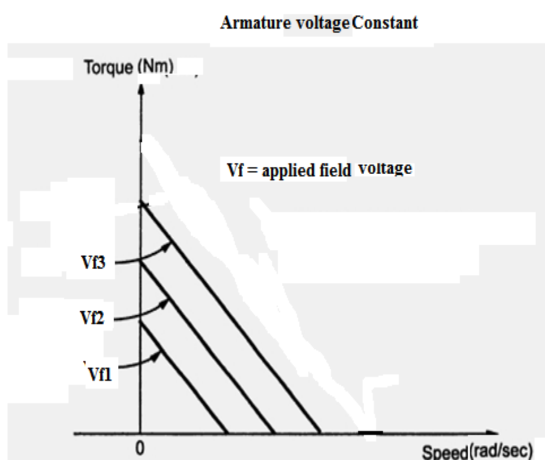
5. Note down the values of t_1, t_2, armature current (I_a) and speed.

Field Control:

1. Adjust spring balance so that there is minimum load on the servo motor. Note that you have to pull the knob k1 in the upward direction to apply load on the servo motor. You may make use of holes to apply a fixed load on the system by using a locking screw.
2. Ensure the pot P_1 (Speed control) is in Max. Anti-clockwise position .switch on the supply and slightly press the control knob in anticlockwise direction so that soft start relay is turned on and armature voltage is applied to the armature from zero onwards.
3. Connect a digital or analog multimeter across the terminals marked armature to measure armature voltage in the range 0-35 volts.
4. Field is varied by fixing values of Armature voltage to a desired value.
5. Note down the values of t_1, t_2, armature current (I_f) and speed.

MODEL GRAPH:





MODEL CALCULATIONS:

Torque = t x R N-m

Where $t = T_1 - T_2$ (T_1, T_2 load in gm)

PRECAUTIONS:

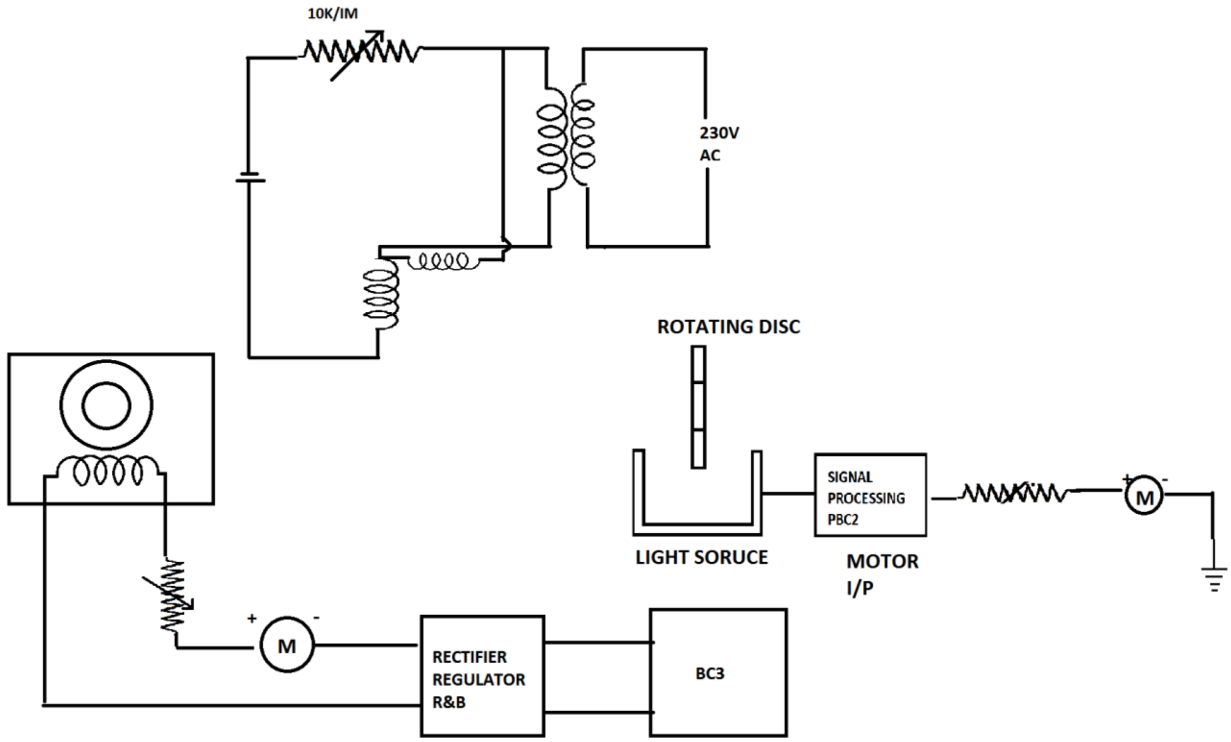
1. The speed control knob should be always in the most anticlockwise position before switching on the equipment.
2. In order to increase the armature voltage, rotate the knob in the clockwise direction in a gentle fashion.
3. In order to increase the load on the servo motor, adjust the spring balance in a careful fashion.

RESULT:

VIVA QUESTIONS:

1. Explain the mechanism of DC Servomotor?
2. Difference between Dc Motor and DC Servomotor in Construction Wise?
3. Applications of Servo Motors?
4. Give the relation between Torque and speed in DC Servomotor?

CIRCUIT DIAGRAM:



EFFECT OF FEEDBACK ON AC SERVO MOTOR

Exp No:05

Date:

EFFECT OF FEEDBACK ON AC SERVO MOTOR

AIM: To determine speed-torque characteristics of a ac servo motor

APPARATUS REQUIRED:

1. Ac servo motor kit
2. Patch cards
3. Multimeter

THEORY: Refer text book by the student.

TABULAR FORMS:

No Load

S.No	Speed(rpm)	E_b(volts)

On Load

v_c = **v_r =**

S.No	Speed(rpm)	I_aA)	E_b(mv)	Power(mw)	Torque(gm-cm)

v_c = **v_r =**

S.No	Speed(rpm)	I_a(A)	E_b(mv)	Power(mw)	Torque(gm-cm)

v_c = **v_r =**

S.No	Speed(rpm)	I_a(A)	E_b(mv)	Power(mw)	Torque(gm-cm)

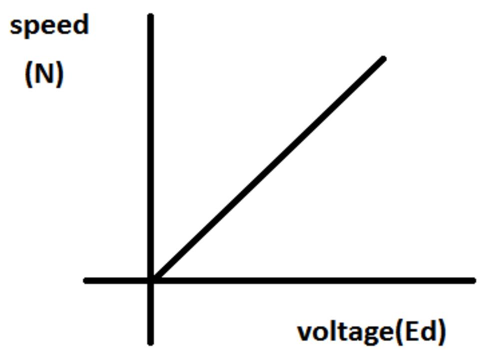
MODEL CALCULATIONS:

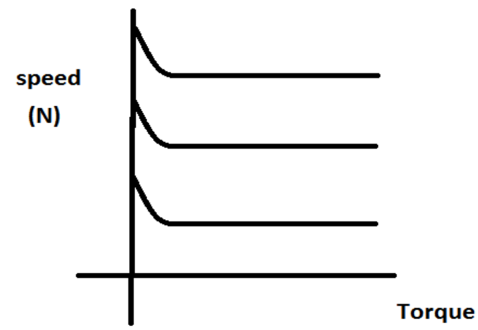
V_c= N=

I_a= E_b=

$$\text{Torque}(t) = \frac{p*1.019*10^4*60}{2\pi N} \text{ gm-cm}$$

MODEL GRAPHS:





PROCEDURE:

1. Keep the switch sw_3 in upward position i.e., load current is in off state and switch sw_2should also be in off state
2. Move p_1 and p_2 are in fully anticlockwise direction
3. Switch on the sw_2 and the speed of the ac servo motor will be indicated by the motor(m) on the rpm meter of front panel
4. With switch sw_3 in off position, vary the p_2 knob of ac servo motor by moving in anticlockwise direction and note down the emf generated by the d.c machine
5. Switch off the sw_3 switch, switch on sw_2 and keep knob in minimum position .measure the reference winding voltage and control winding voltage. note the speed of ac servo motor on switching on the switch sw_3 and start loading ac servo motor by knob p_2 in slow passion . Note down the values of speed and armature current.
6. Change the control winding voltage to a new value of 30v after switch off sw_2
7. Repeat the procedure for different voltage values
8. Plot the speed torque characteristics for various values of control winding voltage.

PRECAUTIONS:

1. Before switch on, p_1 and p_2 should be always brought to most anticlockwise direction.
2. Controls p_1 and p_2 should be operated in a gentle fashion.

