DRONACHARYA
College of Engineering

CONTROL SYSTEM LAB

(EC-616-F)

LAB MANUAL

VI SEMESTER

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CONTROL SYSTEM
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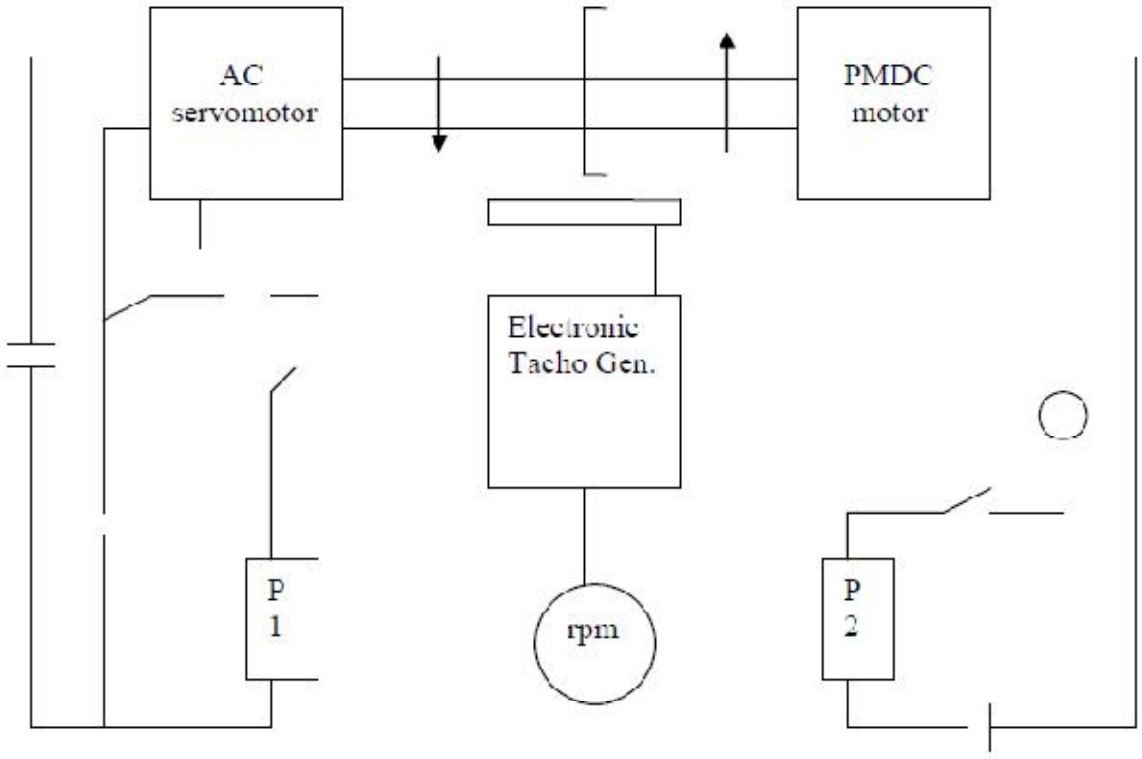
EXPERIMENT NO: 1

AIM: - To study AC servo motor and plot its torque speed Characteristics.

APPARATUS REQUIRED: - AC Servo Motor Setup, Digital Multimeter and Connecting Leads.

THEORY: - AC servomotor has best use for low power control applications. Its important parameters are speed – torque characteristics. An AC servomotor is basically a two phase induction motor which consist of two stator winding oriented 90* electrically apart. In feedback application phase A is energised with fixed voltage known as "Reference" and phase B is energized with variable voltage called "Control voltage". In this setup AC servomotor is mounted and mechanically coupled a small PMDC motor loading purpose. When DC supply is fed to DC motor it runs in reverse direction of servomotor direction to impose load on servomotor. The resultant torque developed by DC motor to overcome it increase the current through it which is indicated by panel meter.

CIRCUIT DIAGRAM:-



PROCEDURE:

1. Switch **O**N the power supply, switches ON S1. Slowly increase control P1 so that AC servomotor starts rotating. Connect DVM across DC motor sockets (red & black).Vary the speed of servomotor gradually and note the speed N rpm and corresponding back emf E_b across DC motor.
2. Connect DVM across servo motor control winding socked (yellow) and adjust AC Servomotor voltage to 70V and note speed N rpm in table.
3. Switch on S2 to impose load on the motor due to which the speed of AC motor decreases. Increase the load current by means of P2 slowly and note corresponding speed N rpm and Ia. Calculate

   P=Ia*Eb and Torque=P*1.019*$10^4$60/2.2.14Ngm/cm

OBSERVATION TABLE:-

TABLE-1

S.NO	SPEED N rpm	Eb volts
1.		
2.		
3.		
4.		

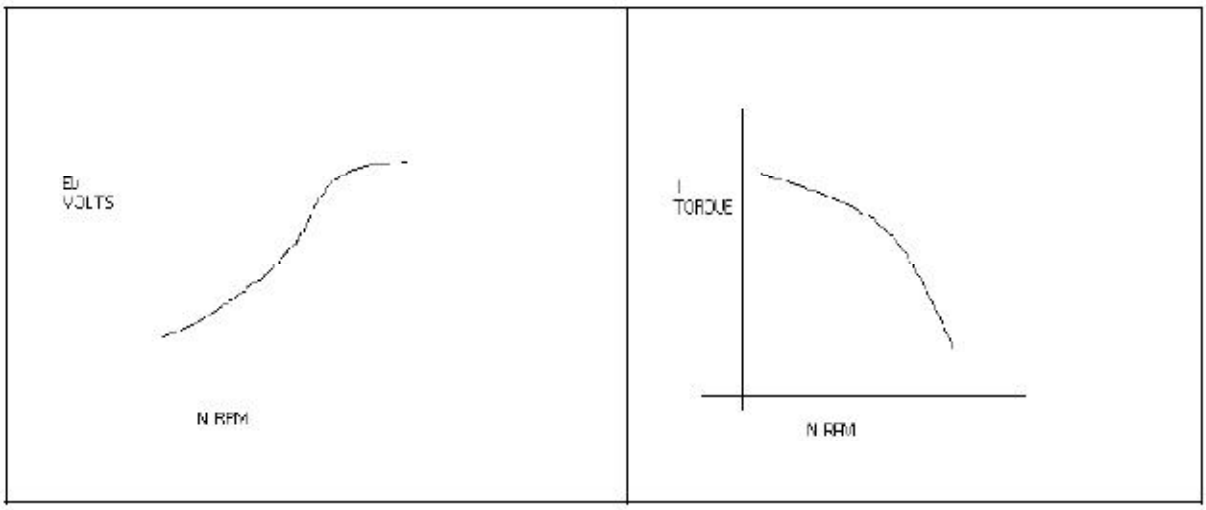
TABLE-2

S.NO	Ia amp	Eb (Tab 1)	Speed N rpm	P watt	Torque
1.					
2.					
3.					
4.					

PRECAUTIONS: -

1. Apply voltage to servomotor slowly to avoid errors.
2. Impose load by DC motor slowly.
3. Take the reading accurately as the meter fluctuates.
4. Switch OFF the setup when note in use.

GRAPH:-



DISCUSSION:-

The graph is plotted between speed and torque. As we reduce the speed of the motor the torque goes on increasing therefore the graph starts with a low value and rises to a high value approximately linearly .This rise in the graph is due to the rising speed-torque characteristics of AC servo motor .

QUIZ:-

Que 1. What is AC servo motor?
Ans. An AC servo motor is basically a two phase induction motor except for some Design feature.
Que.2 What is the use of AC servo motor?
Ans. AC servo motor has best use for low power control application.
Que.3 What are the advantages of AC servo motor?
Ans. It is rugged, light weighted, and has no brush contact as in DC servo motor.
Que4. What is the important parameter of AC servo motor?
Ans. The important parameter of AC servo motor is its speed – torque Characteristics.
Que.5 On what factor does the direction of rotation of AC servo motor Depend.
Ans. The direction of rotation of AC servo motor depends on the phase relationship of Input voltage V1 and V2 .
Que 6. What is the drawback of AC servo motor ?
Ans. The main drawback of AC servo motor is its positive slope which causes Negative damping to lead instability in control system .

Que.7 How the drawback of positive in AC servo motor is overcome ?
Ans. The drawback of positive in AC servo motor is overcome by designing the rotor With very high resistance .
Que.8 What is the input of AC servo motor in feedback control application?
Ans. In feedback control application phase A is given a fixed rated voltage called Reference voltage and phase B is given a variable voltage called control Voltage.
Que.9 What is the phase relationship between reference voltage and control Voltage?
Ans. The reference voltage and control voltage are 90 degrees out of phase with each other.
Que.10 What are the types of AC servo motor ?
Ans. AC servo motors are of various type as squirrel cage rotor motor ,drag cup Rotor and solid iron rotor motor.

EXPERIMENT NO: 2

AIM:- To study dc servo motor and plot its torque speed characteristics.

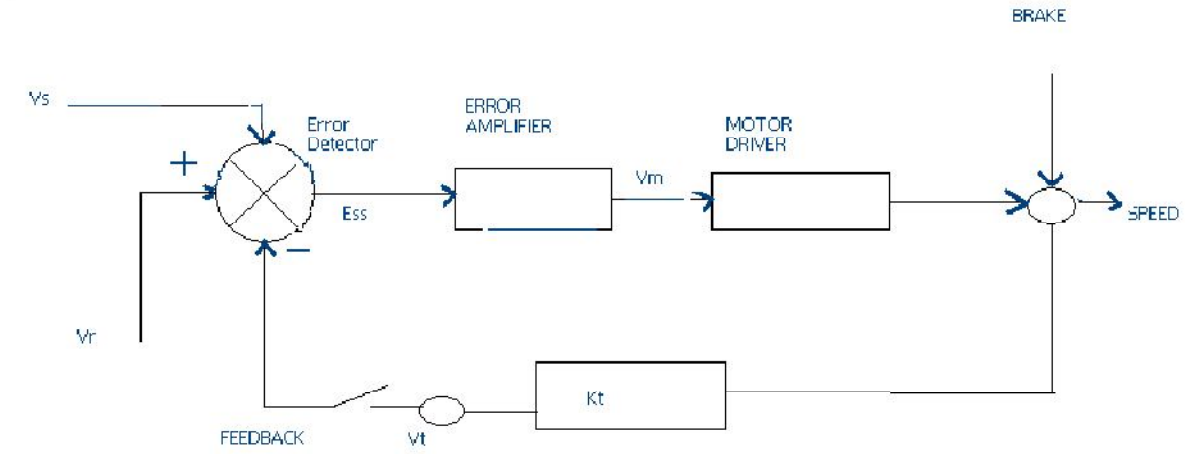
APPARATUS:- DC SERVO MOTOR KIT AND DVM.

THEORY: - The experiment is carried out in two steps.

1. Open loop performance
2. Close loop performance.

In first case the motor is run without feedback. The amplifier gain factor is kept at minimum gain = 3. motor is connected with main unit by 9 pin D Type socket. Step signal is kept off.

CIRCUIT DIAGRAM:-



PROCEDURE:-

OPEN LOOP PERFORMANCE:- Connect the main unit to the supply. Keep the gain switch off. Set Vr = 0.7 or 0.8. connect DVM with feedback signal socket Vt. Note the speed N rpm from display and tacho output Vt in volts from DVM. Record N rpm and Vt volts for successive gain 4-10 in observation table. Calculate Vm = Vr * Ka. Where Ka is the gain set from control 3 – 10.

Vr = 0.7 V.

Vm at gain 3 = 0.7 * 3

= 2.1 V.

Plot N vs Vt and **N Vs Vm** graph.

CLOSED LOOP PERFORMANCE:- In this case the gain switch is kept in on position thus feedback voltage gets subtracted from reference voltage. This is observed by decreased motor speed. Record the result between gain factor Ka and speed N. draw the graph between techo

voltage Vt and speed N.

OBSERVATION TABLE:-

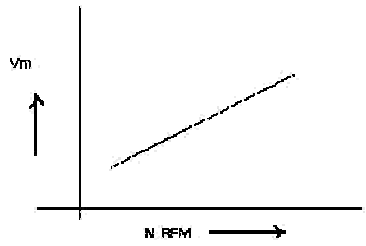
S.NO.	GAIN(Ka)	Vt (volts)	N(rpm)	Vm=Vr×Ka

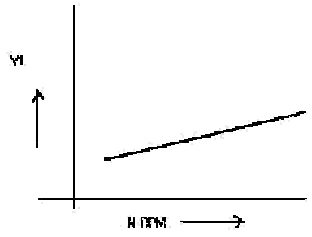
PRECAUTIONS:-

1. Apply the voltage slowly to start the motor
2. Take the reading properly.
3. Do not apply breaks for long time as the coil may get heated up.
4. Switch OFF the main power when not in use.

GRAPH:-

For open loop:





DISCUSSION:-

The graph is plotted between N (RPM) and Vt (techo voltage) and N(rpm) & Vm (motor voltage).the tacho voltage increases linearly as the RPM of DC servo motor increases. Similarly the motor voltage increases with RPM .in open loop. The slope is less but in close loop the slope is sharp and this is due to the feed back gain.

QUIZ:-

Que.1 What are the uses of DC servo motor?

Ans. DC servo motor is widely used in radars, computers, robots, tracking systems and process controllers etc.

Que.2. What are the types of DC servo motors?

Ans. DC servo motors are separately excited or permanent magnet type.

Que.3. How the speed of DC servo motor is controlled?

Ans. The speed of DC servo motor is controlled by varying the armature voltage.
Que.4. What is the relation between torque and speed of DC servo motor?
Ans. The torque of DC servo motor decreases with increase in speed.
Que.5. Why the speed torque characteristics of DC servo motor has large Negative Slope?
Ans. The speed – torque characteristics of DC SERVO MOTOR has a large Negatives Slope due to large armature resistance.
Que.6. What is the effect of negative slope?
Ans. The negative slope provides viscous damping for the servo drive system.
Que.7. In which wattage the DC servo motors are available?
Ans. DC servo motors are available in fraction of a watt to a few hundred watts.
Que.8. What are the special features of DC SERVO MOTORS?
Ans. High torque to inertia ratio, High torque to value ratio, Low inductance of Winding and efficient heat dissipation is the special features of DC servomotor

EXPERIMENT NO-3

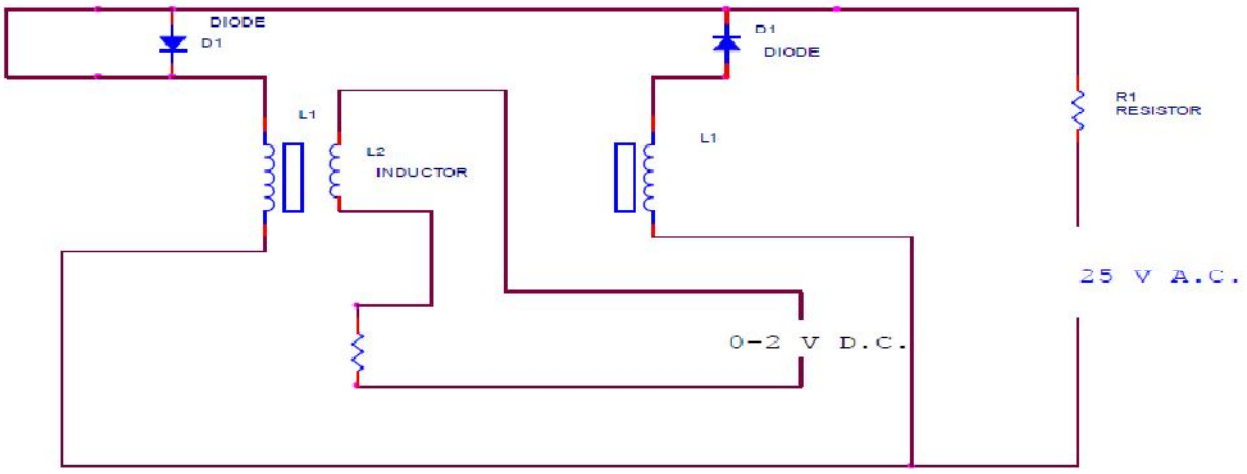
AIM: To study magnetic amplifier and plot its load current and control current characteristics for self.