RESULT:

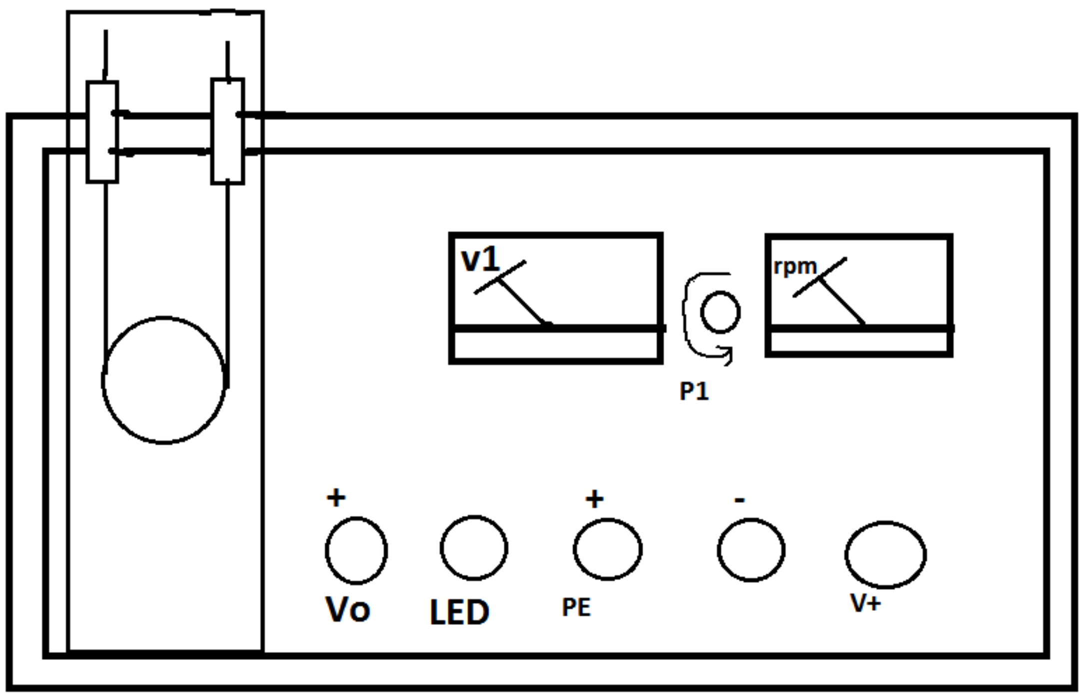
VIVA QUESTIONS:.

1. Explain the mechanism of AC Servomotor?

2. Applications of Servo Motors?

3. Explain the concept of Back EMF?

CIRCUIT DIAGRAM:



TRANSFER FUNCTION OF ARMATURE CONTROLLED DC MOTOR

Exp.No:06

Date:

TRANSFER FUNCTION OF ARMATURE CONTROLLED DC MOTOR

AIM: To determine the transfer function of armature controlled DC motor

APPARATUS:

1. DC servo motor kit

2. Multi meter

3 .Patch cards

THEORY: Refer text book by the student.

TABULAR FORM:

S.No	S_1	S_2	Armature voltage (V_a)	Field voltage (V_f)	Armature current (I_a)	Speed (N) in r.p.m
1.						
2.						
3.						

PROCEDURE:

1. Adjust spring balance so that there is minimum load on the servo motor. Note that you have to pull the knob K_1 in the upward direction to apply load on the servo motor. You may make us of holes to apply a fixed load on the system by using a lacking screw.

2. Ensure the pot P_1 (speed control) is in max antilock wise position switch on the supply. And slightly press the control knob in anticlockwise direction. So that soft start relay is turned on and armature voltage is applied to the armature from zero onwards.

3. Connect a digital or analog multimeter across the terminals marked armature to measure voltage in the range________volts.

4. Armature control:Armature voltage is varied by fixing value of field voltage to a derived value

5. Adjust the armature controlled potentiometer such that V_a =_______volts and fixing controlled potentiometer at V_f = _____volts.

6. Field control:Field voltage is varied by fixing value of armature to ade value.

7. Adjust the armature controlled potentiometer such that V_a =_______volts and fixing controlled potentiometer at V_f = _____volts.

TRANSFER FUNCTION OF ARMATURE CONTROLLED DC MOTOR:

$J.d^2\Theta/dt^2 + B.d\Theta/dt = T$ ___________

Back E.m.f of dc motor is proportional to speed of shaft i.e;

$e_b \,\alpha\, d\Theta/dt \;;\; e_b = k_b.\, d\Theta/dt$

On taking the Laplace transform for the above equations we get,

$I_a(s) R_a + L_a s I_a(s) + E_b(s) = V_a(s)$ _____________

$T(s) = k_t I_a(s)$ _________________________

$Js^2\Theta(s) + Bs\Theta(s) = T(s)$ ______________________

$E_b(s) = k_b s\Theta(s)$ ___________________

On equating and equations

$k_t I_a(s) = Js^2\Theta(s) + Bs\Theta(s)$

$k_t I_a(s) = \Theta(s)\,[Js^2 + Bs]$

$I_a(s) = \dfrac{\Theta(s)\,[Js^2 + Bs]}{k_t}$ __________________

Substitute equation in equation

$$\frac{\Theta(s)\,[Js^2 + Bs]}{k_t} R_a + L_a(s)\frac{\Theta(s)\,[Js^2 + Bs]}{k_t} + E_b(s) = V_a(s)$$ _________

Substitute Ebvalue in equation

$$\frac{\Theta(s)\,[Js^2 + Bs]}{k_t} R_a + L_a(s)\frac{\Theta(s)\,[Js^2 + Bs]}{k_t} + k_b s\Theta(s) = V_a(s)$$ _________

$Js^2 + Bs$ $k_b s$

$$\Theta(s)\ \frac{\quad}{k_t}\ (R_a + L_a s) + \frac{\quad}{k_t} = V_a(s)$$

$$\frac{\Theta(s)}{V_a(s)} = \frac{k_t}{(Js^2 + Bs)(R_a + L_a s) + (k_b.k_t.s)}$$

$$\frac{\Theta(s)}{V_a(s)} = \frac{k_t}{Bs\,[Ts^2/Bs + 1]R_a + L_a s] + [k_b.k_t.s]}$$

$$\frac{\Theta(s)}{V_a(s)} = \frac{k_t}{s(1=s\ m)}$$

Calculation :

RESULT:

VIVA QUESTIONS:

1.Explain the mechanism of DC Servomotor?

2.Difference between Dc Motor and DC Servomotor in Construction Wise?

3. Applications of Servo Motors?

4. Give the relation between Torque and speed in DC Servomotor?

5. Define Transfer Function?

6. Differences between Open loop & Closed Loop Systems?

CIRCUIT DIAGRAM:

Exp.No:07

Date:

STUDY OF LEAD-LAG COMPENSATION NETWORKS

AIM: To determine and study the performance of lead lag compensation networks

APPARATUS:

1. Resistors -10kohm- (2)

2. Capacitors -0.1uf - (2)

3. Function generator, CRO

THEORY: Refer text book by the student.

Derivation

TABULAR FORM:

S.No	Frequency	V_0/V_i		Phase Angle	
		Theoretical	Practical	Theoretical	Practical

S.No	Frequency	V_0/V_i		Phase Angle	
		Theoretical	Practical	Theoretical	Practical

S.No	**Frequency**	**V_0/V_i**		**Phase Angle**	
		Theoretical	**Practical**	**Theoretical**	**Practical**

PROCEDURE:

Study of simple phase lag network

1. Make the connections as shown in fig.

2. Select the components R=10kohm,C=0.1uf .Connect these components so as to rig up phase lag circuit.

3. Switch on the supply

4. Check calibration of phase angle meter by throwing sw2 in CAL position. If meter does not indicate 180, adjust the CAL potentiometer & get 180degrees direction.

5. Keep sw3 in LAG position.

6. Adjust the input excitation to 3volts R.M.S.

7. Now change the audio oscillator output frequency in the range of 20Hz to 100Hz and enter the

result in table1 below.

8. Calculate the theoretical value of modulus of T (jw) and θ from the formula given below.

9. Plot the graphs of modulus of T (jw) and θ against frequency. Find out corner frequency.

10. Connect the resistance of 10kohms or 1kohms across the output terminals ofthe lag network. You may again repeat the experiment .Because of the loading effect; the characteristics of network are drastically affected.

Study of simple phase lead network

1. Make the connections as shown in figure.

2. Select the components R=10K,C=0.1mfd.connect these components so as to rig up phase lead circuit.

3. Switch on the supply

4. Check calibration of phase angle meter by throwing sw2 in CAL position. If meterdoes not indicate 180, adjust CAL potentiometer &get 180 degree indication.

5. Keep the sw3 in lead position. Repeat steps as in except 1, you may connect a load of 1k or 10k across the network and observe the effect of the load on the frequency response and changein phase shift pattern You may perform the experiment for some other combinations of B and C, but the excitation frequency must be in the range of 20Hz to 1000Hz.