APPARATUS REQUIRED: Magnetic amplifier set up, digital multimeter and connecting leads.

THEORY: Self saturation of core is achieved by using two diodes D1 and D2 in series with L1 and L2 load coils. The successive rectified half wave saturates the core in opposite direction in few cycles. This leads to flow of current in RL greatly when control winding in open or there is no current flow. The core does not saturate completely but operates to bring the core out of saturation. DC current is made to flow in controlwinding. The control winding has more number of turns than load winding. Applying a small DC current which oppose the magnetic flux caused by self saturation tends to cut off produced mmf in load magnetic path. This causes to increase inductance in l load winding and the voltage drop across then tends to rise which result in decrease in AC current in RL.If the polarity of DC current is reversed then the saturation of core takes place in opposite direction.

PROCEDURE: Connect the circuit as shown in fig. keep DC voltage to minimum. Select positive direction and switch ON the power. Increase the control current slowly and note the IL, Ic and Vc in observation table. Bring DC voltage to minimum, select negative. direction and repeat the characteristics curve in both direction. Calculate power gain
P (gain) = P(out)/P(in) or Δ IL *RL/ΔIc*Vc

CIRCUIT DIAGRAM:



OBSERVATION TABLE

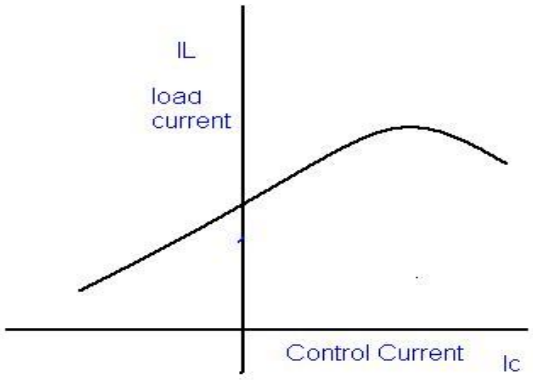
S.No	Ic(mA)	IL(mA)	Vc(+ve)
1.			
2.			
3.			
4.			

S.No	Ic(mA)	IL(mA)	Vc(-ve)
1.			
2.			
3.			
4.			
5.			

PRECAUTION :

1. Apply voltage slowly to control winding as the coil may get heated up and burn.
2. Take the reading carefully and accurately.
3. Switch off the set up when not in use.

GRAPH:-



DISCUSSION:-

The graph is plotted between load current and control current. for positive polarity the Control current rises in the forward direction with rise in load current where as for negative polarity the control current decreases in the reverse direction with rise in load current .This is due to the self saturation of the magnetic core .

QUIZ:-

Que.1. What are the modes of operation of the magnetic amplifier?
Ans. The magnetic amplifier operates in two modes Series-parallel mode and Self saturation mode.
Que.2. What is the value load resistance RL for magnetic amplifier?
Ans. The value of load resistance RL for magnetic amplifier is 50 ohms Fix. Q.3. What is power gain in magnetic amplifier?
Ans. The power gain in magnetic amplifier is the ratio of output power to Input power. Que4. What is current gain in magnetic amplifier?
Ans. The current gain in magnetic amplifier is the ratio of load current to Control current .
Que.5. What is core saturation?
Ans. When MMF in a coil is varied due to a varying current it causes the Magnetization to approach to a limit called saturation.
Que.6. What is the direction of windings in the securable reactor?
Ans. In a securable reactor the two windings are anti- phase with each Other. Que.7. How self saturation is achieved in a magnetic amplifier ?
Ans. The self saturation of core is achieved by using two rectifier diodes D1 & D2 in series with load coil L1 & L2 .
Que.8. How the magnetic core is brought out of saturation?
Ans. The core is brought out of saturation by passing a current through Control winding.
Que.9. Which winding has more number of turns?
Ans. The control winding has more number of turns than the load Winding.
Que.10. Between which parameter graph is plotted for magnetic amplifier? Ans. The graph is plotted between load current and control current.

EXPERIMENT NO-4

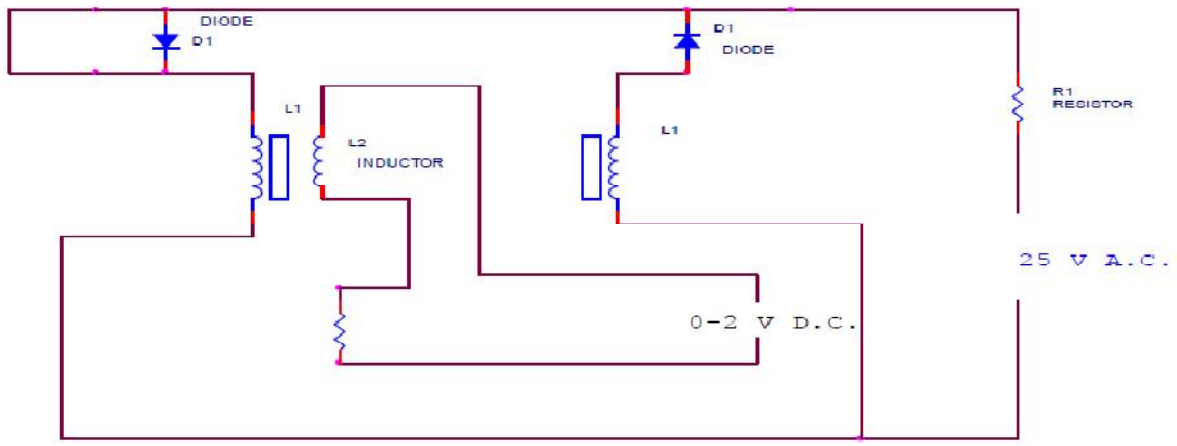
AIM: To plot the load current v/s control current characteristics for self excited mode of the magnetic amplifier.

APPARATUS REQUIRED: Magnetic amplifier set up, digital multimeter and connecting leads.

THEORY: Self saturation of core is achieved by using two diodes D1 and D2 in series with L1 and L2 load coils. The successive rectified half wave saturates the core in opposite direction in few cycles. This leads to flow of current in RL greatly when control winding in open or there is no current flow. The core does not saturate completely but operates to bring the core out of saturation. DC current is made to flow in controlwinding. The control winding has more number of turns than load winding. Applying a small DC current which oppose the magnetic flux caused by self saturation tends to cut off produced mmf in load magnetic path. This causes to increase inductance in l load winding and the voltage drop across then tends to rise which result in decrease in AC current in RL.If the polarity of DC current is reversed then the saturation of core takes place in opposite direction.

PROCEDURE: Connect the circuit as shown in fig. keep DC voltage to minimum. Select positive direction and switch ON the power. Increase the control current slowly and note the IL, Ic and Vc in observation table. Bring DC voltage to minimum, select negative. direction and repeat the characteristics curve in both direction. Calculate power gain
P (gain) = P(out)/P(in) or Δ IL *RL/ΔIc*Vc

CIRCUIT DIAGRAM:



OBSERVATION TABLE

S.No	Ic(mA)	IL(mA)	Vc(+ve)
1. 2. 3.			

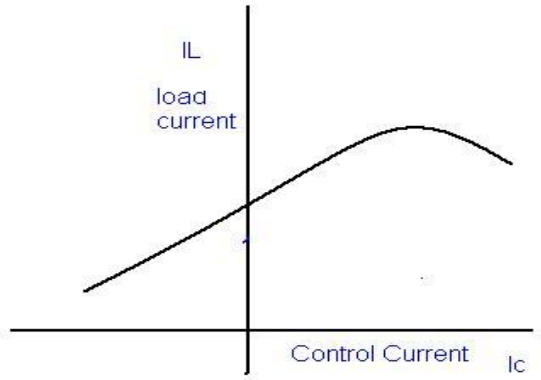
4.			
5.			

S.No	Ic(mA)	IL(mA)	Vc(-ve)
1. 2. 3. 4. 5.			

PRECAUTION :

2. Apply voltage slowly to control winding as the coil may get heated up and burn.
2. Take the reading carefully and accurately.
3. Switch off the set up when not in use.

GRAPH:-



DISCUSSION:-

The graph is plotted between load current and control current. for positive polarity the Control current rises in the forward direction with rise in load current where as for negative polarity the control current decreases in the reverse direction with rise in load current .This is due to the self saturation of the magnetic core .

QUIZ:-

Que.1. What are the modes of operation of the magnetic amplifier?
Ans. The magnetic amplifier operates in two modes Series-parallel mode and Self

saturation mode.

Q.2. What is the value load resistance RL for magnetic amplifier?

Ans. The value of load resistance RL for magnetic amplifier is 50 ohms Fix.

Q.3. What is power gain in magnetic amplifier?

Ans. The power gain in magnetic amplifier is the ratio of output power to Input power.

Q4. What is current gain in magnetic amplifier?

Ans. The current gain in magnetic amplifier is the ratio of load current to Control current .

Q5. What is core saturation?

Ans. When MMF in a coil is varied due to a varying current it causes the Magnetization to approach to a limit called saturation.

Q6. What is the direction of windings in the securable reactor?

Ans. In a securable reactor the two windings are anti- phase with each Other.

Q7. How self saturation is achieved in a magnetic amplifier ?

Ans. The self saturation of core is achieved by using two rectifier diodes D1 & D2 in series with load coil L1 & L2 .

Q8. How the magnetic core is brought out of saturation?

Ans. The core is brought out of saturation by passing a current through Control winding.

Q9. Which winding has more number of turns?

Ans. The control winding has more number of turns than the load Winding.

Que.10. Between which parameter graph is plotted for magnetic amplifier?

Ans. The graph is plotted between load current and control current.

EXPERIMENT NO. 5

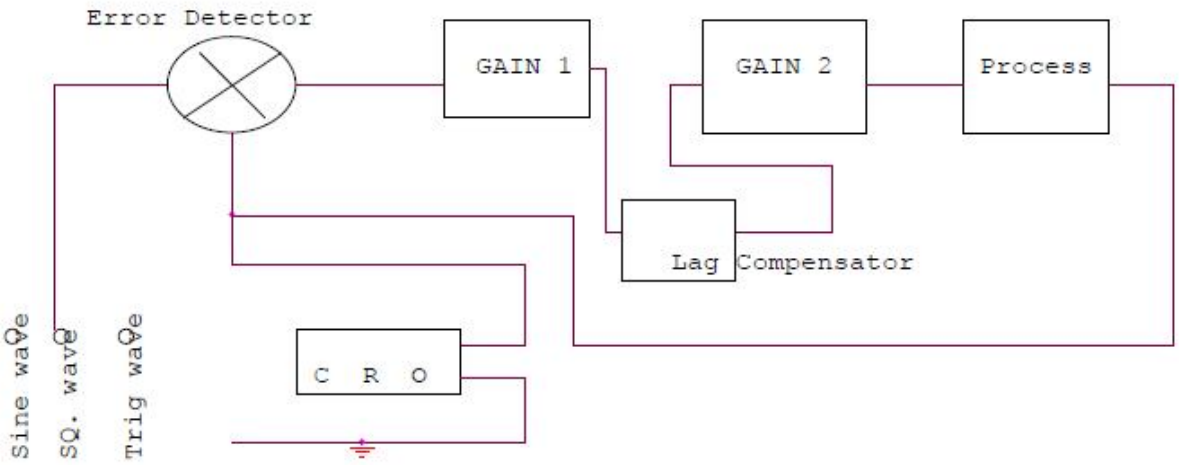
AIM: To study LEAD LAG compensator and draw magnitude and phase plot.

APPRATUS REQUIRED: lead lag compensator kit, CRO, and connecting leads.

THEORY:

Compensation network are often used to make improvement in transient response and small change in steady state accuracy. The set up is divided in to three parts. Signal source: It has sine wave of 10-1200 Hz. Of 0-8 Vpp, Square wave of 20, 40 and 80 Hz of 0- 2 Vpp. Trigger is available for trigger of CRO in external trigger mode. The amplitude is 1.2 Vpp. There are three compensation circuits as lag, Lead and Lag-Lead with transfer function. The set up has two DC regulated power supply for signal source and systems.

CIRCUIT DIAGRAM



PROCEDURE: The experiment is divided in two parts.

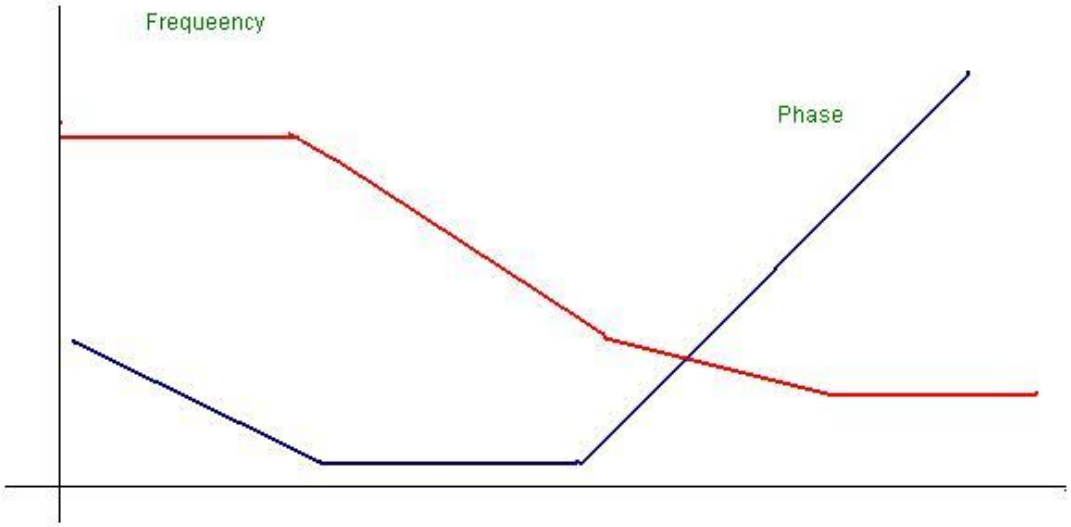
1. Open Loop Response: Connect square wave to gain and CRO across input and output. Select frequency to 80 Hz at 0.2 Vpp. Measure input amplitude Vpp as A and output as amplitude as B. Calculate gain factor=B/A. Connect sine wave with process input, CRO across input and output. Set input voltage =8Vpp. From low frequency end 10Hz note output voltage Vpp as B. Note the phase difference for each test frequency. Connect the sine wave with lag input .connect CRO across input and output. Note the output voltage, phase difference for each test frequency. Prepare a table between input/output voltage, gain magnitude in db and phase angle in degrees. Plot a graph accordingly.
2. Close loop response: connect the square wave signal of 20Hz, 1Vpp at input of error detector. Adjust gain to the value found from plot for required shape of response and sketch it 0 the paper. From the transient response measure maximum over shoot Mp, steady state error Ess and peak time Tp. Select wave frequency to 40Hz, 1Vpp and adjust gain control to 60%. Not gain control setting. Trace wave form on paper with record of Ess, Mp, and Tp. Select frequency to 80Hz and adjust gain control for minimum Ess 0. Trace wave form with Mp and Tp. connect process with lag compensator and gain 2. Set square wave frequency to 20Hz, 1Vpp at error detector input . Adjunct gain control to for similar Ess. Note gain to from dial setting. Trace the wave form on

paper with record of Mp, Tp and Ess.

OBSERVATION TABLE :

S.NO.	A Vpp	B Vpp	GAIN dB	PHASE ANGLE

GRAPH:



QUIZ:

Que.1. What is the use of adder at the input of PID controller?

Ans. Adder is used to sum up the reference signal and feed Back signal.

Que.2. What is the use of time delay?

Ans. Time delay generates a delay of 1.3 seconds between input And output.

Que.3. What is uncommitted amplifier?

Ans. It is an operational amplifier configurated as phase inverter.
Its gain constant is= -1.

Que.4. What is the range of frequency and amplitude of square wave Source?

Ans. The range of frequency is from 10 to 40 hz and amplitude is From 0 to 2 Vpp.

Que.5. What is range of voltage source?

Ans. The range of voltage source is from -2 to +2 v.

Que.6. What is equation of PID controller?
Ans. The equation of PID controller is
$m(t) = Kp\ e(t)+Ki\int e(t)dt+Kd\ de(t)/dt$.
Que.7. What is the transfer function of PID controller?
Ans. The transfer function of PID is G(PID) = m(s)/E(S).
Que.8. What are the methods of tuning PID?
Ans. There are two methods of tuning PID, process reaction curve method and continuous cycling method.
Que.9. What is the main advantage of derivative error compensation?
Ans. Main advantage of this compensation is that as the damping increases due to compensation , system settling time reduces.
Que.10. How derivative output compensation is obtained?
Ans. Derivative output compensation is obtained by means of a Tachometer feedback.

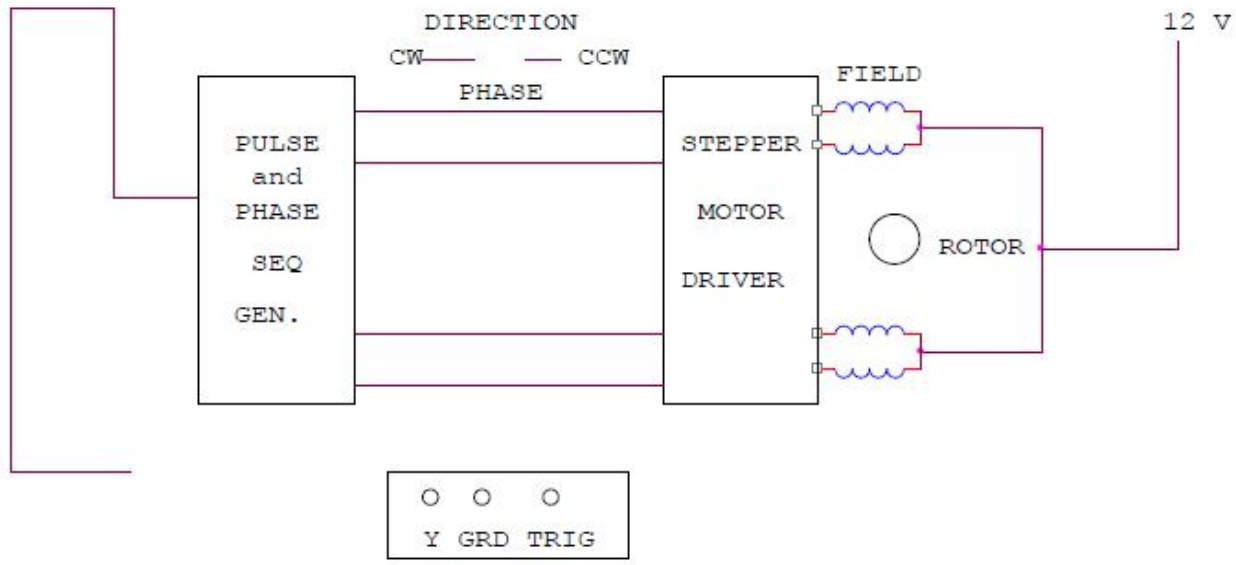
EXPERIMENT No. 6

AIM: - To study the stepper motor and to execute microprocessor computer based control of the same by changing number of steps, the direction of rotation and speed.

APPARATUS USED: - Stepper Motor Kit, µP Kit, Interface Cord and Connecting Leads.

THEORY:- The stepper motor is a special type of motor which is designed to rotate through a specific angle called step for each electrical pulse received from its control unit. It is used in digitally controlled position control system in open loop mode. The input command is in form of a train of pulses to turn the shaft through a specified angle. the main unit is designed to interface with µP 8085 kit. The stepper motor controller card remains active while the pulse sequence generator disabled as given plug is connected with µp interface socket . The following programme enables the stepper motor to run with µp 8085 kit. For two phases four winding stepper motor only four LSB signals are required.

CIRCUIT DIAGRAM:-



PROCEDURE:-

Connect the stepper motor with µp 8085 kit as shown in fig. press EXMEM key to enter the address as given then press NEXT to enter data .

ADDRESS DATA

2000 3E 80 MVI A, 80 Initialize port A as output port.
2002 D3 03 OUT 03 OB
2004 3E F9 Start MVI AFA
2006 D3 00 OUT 00 Output code for step o.
2008 CD 3020 call delay delay between two steps.
200B 3E F5 MVI A, F6 Location reserve for current Delay.

200d D3 OO OUT OO Output code for step 1.
200F CD 3020 Call delay delay between two steps.
2012 3E F6 MVI A, F5
2014 D3 OO OUT OO Output code for step 2.
2016 CD 3020 calls delay between two steps.
2019 3E FA MVI A, F9.
201B D3 OO OUT OO Output code for step 3.
201D CD 3020 call delay delay between two steps.
2020 C3 04 20 JMP START Start.
Press FILL key to store data in memory area. This will complete the pulse sequence generation. To delay programme route, first press EXMEM to start, a dot sign will appear in address field then enter the start address. Press NEXT to enter data.

ADDRESS DATA

2030 11 00 00 LXI D 00 00 Generates a delay.
2033 CD BC 03 CALL DELAY
2036 11 00 00 LXI D 00 00 Generates a delay.
2039 CD BC 03 CALL DELAY
203C C9 RET

Press FILL to save data to execute the programmed press the key GO .The above programme is to rotate the motor at a particular as defined by the given address.Changing the following contents will change the motor speed.

ADDRESS DATA

2030 11 00 20 AND 2036 TO SIMILAR 11 00 20
CHANGE 11 00 10 TO 11 00 10
CHANGE 11 00 05 TO 11 00 05
CHANGE 11 00 03 TO 11 00 03.

The motor direction depends upon codes FA, F6 ,F5 AND F9.Change in following codes will change the motor direction.

ADDRESS DATA
2005 3E F9 TO 3E FA
200C 3E F5 TO 3E F6
2012 3E F6 TO 3E F5
2019 3E FA TO 3E F9.

OBSERVATION TABLE:-

Sr No.	**No. of Pulses**	Displacement	Step Angle

RESULT:- The stepper motor runs as per fed programme.

PRECAUTION:-

1. Make the connection of motor with µp kit properly.
2. Feed the programme carefully and correctly.
3. Do not change the motor direction at high speed.

QUIZ:-

Que.1.Why the application of stepper motor is increasing?

Ans. The use of stepper motor is increasing due to availability in large power rating and reducing cost.

Que.2. What is stable condition of rotor in stepper motor ?

Ans. It is that angle at which torque is zero and is positive for smaller angle and negative for larger angle.

Que.3. What are the modes of operation of stepper motor?

Ans. There are two modes of operation of stepper motor, open loop and close loop mode.

Que.4. What are the types of stepper motor?

Ans. There are three types of stepper motors, VR stepper motor, P stepper motor and hybrid stepper motor.

Que.5. How the windings of stepper motor are wound?

Ans. The windings of stepper motor are wound in such a way that there are only two phases.

Que.6. How many logics are there in each sequence?

Ans. There are two logics in each sequence, 0 and 1.

Que.7. In how many phases does the motor run?

Ans. The stepper motor runs in four phases, A,AB, B and AB. Que.8. Why the stepper motor is run in four phases?

Ans. The stepper motor is run in four phases to avoid over stepping and to improve the response

Que.9. On what factor does the settling time of stepper motor depend?

Ans. The settling time of stepper motor depends upon loading and input sequence.

Que.10. What is use of µp kit?

Ans. The µp kit is used to run the stepper motor as per the fed programme.

EXPERIMENT No. 7

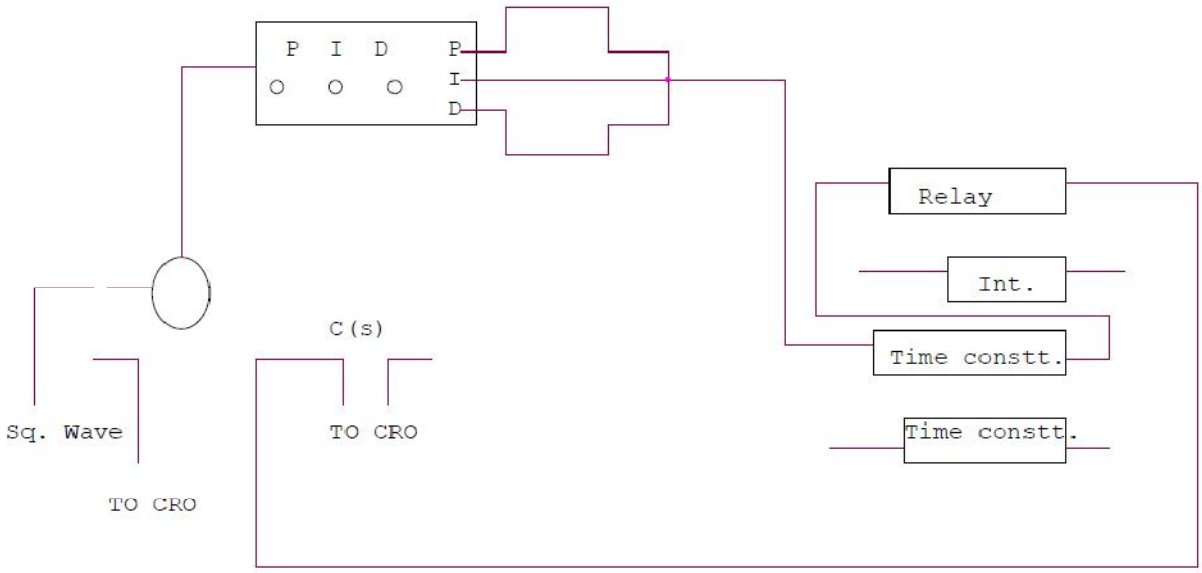
AIM:-To implement a PID controller for level control of a plant.

(a)To observe open loop performance of building block and calibration of PID controls
(b)To study P, PI, PID controller with type 0 system with delay
(c) To study P, PI, PID controller with type 1 system

APPARATUS REQUIRED: PID controller setup, CRO and connecting leads.

THEORY: - The setup is designed to study performance of analog PID controller with regulated system. The board has built in signal source, DVM, simulated process and thre adjustable parameters as PID,Pfor proportional gain , I for integrated gain and D for derivative gain .three socket are given to add or out any parameter PI &D .threr are two signal sources of squire wave which is adjustable in frequency (10-40 Hz) and amplitude (0-2 Vpp) and other signal source in shape of triangular wave to sweep CRO in X-direction. One DC voltage output which is continuously variable between – 2Vand +2V.

CIRCUIT DIAGRAM:-



PROCEDURE:

P control mode: connect the circuit as shown in the figure. Switch over CRO for XY mode. Adjust P control to 0.1 and note the X and Y values. Increase the value of P and note the results in table. Input 1.0 Vpp , squire wave of 50ms . I not connected to adder and D control at 00. switch over CRO in tigger mode and find out period of oscillation. Switch over again in XY mode and find out percentage over shoot and steady state error

PI control mode : connect the circuit as shown in figure set Kp =reading of dial. Kd=00. input signal of squire wave amplitude = 1Vpp at 20 Hz. Switch over CRO in XY mode. Increase I in steps and note the reading . find the result of Ki for 10-15 % over shoot with minimum Ess .

PID control mode : connect the circuit as shown in figure. Input =1Vpp squire wave of same frequency adjust Kp and Ki as table 1 and 2 . increase Kd in steps and note the Ypp and Xpp output from CRO. The equation of PID controller is

$M(t) = Kp\ e(t) + Ki \int e(t)\,dt + Kd\ de/dt$

OBSERVATION TABLE :

S NO.	Kp	Xpp	Ypp	OSPP	ESSPP

PRECAUTIONS:

1. Do not keep CRO in XY mode for long time.
2. Take the reading carefully and accurately.
3. Apply the required signal to the kit to avoid error.
4. Switch off the kit when not in use.

DISCUSSION:-In open loop response the plots are performed between Magnitude/frequency and phase/frequency. The upper curve is for gain/Frequency raised to 9.35 db. The middle curve is for frequency and the Lower curve is for phase. This shift in gain-cross over frequency and phase Margin is due to applied gain KA.

QUIZ:-

Que.1. What for compensation networks are used?

Ans. Compensation networks are used to make appreciable improvement in transient response and small change in steady- state accuracy.

Que.2. What are the types of compensation networks?

Ans. There are three types of compensation networks, LEAD, LAG and LEAD- LAG Compensation network.

Ans. The all pass filter is used to observe phase/frequency response.

Que.4. What is use of inverting amplifier?

Ans. The inverting amplifier is used to invert the phase oh feed back signal. It has gain K= -1.

Que.5. What are the responses of compensation network?
Ans. Compensation network has two responses, open loop response and Close loop response.
Que.6. What is use of LEAD compensation?
Ans. LEAD compensation is used to improve the phase margin to any desired Value for a specified error constant.
Que.7. What is the use effect of LEAD compensation on the system?
Ans. It increases the bandwidth and makes the speed response faster.
Que.8. What is the effect of LAG compensator on the system?
Ans. It reduces the bandwidth and slows down the speed response.
Que.9. What is use of LAG compensation?
Ans. LAG compensation is used for high order system with large error Constant and large bandwidth.
Que.10. What is process or plant?
Ans. It consists of an active network simulation of second order system Its transfer function is K/(St+1).

EXPERIMENT NO. 8

AIM:- To study basic open loop and close loop control systems.

Control System :-

A control system is a combination of elements intended to act together to accomplish an objective. Control systems are classified into two general categories. Open loop and closed loop control system. The distinction is determined by the control action, which is that quantity responsible for activating the system to produce the output.

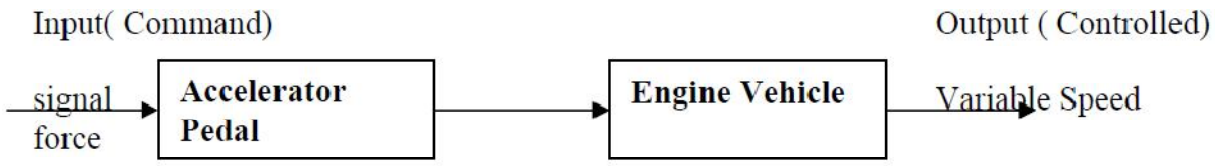
Open loop control system:-

An open loop control system is one in which the control action is independent of the output. The important features of open loop control system are:-

(1) Their ability to perform accurately is determined by their calibration, which implies to establish the input-output relation to obtain a desired system accuracy.

(2) They are not generally troubled with problems of instability.

BLOCK DIAGRAM:-



Examples of open loop control system:-

1. A man working on a road with his eyes closed is an example of open loop control system. The major components in walking are the brain, the eyes and the feet. The input may be chosen as desired work direction and the output actual work direction. The control action is determined by the eyes which detect the difference between input and output and send information to brain. Since the eyes are closed therefore the system is open loop.
2. Another example of open loop control system is an electric automatic coffee maker. One possible input for coffee maker is amount of coffee used. In addition most coffee makers have a dial which can be set for weak, medium or strong coffee. This setting usually regulates a timing mechanism. There for brewing time of coffee is another possible input and the output of any coffee maker can be chosen as coffee strength.

CLOSE LOOP CONTROL SYSTEM:-

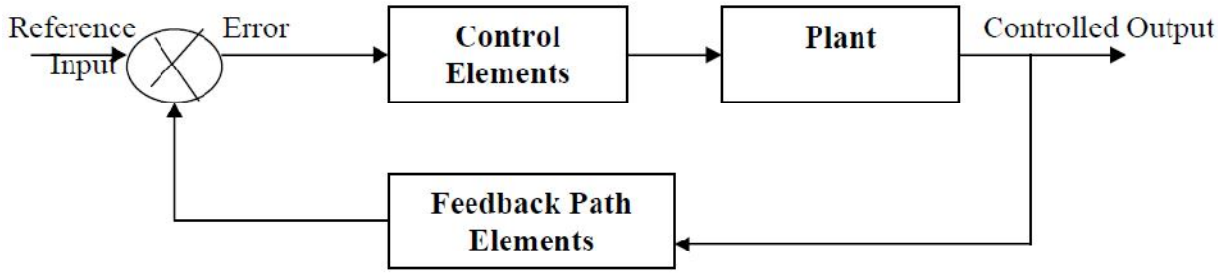
A close loop control system is one in which the control action is some how dependent of the

output. Close loop control systems are commonly called feedback control system. Feedback is that characteristics of close loop control system which differentiates it from open loop. It is the property of closed loop system which permits the output to be compared with the input. So that appropriate control action maybe formed as a function of input and output.

Important features of feedback are:-

1. Reduced effects of non linearites and distortion.
2. Increased accuracy.
3. Increased bandwidth.
4. Reduced sensitivity of the ratio of output to input to variations in system characteristics.
5. Tendency towards oscillation or instability.

BLOCK DIAGRAM:-



Examples of closed loop control system:-

1. A man working on a road with his eyes open is an example of closed loop control system. As eyes can distinguish between the desired walk direction and actual walk direction and make the necessary correction therefore the system is closed loop.
2. Another example of closed loop control system is an automatic toaster. In which each heating element supplies same amount of heat to both sides of the bread. And toast quality can be determined by its color. The toaster is initially calibrated for a desired toast quality which needs no re-adjustment. The toaster is automatically switched off when the sensor sees the desired color with the help of feedback linkage which may be electrical or mechanical. Since the output (color of toast) is dependent on input (temperature setting) there for the system is closed loop.

QUIZ:-

Qur.1 What is control system?

Ans It is combination of elements intended to act together to accomplish an objective. Que.2 How control system is classified?

Ans Control systems are classified as open loop and close loop open control system. Que.3 What is open loop control system?

Ans A system in which control action is independent of output. Que.4 What is closed loop control system?

Ans A system in which the control action is dependent on the output. Que.5 What are the main features of open loop control system?

Ans Ability to perform accurately and free from troubles of instability. Que.6 What are the main features of close loop control system?

Ans Reduced distortion and increased accuracy and bandwidth are the main features of close

loop control system.

Que7. Give the examples of open loop and closed loop system?

Ans. In old Air conditioning system, the systems used to work at certain interval without observing the room temperature. But in modern Air Conditioning System, the system senses the room temperature by using temperature sensor,if temperature exceeds certain limit then only the system starts cooling. So, old systems are example of open loop control and new systems are example of closed loop control.

Que 8. What is meaning of feedback?

Ans. Process in which the effect or output of an action is 'returned' (fed-back) to modify the next action. Feedback is essential to the working and survival of all
regulatory mechanisms found throughout living and non-living nature, and in man-made systems such as education system and economy.

Que9.What is error?

Ans. The difference between the SP and the PV. When errors are detected, the controller sends instructions to the control system to adjust the output to compensate. Que10.What is gain?

Ans. The ability of the control system to increase the power or amplitude of its signal.

EXPERIMENT NO:9

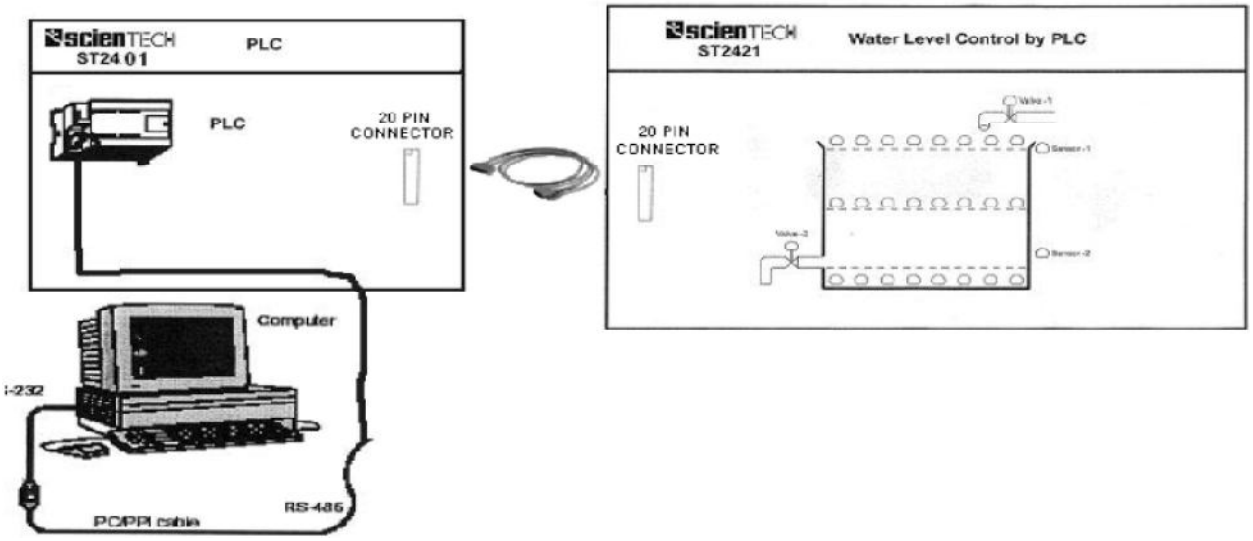
AIM: To study water level control using industrial PLC

APPARATUS REQUIRED: -Trainer kit ST2421 PLC trainer ST2401, ST2402 and connector.

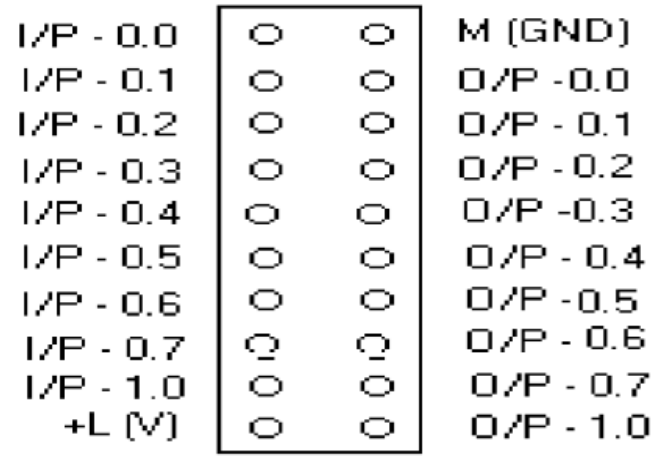
THEORY:

Water level controlling is shown with the help of LEDs. The apparatus is connected with output of PLC. Two valves for filling and draining water are shown, for indicating ON\OFF condition of valve LED is used. Filling of tank indicated by two sensors, positioned to sense maximum and minimum water levels of tank.

CONNECTION DIAGRAM:-



PIN CONFIGURATION OF CONNECTOR:-



PROCEDURE :

1. First the valve-1 will open (LED is ON),then water level will increase (row of LEDs will glow)
2. As level reaches above sensor-1, sensor LED will glow. As water level reaches above sensor-2 valve-1 gets closed.
3. After some delay valve-2 will get ON , which will drain water. As soon as water level goes below sensor-1, valve-2 will close. And same process will go on.

Truth Table

Sensor-1	Sensor-2	Valve-1	Valve-2
OFF	OFF	ON	OFF
ON	OFF	ON	OFF
ON	ON	OFF	ON

PRECAUTIONS:-

1. Use only the mains cord designed for this instrument
2. To avoid fire or shock hazards, observe all ratings and marks on the instrument.
3. Use the fuse type and rating specified for this instrument.
4. Do not operate in wet / damp conditions.
5. Do not operate in an explosive atmosphere.
6. Keep the product dust free, clean and dry.

QUIZ:-

Q.1 What is PLC?

Ans. A programmable logic controller (PLC) or programmable controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assemble lines, amusement rides, or light fixtures.

Q.2 What is full form of PLC?

Ans. The full form of PLC is Programmable Logic controller.

Q.3 What are the applications of PLC ?

Ans. Manufacturing Industry, Travel Industry, Textile Industry etc.

Q.4 Which is the famous programming language is used in PLC?

Ans. Ladder logic is mainly used in PLC.

Que5.What are the advantages of PLC.

Ans. Flexible, Correcting Errors, Space Efficient, low cost.

Que6. What are the most popular PLC's used on the packing industry?

Ans:Packaging industry PLC's, most notably cosmetic and pharamaceutical packaging machinery

Q.7 Why PLC is different from other Computers?

Ans. The main difference from other computers is that PLCs are armored for severe conditions (such as dust, moisture, heat, cold) and have the facility for extensive input/output (I/O)

arrangements.

Que8.What is DCS?

Ans. DCS is Distributed Control Systems which is used to control very big plants by using simple GUI screens.PLCs are interfaced with DCS for interlocking.

Que9.What is SCADA?

Ans. SCADA is Supervisory Control and Data Aquisition which is used to control and Monitor small number of Equipments in a field.

Que10.What is the difference between PLC and Relay?

Ans. PLC is the much less complex than large relay based system.Also PLC is the very flexible due to network architecture compare to relay panel.

EXPERIMENT NO:10

AIM: To study the MATLAB package for simulation of control system design.

APPARATUS REQUIRED: Matlab Software

THEORY:

To start MATLAB click on the MATLAB icon or type in MATLAB, followed by pressing the *enter* or *return* key at the system prompt. The screen will produce the MATLAB prompt >> (or EDU >>), which indicates that MATLAB is waiting for a command to be entered. In order to quit MATLAB, *type quit* or *exit* after the prompt, followed by pressing the *enter* or *return* key.

Display Windows

MATLAB has three display windows. They are

1. A *Command Window* which is used to enter commands and data to display plots and graphs.
2. A *Graphics Window* which is used to display plots and graphs
3. *An Edit Window* which is used to create and modify M-files. M-files are files that contain a program or script of MATLAB commands.

Entering Commands

Every command has to be followed by a carriage return <cr> (enter key) in order that the command can be executed. MATLAB commands are case sensitive and *lower case* letters are used throughout.To execute an *M-file* (such as Project_1.m), simply enter the name of the file without its extension (as in Project_1).

In order to see some of the MATLAB capabilities, enter the *demo* command. This will initiate the *MATLAB EXPO. MATLAB Expo* is a graphical demonstration environment that shows some of the different types of operations which can be conducted with MATLAB.

Abort

In order to *abort* a command in MATLAB, hold down the control key and press c to generate a local abort with MATLAB.

The Semicolon (;)

If a semicolon (;) is typed at the end of a command the output of the command is not displayed.

Typing %
When percent symbol (%) is typed in the beginning of a line, the line is designated as a comment. When the *enter* key is pressed the line is not executed.

The clc Command
Typing *clc* command and pressing *enter* cleans the command window. Once the *clc* command is executed a clear window is displayed.

Help
MATLAB has a host of built-in functions. For a complete list, refer to MATLAB user's guide or refer to the *on line Help*. To obtain help on a particular topic in the list, *e.g.*, inverse, type *help inv*.

MATLAB has an excellent collection of commands and functions that are useful for solving control engineering problems. Plotting root loci, Bode diagrams, polar plots, Nyquist plot, Nichols plot, and state space method are obtained using MATLAB.Transient responses include the step response, impulse response, and ramp response. They are often used to investigate the time-domain characteristics of control systems. Transient response characteristics including the rise time, peak time, maximum overshoot, settling time, and steady state error can be obtained from the step response. When the numerator and denominator of a closed-loop transfer function are known, the commands
step **(num, den), step (num, den, *t*)** in MATLAB can be used to generate plots of unit- step responses. Here, *t* is the user specified time.

The MATLAB command ''bode'' obtains the magnitudes and phase angles of the frequency response of continuous – time, linear, time – invariant systems. The MATLAB bode commands commonly used are:

Bode(num, den)
bode(num, den, *W*)
bode(*A, B, C, D*) (3.36)
bode(*A, B, C, D, W*)
bode(sys)

where *w* is the frequency vector.

MATLAB bode commands with left hand arguments commonly used are:
[mag, phase, *w*] = bode (num, den)
[mag, phase, *w*] = bode (num, den, *w*)

[mag, phase, *w*] = bode (A, B, C, D)
[mag, phase, *w*] = bode (A, B, C,D, *w*)
[mag, phase, *w*] = bode (A, B, C, D, iu, *w*)
[mag, phase, *w*] = bode (sys)

The MATLAB commands given returns the frequency response of the system in matrices mag, phase, and *w*. The plot is not drawn on the screen. The matrices mag,phase provide the magnitudes and phase angles of frequency response of the system, computed at the specified frequency points.

The magnitude may be converted into decibles using the MATLAB statement
magdB = 20 * log 10 (mag)

In MATLAB , the following command

logspace (*d*1, *d*2)
or logspace(*d*1, *d*2, *n*). logspace(*d*1, *d*2) are used to specify the frequency range that will generate a vector of 50 points logarithmically equally speed between decades 10*d*1 and 10*d*2
The MATLAB command

w = logspace (– 1, 2)

may be used to generate 50 points between 0.1 and 100 rad/sec. Similarly, the MATLAB command

logspace (*d*1, *d*2, *n*)
generates *n* points logarthimatically equally spaced between 10d1 and 10d2 where by the *n* points include both the endpoints. The MATLAB command

nyquist (num, den)

Draw the Nyquist plot of the transfer function
G(*s*) = num(s)/den(s)
where num and den contain the polynomial coefficients in descending powers of *s*.
The other MATLAB command uses for drawing Nyquist plots are:

nyquist (num, den, *w*)
nyquist (*A*, *B*, *C*, *D*)
nyquist (*A*, *B*, *C*, *D*, *w*)

nyquist (A, B, C, D, iu, w) (3.48)
nyquist (sys)
where w is the frequency vector.

The MATLAB command involving the user – specified vector w in computes the frequency response at the specified frequency points. The following MATLAB commands

[re, im, w] = nyquist (num, den)
[re, im, w] = nyquist (num, den, w)
[re, im, w] = nyquist (A, B, C, D)
[re, im, w] = nyquist (A, B, C, D, w)
[re, im, w] = nyquist (A, B, C, D, iu, w)
[re, im, w] = nyquist (sys)

are used to obtain the frequency response of the system in the matrices Re, im, and w. The plot is not drawn on the screen. The matrices Re and im contain the real and imaginary parts of the frequency response of the system, computed at the frequency points specified in the vector w.