Study of simple phaselead –lag network

1. The LEAD-LAG compensator is a combination of lag compensator of lead compensator.

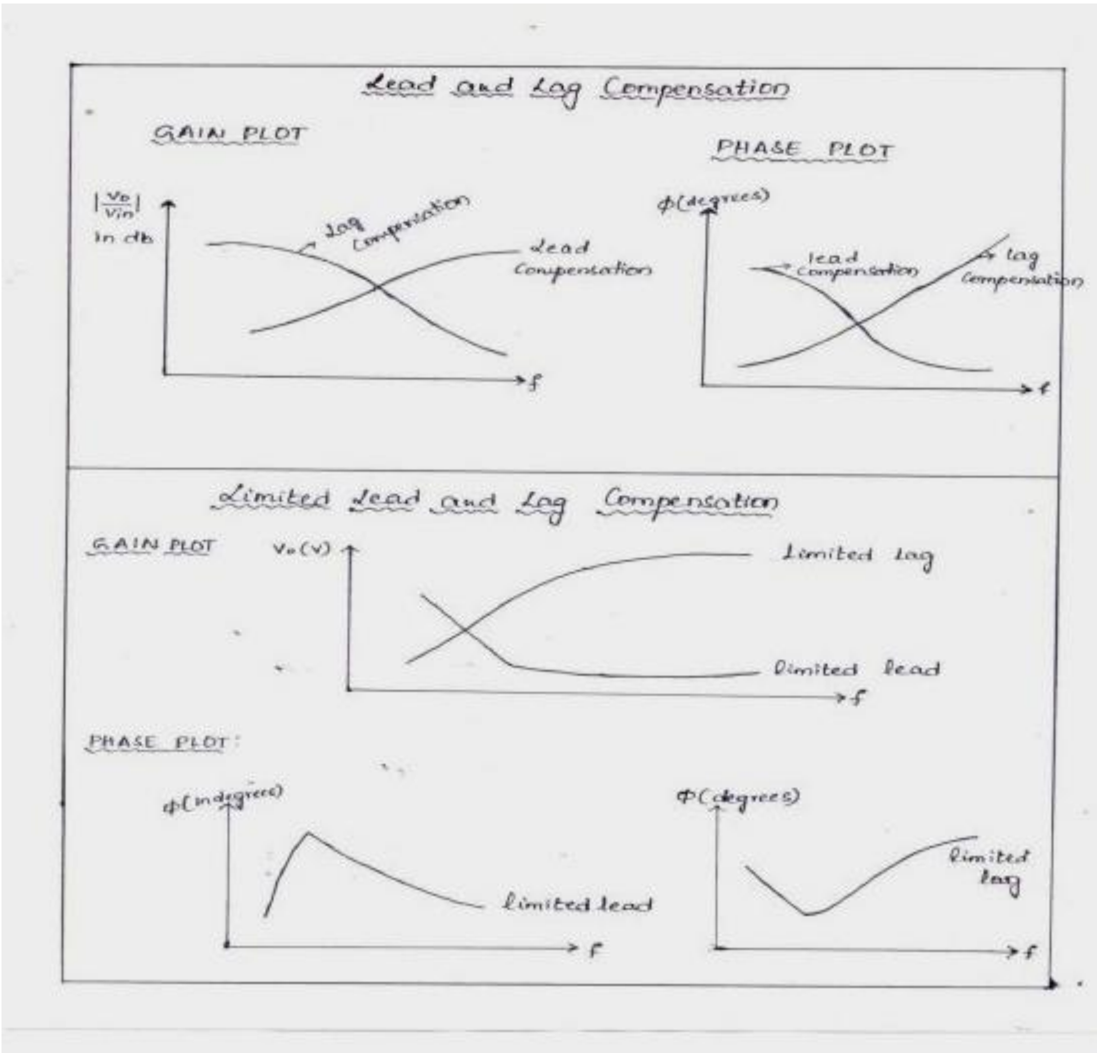
2. Make the connections as shown in figure.

3. Select components R1=R2=10K, C1=C2=0.2mfd & rig up thr lag lead compensator. Repeat the steps

4. You may have to change sw3 from lag to lead as you sweep through the frequency range

when meter goes off the scale then you have to effect the changeover the lead lag switch(sw3).

MODEL GRAPHS:



RESULT:

VIVA QUESTIONS:

1. what is compensation.

2. what is the use of compensation.

3 what is mean lag compensation.

4 what is mean lead compensation

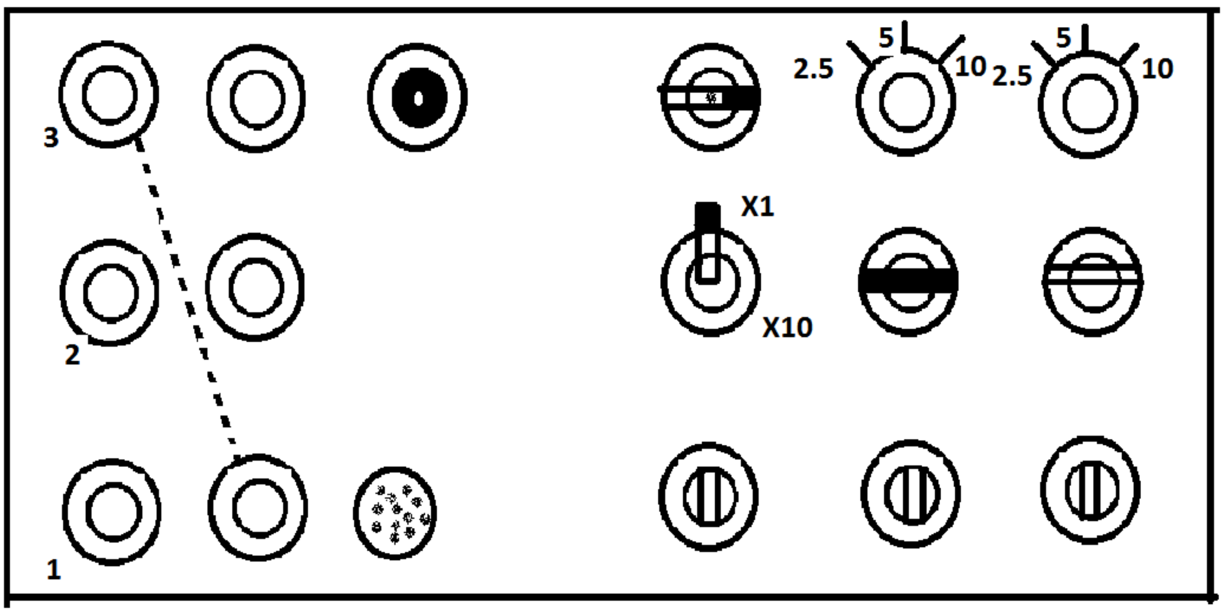
5 what is mean lag-lead compensation

6 what is mean limited lag compensation

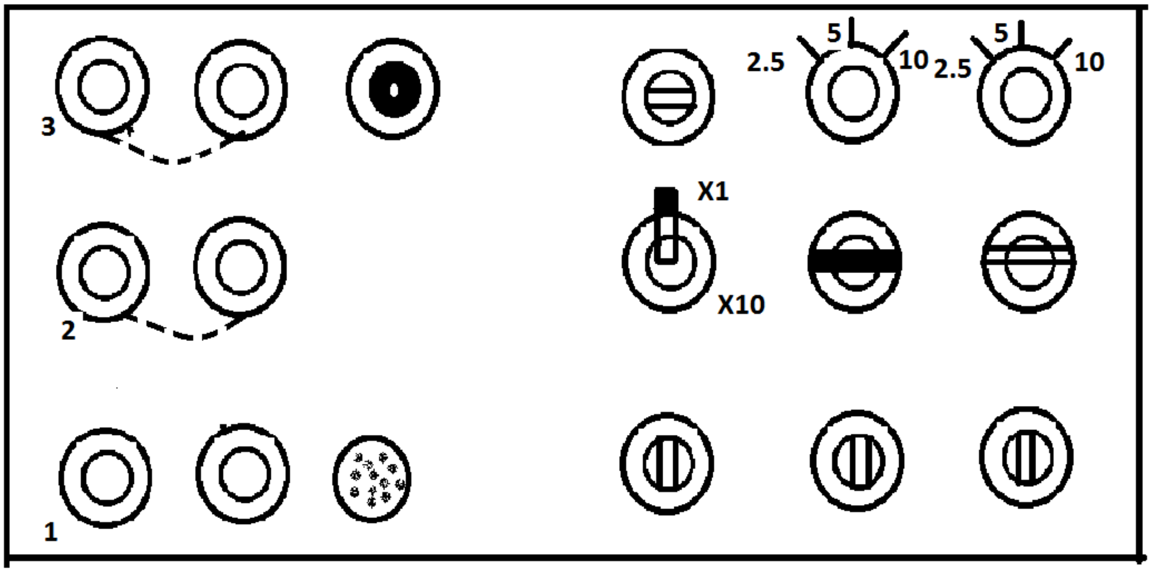
7. what is mean limited lead compensation

CIRCUIT DIAGRAM:

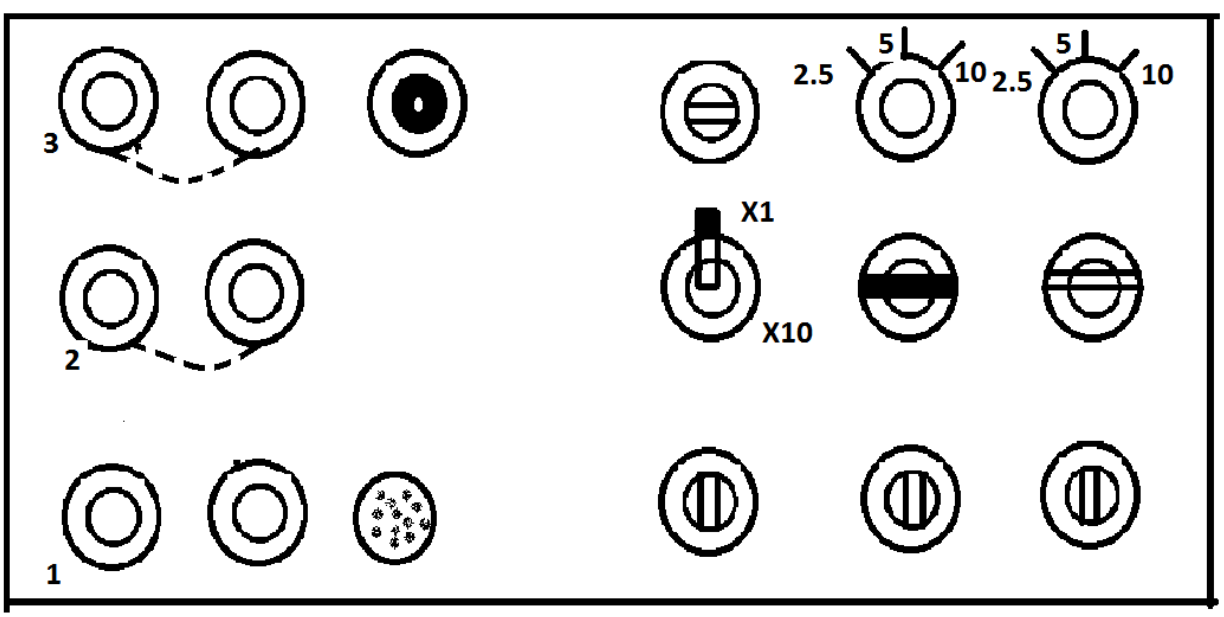
P CONTROLLER



PID COTROLLER



PD CONTROLLER



Exp.No:08

Date:

EFFECT OF PID CONTROLLERS IN A TEMPERATURE CONTROLLER

AIM: To study the Temperature controller using PID.

APPARATUS: PID controller unit, plant patch cards.

THEORY: Refer text book by the student.

Experiment No-1:

Aim: To study the phenomenon of set for proportional controller when the load theprocess is varied.

PROCEDURE:

1. Establish the connection between the conditioning unit and the modelprocess with the help of cables provided.

2. connect red-3 and black- 1 with the help of patch card.

3. Set the “SET” potentiometer at the position of 20 Ohm corresponding to degree centigrade of temperature.

4. Set proportional band control to 10% i.e KL =10.

5. Now turn ON the power supply and also turn ON the fan. Place the fanregulator at low position.

6. Wait until the deviation indicator stabilizes at some point. Record thedeviation and readings and percentage of power reading at interval of 15seconds.

7. Now suddenly increase the fan speed to full level by moving fan control tohigh position.

8. Now note the deviation meter reading when the pointer stabilizes. Recordthe deviation and meter readings. The differences between the two readingsi.e steps 6 is the off set,(steady state error) associated with the proportional control.

9. Now you may increase the gain to 100i.e proportional band to that andrepeat the steps 5-8 In this expt. You will observe that the offset error isreduced.

10. You may perform experiments with various gain settings.

INTEGRAL CONTROL:

1. Integral I action is a made of control action in which the value of the manipulated variable is changed at a rate proportional to the deviation. Thus if the deviation is doubled over a previous value, the final control element is moved twice as fast.

2. The integral action adjustment is the integral time. For a step change ofdeviation, the integral time is the time required to add and increment, theresponse equal to the original step change of response. Integral action is usedalone very seldom.

3. Integral action is generally used in association with proportional actionas a result of integral action the action the offset error is almost reduced to zero,but the transient is adversely effect on the process under the conditions of loadvariations.

DERIVATIVE ACTION:

1. A derivative control action may be added to proportional control andcontinued P+D control action obtained.

2. Derivative control action may be defined as a control action in which the magnitude of the manipulated variable is proportional to the rate of change of derivation. The net effect of thederivative action to shift the manipulated variable ahead by a time Td, thederivative time.

3. The controller response now leads the time changer of deviation to thisextent the derivative response anticipates.

4. Derivative time is defined as theamount of lead. Expressed in minute of time that control action is given. Thesignal feed back is

$$(1/(1+sCR)) * V/K1$$

Where … s is the Laplace operator. The transfer equation will be

(0+ (1/(1+sCR)) X V/K1) A =V

If a>>K1, V= -K1(1+sCR)0

And transforming

V= -(K10 + K1CR X d0/dt) = -(K10 Xd0/dt)

CR is the derivative action time td or K3 = derivative action factor = K1CR.

EXPERIMENT NO-2(P+I):

AIM: To show the effect of integral action in eliminating the offset. To observe thatthe integral action has destabilizing effect on the process when load changes occur.

PROCEDURE:

1. Establish the connections as per fig.5 with the help of patch cords. Get theindicating settings for the various controls. a) SET = 20ohms (i.e 50 degreescentigrade) The advantages of derivative action are that the proportional gain madelarger without producing excessive oscillations.

2. This turn reduces offset. It is sometimes possible through the use of P+D toreduce offset to such a small value that integral act it be required. The actionimproves that transient response considerably under larger load changes.

EXPERIMENT NO – 3(P+D):

AIM: To observe the establishing effect of the derivative action.

PROCEDURE:

1. Establish the connections as per fig.8 with the help of patch cords get the indicating settings for the various controls.

SET = 20ohms (i.e 50 degrees centigrade)

PB = 10%. Coarse control for derivative action = 2.5sec.

Fine control = midway.

2. Turn off the fan with fan control is low position.

3. Wait until the process stabilizes.

4. Now introduce the load change by moving the fan control to high position.Take the record for deviation meter at the interval of 5 to 10 sec. You may observe that the process comes to almost zero deviation point quickly. In factin this process the performance of P+D and P+I+D are almost identical.

5. You may perform expts for settings of derivative time and PB element.

Controller transfer equation:

Consider fig. 6, the feedback signal is V/k1 where V is the output and K1is proportional of the signal feedback.This is summed with the deviation signal and the sum is amplified by

gain A to produce the output to V i.e.,

$$\text{i.e.,} \quad V = \frac{(0+V/K1)A = V}{k1}$$

Now is A>K1, K1/A tends to zero i.e., V=-K1*0

This is the required relation for proportional control (signal term).K1 iscalled proportional sensitivity or proportional action factor. It is usuallyexpressed in terms of the inverse function (proportional band). This is becauseof the output has limit of 0 to 100% of maximum available heater power, Valueopening etc., so that it is convenient to refer the system parameters to thisscale.

Consequently if the full output swing is obtain for an input swing whenk1=1,the proportional band is 100%. If the output swing is obtain for 0/10,then k1=10 and proportional band is 10%.

In this process zero deviation is made to correspond to 50% of power input.

Suppose the process is given zero deviation from normal load on it withproportional control. Now the load is increase to bring the error back to zero,but for the output to remain at a new higher level, there must be some finiteerror i.e., deviation from normal load condition. This finite error which occurswhen the process loads are varied is called as offset. The finite error whichoccurs when the process loads are varied is called as offset. The only way toreduce the offset and hold the process parameter at the set point is to increasethe proportional gain.

TABULAR FORM:

P-CONTROLLER:

LOW DISTURBANCE		HIGH DISTURBANCE	
DEVIATION IN ^{O}C	**% OF POWER**	**DEVIATION IN ^{O}C**	**% OF POWER**

PI-CONTROLLER:

LOW DISTURBANCE		HIGH DISTURBANCE	
DEVIATION IN ^{O}C	% OF POWER	DEVIATION IN ^{O}C	% OF POWER

PD-CONTROLLER:

LOW DISTURBANCE		HIGH DISTURBANCE	
DEVIATION IN ^{O}C	% OF POWER	DEVIATION IN ^{O}C	% OF POWER

PID-CONTROLLER:

LOW DISTURBANCE		HIGH DISTURBANCE	
DEVIATION IN ^{O}C	% OF POWER	DEVIATION IN ^{O}C	% OF POWER

RESULT:

VIVA QUESTIONS:

1. Define proportional?

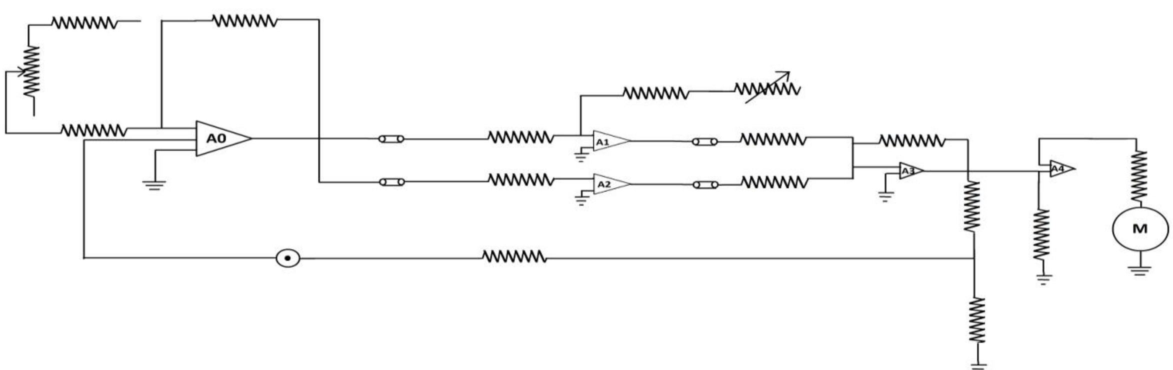
2. Define integral controller?

3. Why should we do not connect first order& second order in the loop of PID controller?

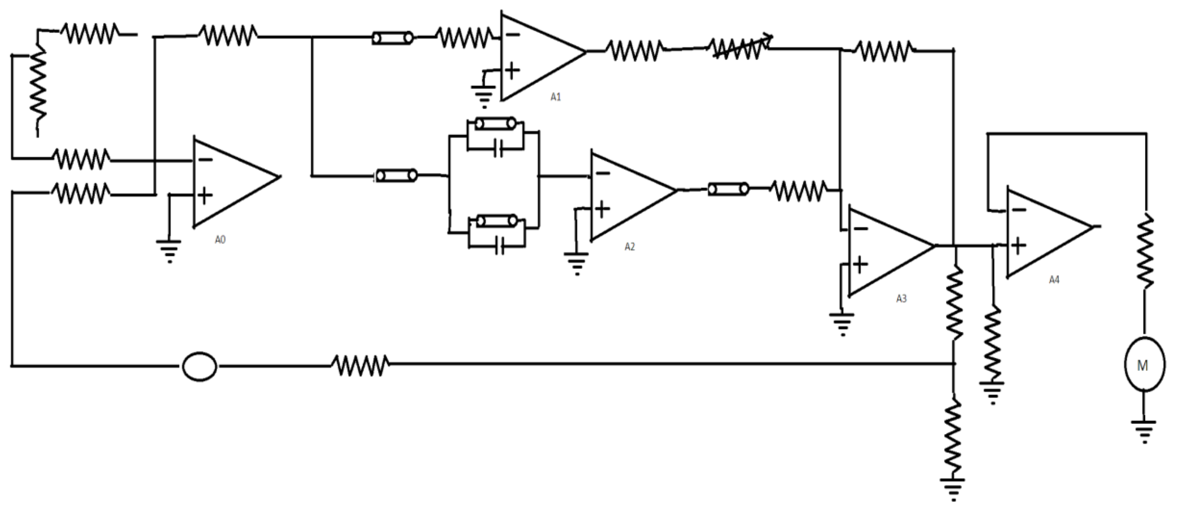
4. Define second order system?

5. Where shall we apply PID controller

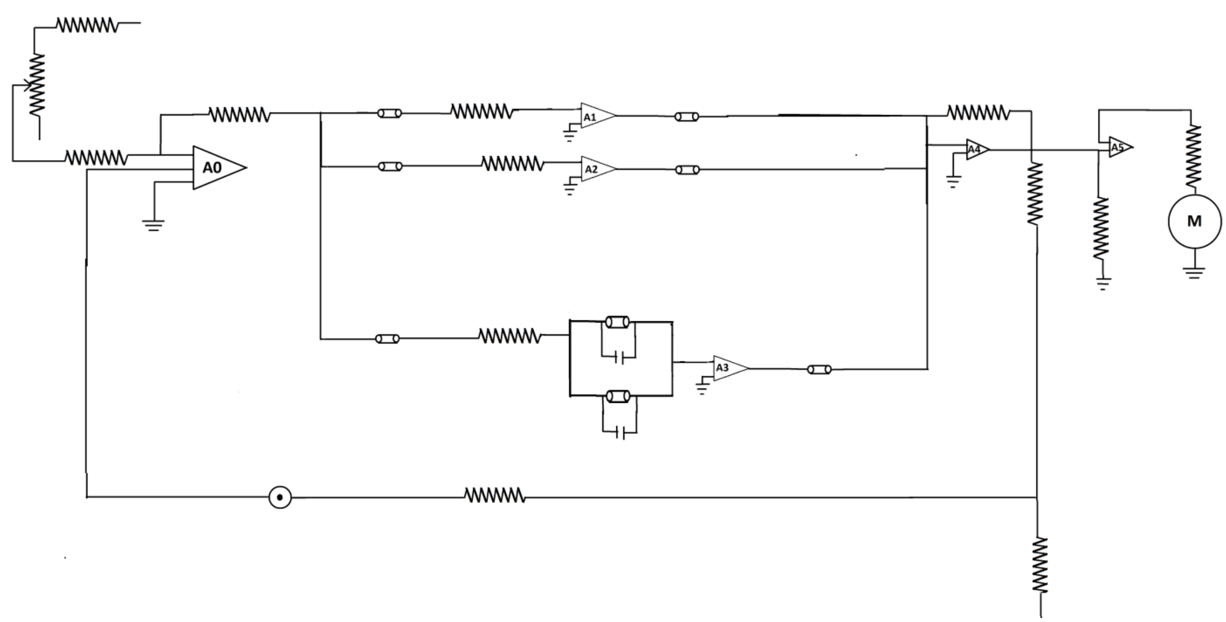
CIRCUIT DIAGRAM:



P controller



PD controller



Exp.No:09

Date:

EFFECT OF FEEDBACK ON P, PD,PI,PID CONTROLLER

AIM: To study the effect of P, PD, PI, PID controller on a second order system.

APPARATUS REQURED:

1. PID controller unit,
2. Patch cords
3. CRO

PID CONTROLLER UNIT:-

Front panel details:-

1) Main: Main on/off switch

2) Square: Variable square wave out 0-2v.

3) Level: Potential meter to vary the amplitude of square wave And triangular wave

4) Frequency: Potential meter to vary the frequency of square wave And triangular wave

5) Triangle: Triangle wave O/P for triggering purpose in x-y Mode

6) Amplitude: Potential meter to vary the D.C voltage from 0-12v

7) Dc: Variable Dc O/P 0-12v

8) GND: Ground terminal

9) DPM: 31/2 digit DC volt meter to measure DC voltage at Different points

10) Vin: +ve I/P of error detector feedback voltage

11) **Vf:** -ve I/P of error detector feedback voltage

12)Ve: Error voltage

13) P: 10 turn potential meter to vary potential gain from 0-20 with indicating dial

14) I: 10 turn potential meter to vary the integral gain from 10-1000

15) D: 10 turn potential meter to vary the derivative gain from 1- 0.01

16) Controller: PID controller with variable PID parameters.

17) ON/OFF: On/off switch for P,I,D individually

18) +: Adder

19) INV AMP: Units gain inverting amplifier to find the effect of Positive feed back

20) Process:

A) First order system : First order system with time constant of – 3m sec.

B) Second order system: Second order system with time constant of 5 sec.

C) Time constant: 1m sec – Suitable for square wave I/P

D) Integrator: 2m sec. Time with 1800 phase shift

TABULAR FORM:

P-CONTROLLER:

S.No	Load	Set Voltage(V_s)	Gain	Error Voltage(V_e)	Feedback Voltage

PI-CONTROLLER

S.No	Load	Set Voltage(V_s)	Gain	Error Voltage(V_e)	Feedback Voltage

PID-CONTROLLER

S.No	Load	Set Voltage(V_s)	Gain	Error Voltage(V_e)	Feedback Voltage

PROCEDURE:

A) PROPORTIONAL +INTEGRAL CONTROLLER –CLOSED LOOP:

1. Make the connections as shown in the figure.

2. Connect DC supply to V_{in}

3. Connect first order plant in the loop.

4. Set again values.

5. Note down Vdigital,Vanalog for different loads.

B) PROPORTIONAL + DERIVATE CONTROLLER –CLOSED LOOP:

1. Make the connections as shown in the figure.

2. Connect DC supply to V_{in}

3. Connect first order plant in the loop.

4. Set again values.

5. Note down Vdigital,Vanalog for different loads.

(C) INTEGRAL + PROPORTIONAL + DERIVATOR CONTROLLER (PID):

1. Make the connections as shown in the figure.

2. Connect DC supply to V_{in}

3. Connect first order plant in the loop.

4. Set again values.

5. Note down Vdigital,Vanalog for different loads.

RESULT :

VIVA QUESTIONS:

1. Define proportional controller?

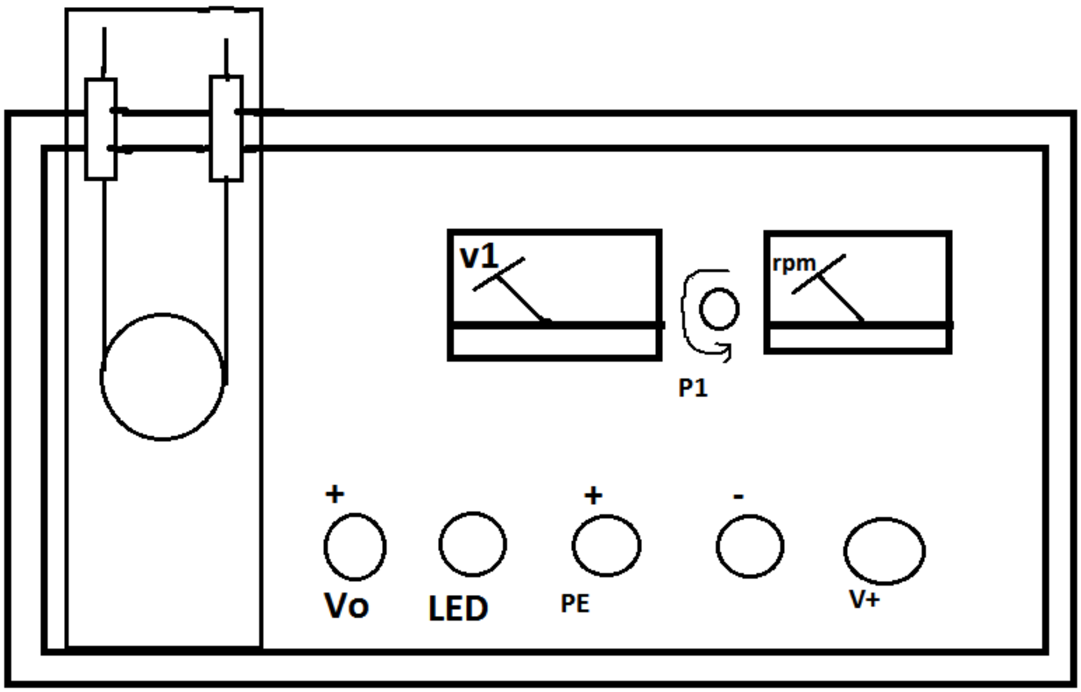
2. Define integral controller?

3. Why should we do not connect first order& second order in the loop of PID controller?

4. Define second order system?

5. Where shall we apply PID controller

CIRCUIT DIAGRAM:



DC POSITION CONTROL SYSTEM

Exp No:10

Date:

DC position control system

AIM: To study the performance characteristics of a DC motor angular position control system.

APPARATUS REQURED:

1. DC position control system kit.

TABULAR COLOUMS:

WITHOUT STABILIZING FEEDBACK

S. no	Input angular position in degrees			output angular position in degrees			Remarks		
	20	40	60	20	40	60	20	40	60

WITH NEGATIVE FEEDBACK:

S. no	Input angular position in degrees			output angular position in degrees			Remarks		
	20	40	60	20	40	60	20	40	60

WITH NEGATIVE FEEDBACK:

S. no	Input angular position in degrees			output angular position in degrees			Remarks		
	20	40	60	20	40	60	20	40	60

WITH POSITIVE FEEDBACK:

S. no	Input angular position in degrees			output angular position in degrees			Remarks		
	20	40	60	20	40	60	20	40	60

PROCEDURE:

OPERATION INSTRUCTION:

1. Before switching on the mains, see that the switches SW3,SW4(on the LHS panel) are in down ward position i.e. ON position.

2. Keep the input potentiometer P! in 10 degree position.

3. Adjust the potentiometer P3(amplifier gain Adj .) in the position.

4. Now switch ON the main unit LED 'R' and LED "G" should glow.

OPERATION WITHOUT STABILIZING FEEDBACK or open loop(SW1 in off position i.e. tacho out):

1. Now slowly advance the input potentiometer P1 in clockwise direction. The output potentiometer along with load will be seen to be following the change in the input potentiometer.

2. When the input is disturbed, the null indicator will be showing some indication but when it may be noted that when input pot is moved in anticlockwise Direction, the output pot P2 also moves in the reverse direction.

STEP CHANGE INPUT:

keep the pot p1 at around 180 degree position .pot P2 also will be in the same position.

Now change the input pot in the step fashion by about 60 to 80 degrees(in fact approximating step input), The output will be observed to change in oscillatory mode before it settles to a final position. The tendency for oscillations is found to be dependent on the amplifier gain setting. For high gain there are too many oscillations where as low gain oscillations are reduced but with static error.

OPERATIONS WITH STABILIZING FEEDBACK(closed loop):

1.Now put the SW1 switch in lower position i.e, TACHO IN position .Sw2 must be download position i.e, degenerative mode. Keep P4 in fully anti clockwise direction, output again indicates oscillations.

2. Now take the pot P1(input potentiometer) to 180 degrees position, effect the step input change in one of the direction, output again indicates oscillations.

3. Now advance the tacho gain pot P4 in clockwise direction the output now is observe to follow the input in smooth fashion without oscillations. If the tacho gain pot P4 is too much advance, the output now follows input in a sluggish fashion indicating over damped system. Now take the pot P1 to 180 degrees position.

4. Now the switch SW2 in upward position i.e, regenerative mode. Now if the port P1 is disturbed, the output pot P2 is found to oscillate continuously around desired position. As the amount of feedback is adjusted the frequency and amplitude of output is observed to vary.

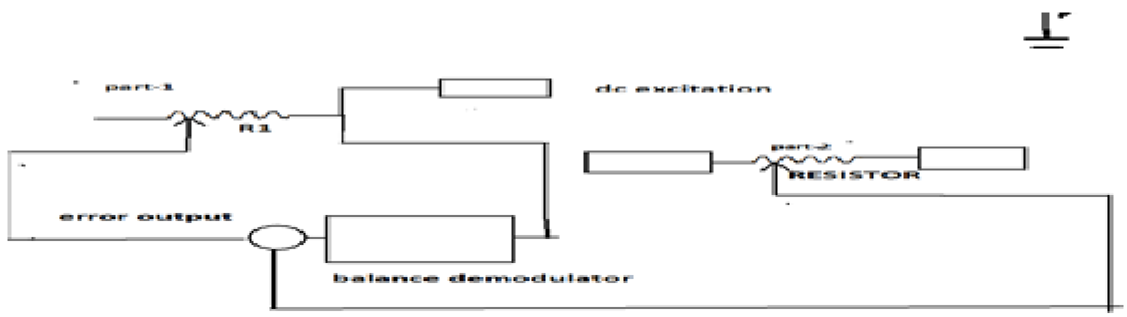
5. Bring the switch SW2 in downward position.

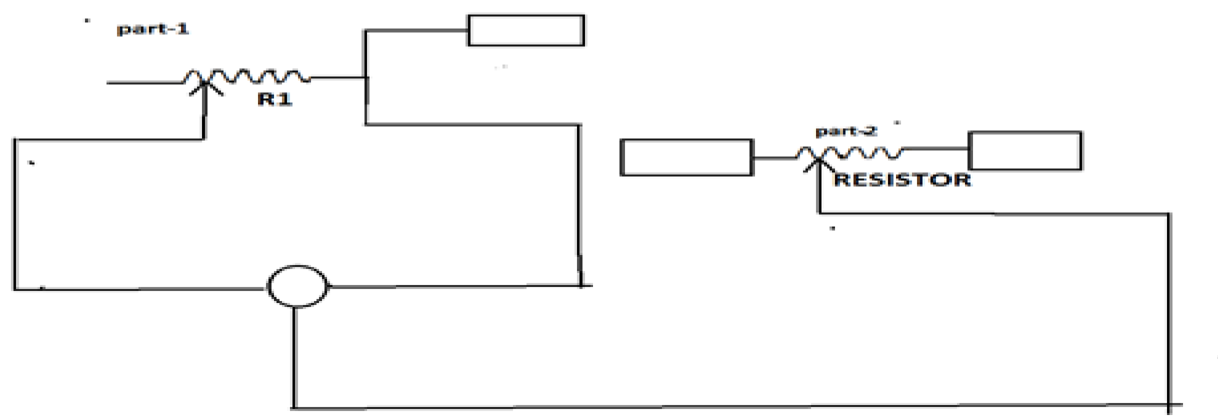
PRECAUTIONS :

1. Heating and possible damage of the power stage.
2. Don't operate this mode for long time.

RESULT:

CIRCUIT DIAGRAM:





Exp No:12

Date:

POTENTIOMETER AS ERROR DETECTOR

AIM: To study the performance characteristics of an angular position error detector using two potentiometers

APPARATUS REQURED:

1. Potentiometer kit.

2. Dual trace CRO.

3.Connecting wires.

TABULAR COLOUMS:

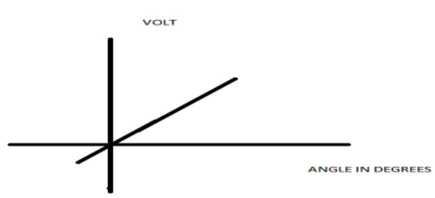
AC excitation:

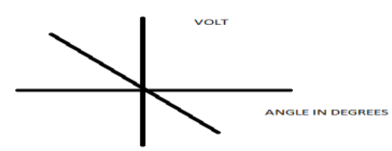
POT-1 POSITION IN Θ_1	POT-2 POSITION IN Θ_2	$\Theta_2 = \Theta_1 - \Theta_2$	OUTPUT VOLTAGE

DC excitation:

POT-1 POSITION IN θ_1	POT-2 POSITION IN θ_2	$\theta_2 = \theta_1 - \theta_2$	OUTPUT VOLTAGE

Model Graph:





PROCEDURE:

1. Connect the power and select the excitation switch to DC keep pot 1 to center 180◦. Connect DVM to error output. Turn pot 2 from 20◦ to 360◦ in regular steps noted displacement Ɵ2 and output voltage v0. Plot graph between ve and Ɵ2= Ɵ2.

2. Connect the power and select the excitation switch to AC connect one of CRO input with carrier output socket and ground connect to other input of CRO with error output socket. Keep pot 1 fixed at 180◦ and move P2 from 20◦ to 360◦. Note displacement and demodulator voltage V2 . Plot graph between displacement and demodulator voltage.

RECAUTIONS:

1.Select the excitation switch as required AC or DC wrong selection maximum cause error experiment or damage the setup.

2. Take the readings carefully.

3. Switch off the setup when not in use.

RESULT:

CIRCUIT DIAGRAM:

Exp No:10

Date:

TRANSFER FUNCTION OF D.C. GENERATOR

AIM: To find out the transfer function of a D.C Generator, after determining the various constants.

NAME PLATE DETAILS:

	MOTOR	GENERATOR
Voltage		
Current		
Power		
Speed		
Excitation		

APPARATUS REQUIRED:

S.no	Name of apparatus	Type	Range	Qty
1.	Motor Generator set			
2.	Rheostat			
3.	Ammeter			
4.	Voltmeter			
5.	Tachometer			

6.	Multimeter			

TABULAR FORMS:

S.no	Voltage(V)	Current(A)

Field Resistance(R_f):

S.no	Voltage(V)	Current(I)	$R_f = V/I$

Field Impedence (Z_f):

S.no	V_1(V)	V_2(V)	V_3(V)

THEORY: Refer text book by the student.

PROCEDURE:

Procedure for calculations of E_g:

1. Connect the circuit as per the diagram.
2. Keep the Motor field rheostat at minimum position and Generator field rheostat at maximum position.
3. Start the motor with the help of 3-point starter and adjust the motor field rheostat till the motor reaches to its rated speed.
4. Gradually increase the field currentcurrent of generator by minimize the Generator field rheostat resistance.
5. Note the terminal voltage (v) of the Generator at various field current (If).Till the Generator attains its rated voltage.
6. The relationship between no load voltage(v) and field current (If) ,gives the open circuit charateristics (O. C.C).
7. Draw the graph (O.C.C) between terminal voltage (v) and field current(If) to find out the critical field resistance and critical speed .

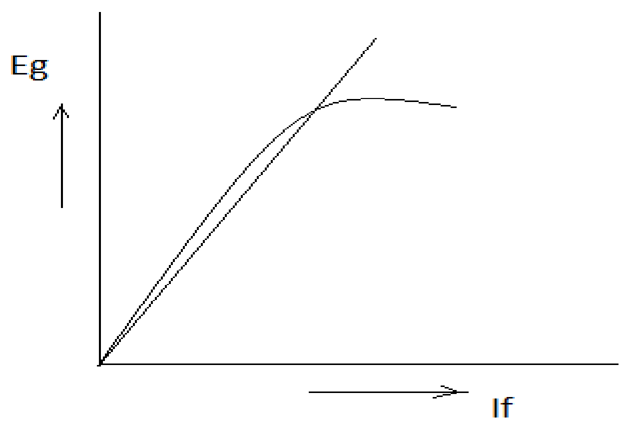
Procedure for Calculation for Z_f :

1. Connect the circuit as per the diagram.
2. Applying different voltages and note down corresponding values from the meters.
3. By considering reading Z_f is calculated.
4. Bring auto Transformer minimum position.
5. Switch of the circuit.

Procedure for calculation R_f :

1. Connect the circuit as per the diagram.
2. Apply D.C Voltage and down values.
3. Bring auto Transformer minimum position.
4. Switch of the ciricuit.

MODEL GRAPH:



CALCULATIONS:

Field Impendance :-

R = $\frac{V}{I}$

I = $\frac{V}{R_a}$

Z = $\frac{V}{I}$

X_f = $\sqrt{(Z)^2 + (307.43)^2}$

X_f =

$L_f = \dfrac{X_L}{2\Pi f}$ =

Taking, K $= \dfrac{\Delta E_g}{\Delta I_f}$ =

$T(s) = \dfrac{K_g}{L + ST_g}$ =

$T_g = \dfrac{L_f}{R_p}$ =

PRECAUTIONS :

1. Loose connections should be avoided.
2. Operate the 3 – point starter carefully.
3. Proper rating meter should be used.
4. Run the Motor rated speed.
5. Check the connections before giving supply.

RESULT:

VIVA QUESTIONS:

1. Define Transfer function?

2. Define Open loop System?

3. Define Closed Loop System?

Experiment No: 11

Date:

STABILITY ANALYSIS OF LINEAR TIME INVARIANT SYSTEMS

(Bode, Root Locus, Nyquist plots using MATLAB)

AIM: To analyze the stability of given linear time invariant systems using MATLAB.

SIMULATION TOOLS REQUIRED: PC with MATLAB Software.

PROCEDURE:

1. Open the MATLAB command window clicking on the MATLAB icon.
2. Click on file menu and open new M file.
3. Enter the MATLAB code.
4. Click on the debug menu and run the code.
5. Then copy the obtained plot.

PROGRAMS:

BODE PLOT:

```
num=input('enter the numerator:');

den=input('enter the denominator:');

sys=tf(num,den);

disp(sys);

bode(sys);

[gm,pm,weg,wep]=margin(sys);

if((gm<0)|(pm<0));
```

```
    disp('system is unstable');
else
    disp('system is stable');
end;
clear;
```

RESULTANT WAVE FORMS:

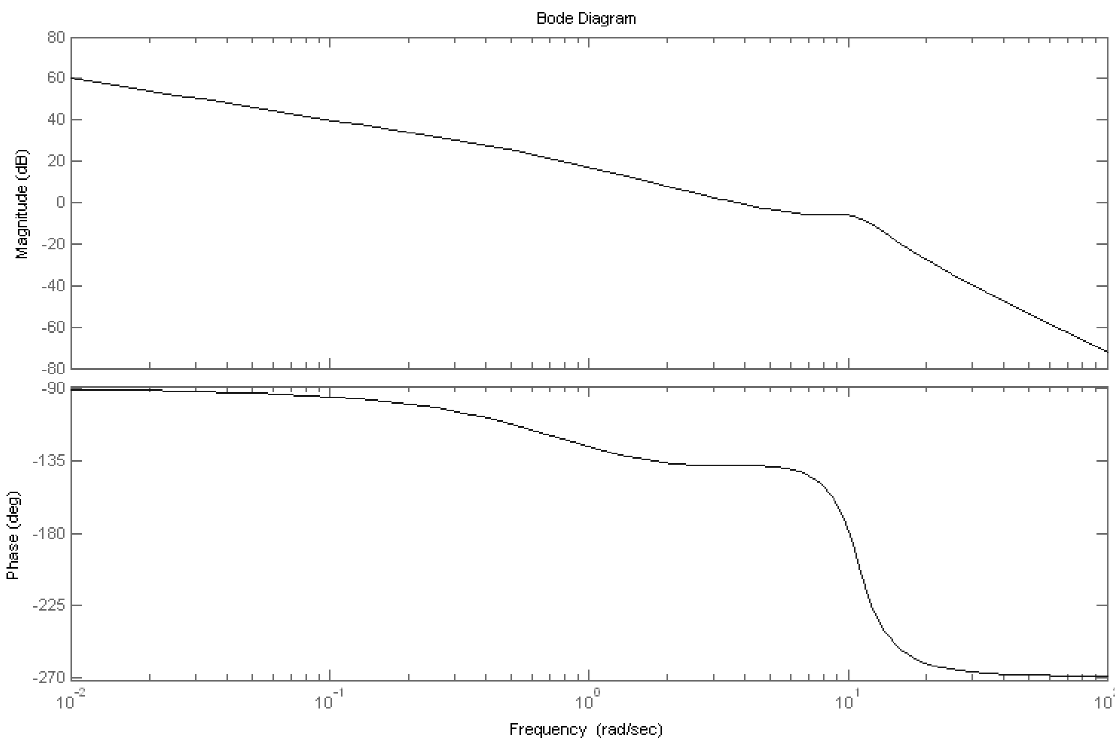


Fig: BODE PLOT

- G(S)=75(1+0.25)/s(s^2+16s+100)
- A=[15 75]
- B=[1 16 100 0]
- System is stable
- Gm=inf
- Pm=91.6644
- Weg=inf

- Wep=0.7573

NYQUIST PLOT:

```
clear;
num=input('enter the numerator:');
den=input('enter the denominator:');
sys=tf(num,den);
disp(sys);
nyquist(sys);
[gm,pm,weg,wep]=margin(sys);
if((gm<0)|(pm<0));
    disp('system is unstable');
else
    disp('system is stable');
end;
clear;
```

RESULTANT WAVE FORMS:

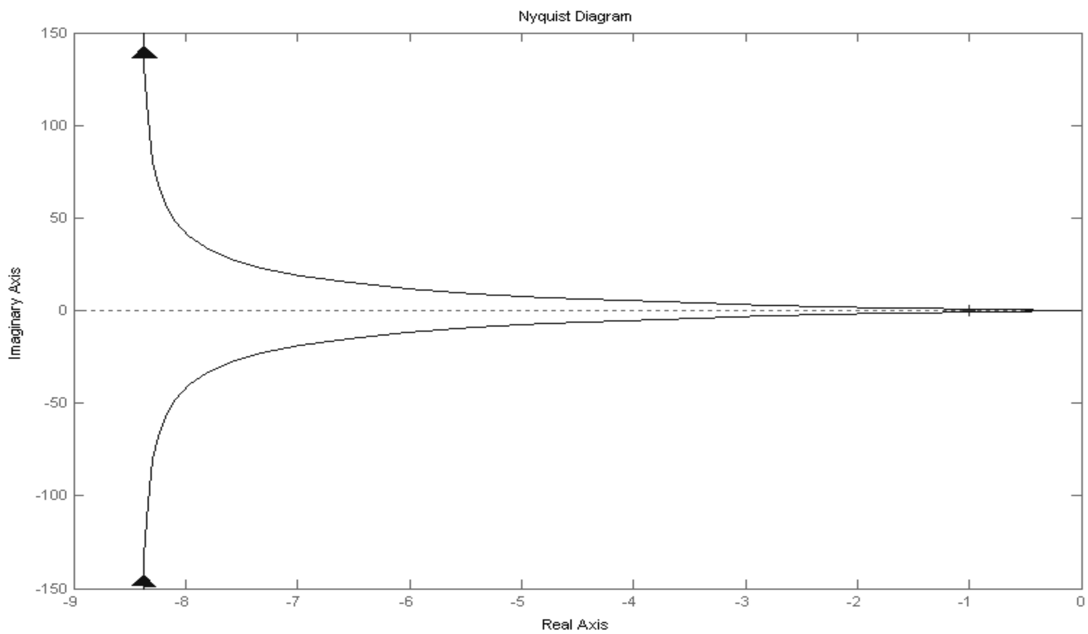


Fig: NYQUIST PLOT

- G(S)H(S)=(s+2)/(s+1)(s-1)
- A=[1 2]
- B=[1 0 -1]
- System is unstable
- Gm=0.50
- Pm=29.7131
- Gef=0
- Pef=1.1414

ROOT LOCUS PLOT:

```
num=input('enter the numerator:');
den=input('enter the denominator:');
sys=tf(num,den);
rlocus(sys);
[r,k]=rlocus(sys);
[m,n]=size(r);
```

```
for i=1:n
for j=1:m
if real(r(j,i)>0)
        strl=strcat('the given system is unstable at k',num2str(k(j)));
        disp(strl);
break;
end;
end;
end;
```

RESULTANT WAVE FORMS:

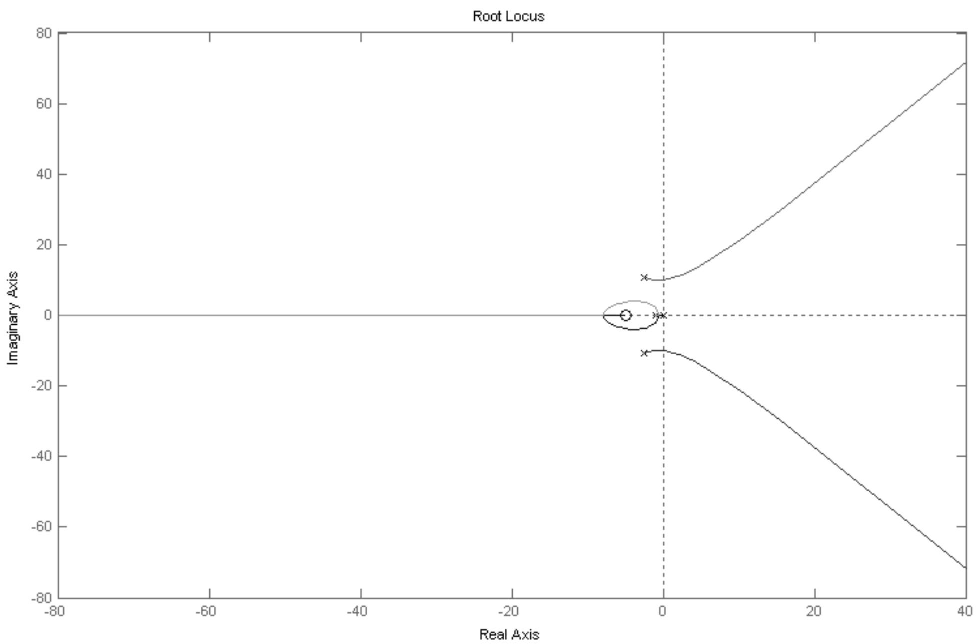


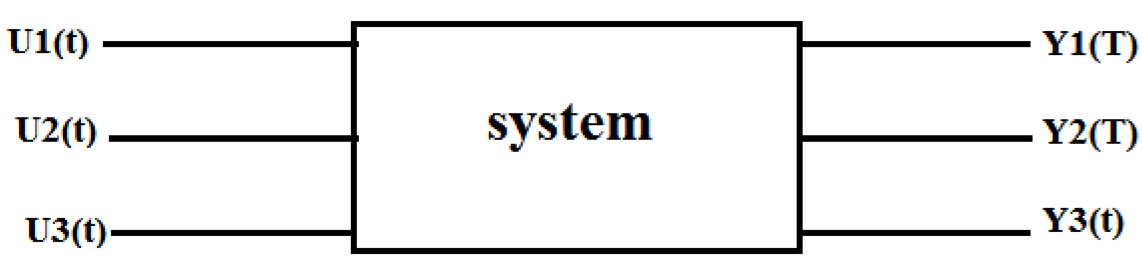
Fig:**ROOT LOCUS PLOT**

- G(s)=k(s+9)/s(s^2+4s+11)
- A=[1 9]
- B=[1 4 11 0]

- System is unstable
- K=13.47
- K=40.54
- K=106.21
- K=278.26
- K=279
- K=310984.34
- K=inf

RESULT:

State-space model representation:



Experiment No: 12

Date:

SIMULATION OF A STATE SPACE MODEL USING MATLAB

AIM: To find the transfer function of the given system, controllability, observability and state space model

X=AX+BU

Y=CX+DU

$$A=\begin{bmatrix}-1 & 1 & 0\\ 0 & -4 & 2\\ 0 & 0 & -1\end{bmatrix} \quad B=\begin{bmatrix}1\\0\\1\end{bmatrix} \quad C=\begin{bmatrix}1 & 0 & 1\end{bmatrix} \quad d=0$$

SIMULATION TOOLS:

1. IBM PC compatible with MATLAB software.

2. MATLAB SIMULATOR.

THEORY:

state: Minimum amount of information required to estimate the future of the system.

state variable: The minimal set of these variables which describe the state of the system.

Suppose 'n' state variables are represented as 'n' components of a state then vector is known as state vectors

$$X(t)=\begin{bmatrix}x1(t)\\x2(t)\\x3(t)\end{bmatrix}_{n*1}$$

State equation is $x(t)=AX(t)+BU(t)$

o/p equation $y(t)=CX(t)+DU(t)$

Transfer function matrix $T.F=C(SI-A)^{-1}B+D$

A system is said to be completely state controllable if it is possible to find an i/p U(t) that will transfer a system from many initial state to any final state over a specified time interval

controllable matrix $S=\{B\ AB\ A^2B\text{------}A^{n-1}B\}$

If rank of the matrix 'n', then the system is state controllable

Rank (s)=n $[B \neq 0]$

A system is said to be state observability the state of the can be determined from the knowledge of the i/p U(t) and o/p y(t) over a finite interval of time. The representation is $W=[\ C^TA^T\ C^T(A^T)^2\ C^T\text{----}(A^T)^{n-1}C^T]$

Rank (W)= n [observable]

program-1:

```
A= [-1 1 0; 0 -4  2; 0 0 -10];

B= [1 0 -1];

C= [1 0 1];

D=[0];

[num, den]= ss2tf[A,B,C,D];

disp (num);

disp(den);
```

program-2:

```
A= [-1 0 0; 0 -4 2; 0 0-10];
```

```
B= [1 0 -1];
C= [1 0 1];
D= [0];
S= ctrb(A,B);
n=det(s);
if abs(n)<eps
disp('system is not controllable');
else
disp('system is controllable');
end
```

program-3:

```
A= [-1 1 0; 0 -4  2; 0 0 -10];
B= [1 0 -1];
C= [1 0 1];
D=[0];
W= obsv(A,C);
n=det(W);
if abs(n)<eps
disp('system is not observability');
else
disp('system is obesrvability');
end
```

Result: