Assignment No. ....

Assignment No. ....

List of Labs:

Assignment No. ....

Assignment No. ....

Lab # 02

To study speed Vs Input voltage characteristics of an armature control DC motor.

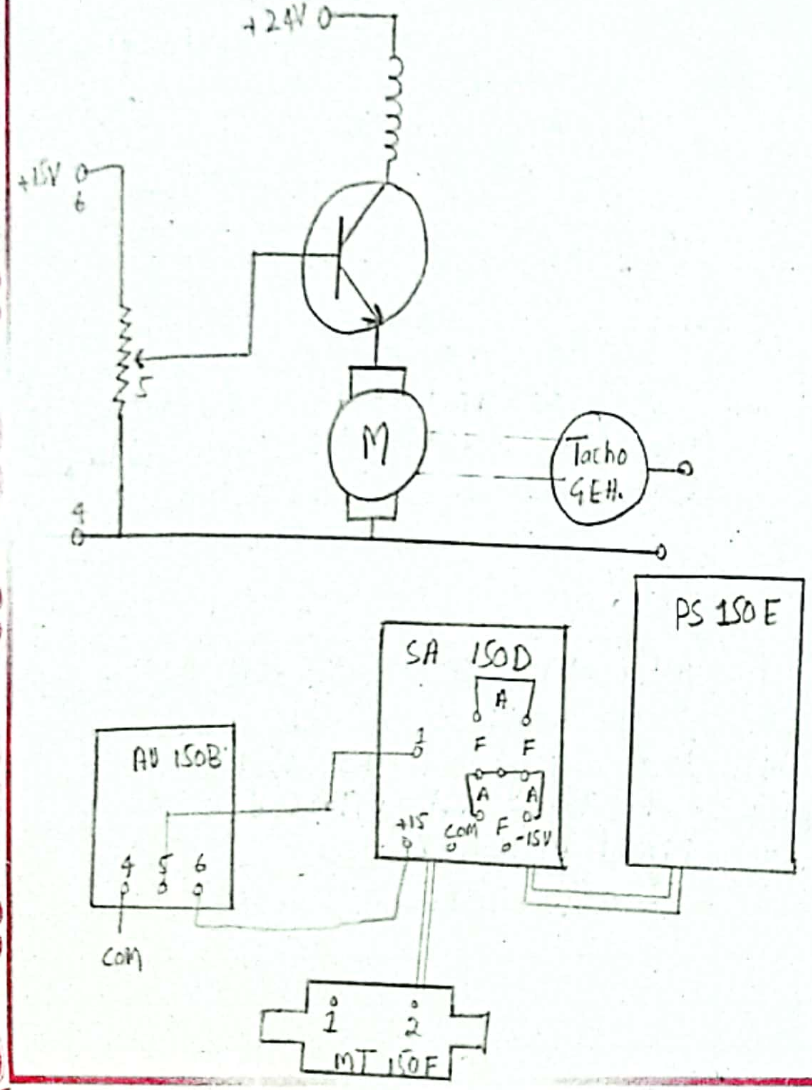
Objective:

In this experiment, we are going to study Speed Vs Input voltage characteristics of armature controlled DC motor under no load condition in open loop.

Apparatus:

i- Attenuator unit (Potentiometer) AU 150B.
ii- Servo Amplifier SA 150D.
iii- Power Supply unit. PS 150E
iv- Motor Tacho unit MT 150E.
v- Digital Multimeters.
vi- Connecting wires.

Circuit Diagram:



Theory:

The principle of DC motor is based upon Faraday's law of electromagnetism. Hence, when we apply input voltage to armature it carries current in it and start rotating in magnetic field. Similarly, when we increase the i/p voltage the current flowing through it also increases and hence the force applying on it also increase and as a result the speed increases.

Procedure:

i- Mount all the units on the base board and interconnect them according to circuit diagram.

ii- Servo amplifier connections are made for armature control of motor by linking together the three parts/pairs of circuit on the front of servo amplifier unit marked with letter A.

iii- Connect the digital multi-meter across the terminals 1 and 2 on the motor

Assignment No. ....

Observation:

S.No	Input (position → Voltage)	Output (voltage → Speed)
1	0	0
2	2	0
3	3.5	0
4	4	0.5
5	4.5	2
6	5	3.5
7	5.5	4.7
8	6	6.1
9	6.5	7.4
10	7	8.4
11	7.5	10
12	8	11.1
13	9	12.6
14.	9.5	14.8
15	10	16
		17.5

Assignment No. ....

tacho unit. The reading of multi-meter gives the speed of the motor in volts. To connect it into rev/sec multiply it with tacho generator constant Kc.

iv- The potentiometer supplies the variable o/p to the servo amplifier. Set the potentiometer to 0 initially.

v- Switch the power supply unit ON. Adjust the potentiometer until the motor just begins to run and note the potentiometer setting and the corresponding speed of the motor. As the o/p of Tacho as indicated by the digital multi-meter.

vi- From the results, plot the output voltage, i-e speed against potentiometer settings i-e input volts.

Conclusion:

At the end of experiment, we can see that the armature controlled DC motor run at variable speed.

Assignment No. ....

Assignment No. ....

Lab # 03.

To study Speed Vs Torque characteristics of Armature controlled DC Motor.

Objective:

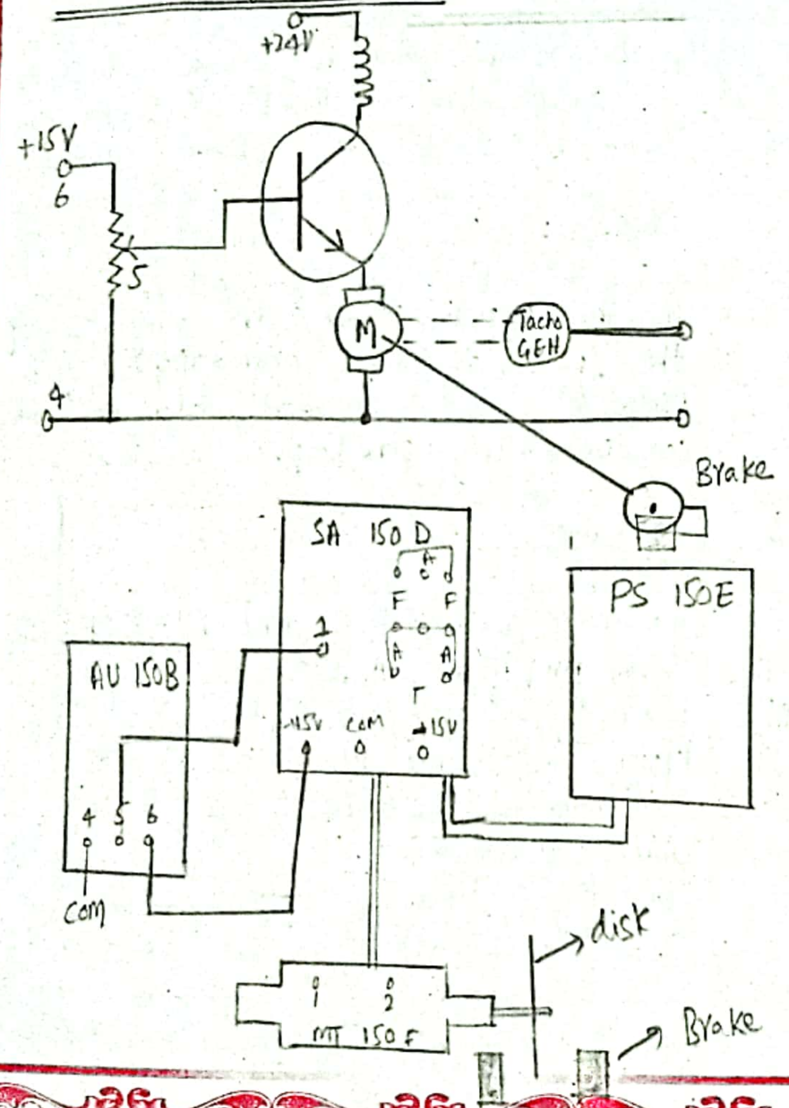
In this experiment, we are going to study the speed Vs Torque characteristics of Armature controlled DC motor under no load condition in open loop.

Apparatus:

i- Attenuator unit (Potentiometer) AU 150B.
ii- Servo Amplifier SA 150D.
iii- Power Supply unit PS 150E.
iv- Motor Tacho unit MT 150E.
v- Callibration Disk Brake LU 150B.
vi- Digital Multi-meter.
vii- Connecting wires.

Assignment No. ....

Circuit Diagram:



Assignment No. ....

Theory:

The lenz law state's that, "The current induced in a circuit due to change in a magnetic field is directed to oppose the change in flux and to exert a mechanical force which opposes the motion."

When we apply brake to moving disk, The conductor is moving in a magnetic field induce a current in it and hence according to lenz law it oppose its cause and hence oppose its motion and gets slow down.

Procedure:

i- Mount all the units on the bases board and interconnect them according to ckt diagram.

ii- Servo amplifier connections are made for armature control of motor by linking together the three pairs of circuit on the front of servo amplifier unit.

Assignment No. ....

Observations:

Load (Position)	Speed (volts).
10	3
9	4
8	4.6
7	5.4
6	6.5
5	8.6
4	15.6
3	18.6
2	21.0
1	22
0	23

Assignment No. ....

iii- Connect the digital multi-meter across the terminal 1 and 2 on the motor tacho unit. The reading of multi-meter gives the speed of the motor in volts. To convert it into rev/sec multiply it with tacho generator constant Kc.

iv- The potentiometer supplies the variable i/p voltage to the servo amplifier, set the potentiometer to 0 initially.

v- Switch the power supply unit ON. Adjust the potentiometer until the power supply unit shows max. current. Adjust the break setting to 10 and note the corresponding reading of multi--meter connected with tacho. Repeat the same bringing the break setting to 9 and so on.

vi- from the result, plot the break setting i.e, speed against tacho setting i-e volts.

Conclusion.

At the end of experiment we can conclude that the armature control has wide range of speed compared to field control.

Assignment No. ....

Assignment No. ....

Lab # 04.

To use operational amplifier as a summer and gain controller.

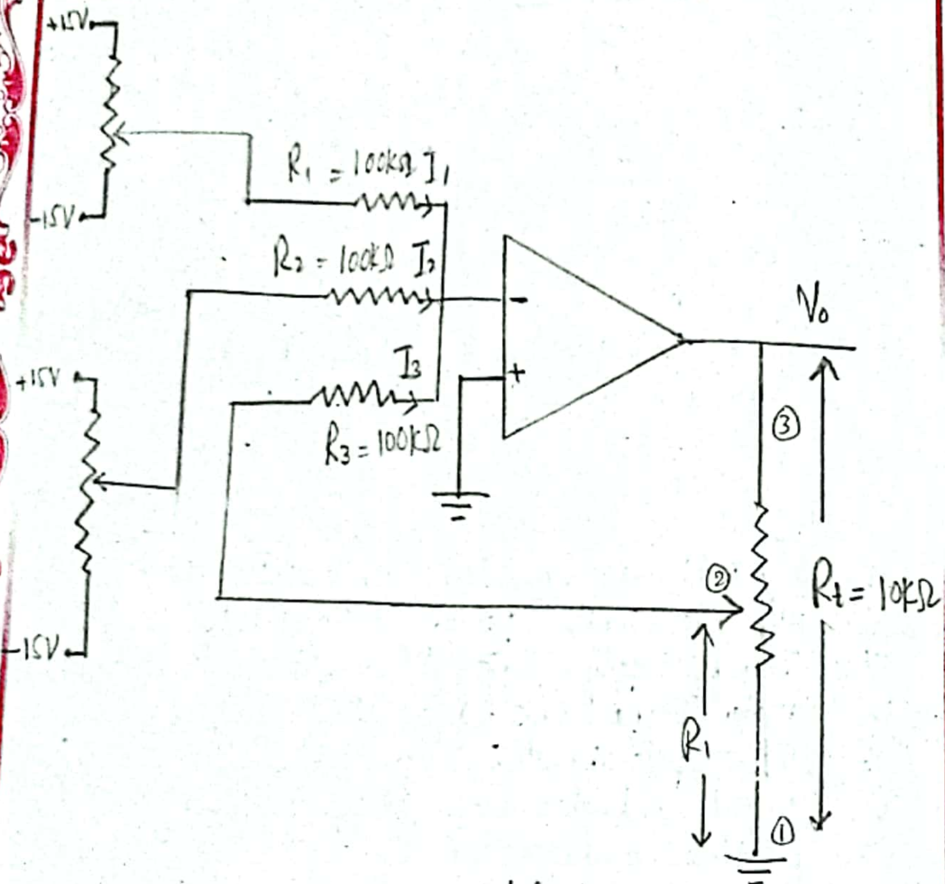
Objective:

In this experiment we are going to study operational amplifier as a summer and gain controller.

Apparatus:

i- Operational amplifier unit OU 150A.
ii- Attenuator unit (potentiometer) AU 150B.
iii- Power Supply unit PS 150E.
iv- Motor Tacho unit MT 150E
v- Input potentiometer unit IP 150H
vi- Output potentiometer unit OP 150K.
vii- Digital multimeter.
viii- Connecting wires.

Circuit Diagram:



$$\alpha = \left(\frac{R_1}{R_t}\right)$$

Theory:

"An operational amplifier is an integrated circuit that can amplify weak electric signal"

An Op-amp has two input pins and one output pin. Its basic role is to amplify and output the voltage difference between the two input pins.

It can be use as summer.

From the circuit diagram,

$$I_1 + I_2 + I_3 = 0$$

$$I_1 + I_2 = -I_3$$

$$\frac{V_1}{R_1} + \frac{V_2}{R_2} = -\frac{(R_1/R_t)V_o}{R_3}$$

If $R_1 = R_2 = R_3 = 100k\Omega$

$$V_1 + V_2 = -\frac{R_1}{R_t} V_o$$

$$\Rightarrow V_o = -\frac{R_t}{R_1}(V_1 + V_2).$$

Assignment No. ....

$$V_o = -\frac{1}{\alpha}(V_1 + V_2) \quad \because \alpha = \frac{R_f}{R_1}$$

Procedure:

i- Mount all the units on the baseboard and connect them according to ckt diagram

ii- Set the selector switch on the operational amplifier OU 150A to the external positions.

iii- Set the attenuator unit AU 150A initially to 10 unity gain and then vary the scale for variable gain.

iv- Set input and output potentiometer to zero to detect error.

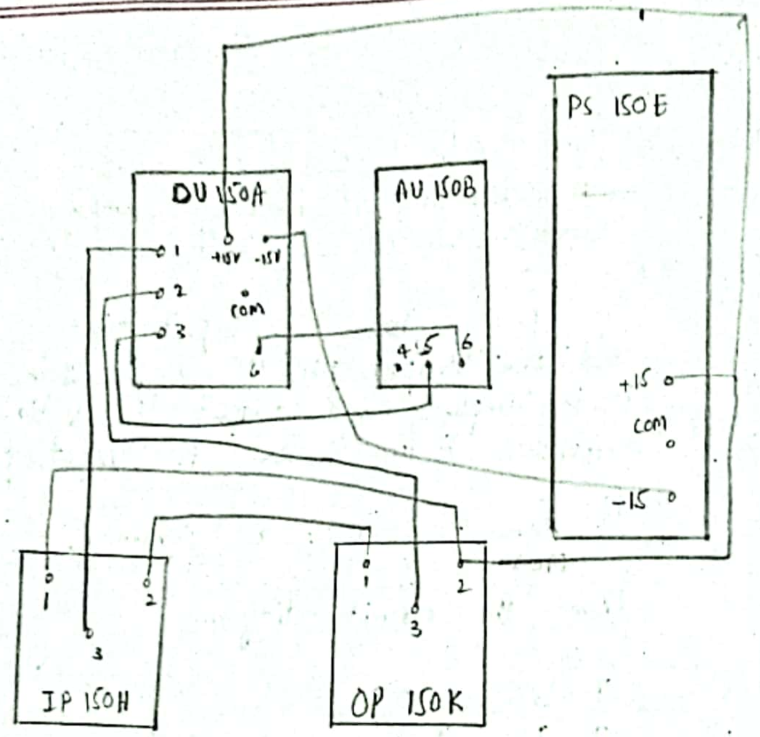
v- Connect ±15V to both i/p & o/p potentiometer.

vi- Add both reading and multiply it with -ive polarity of inverting amplifier.

vii- Verify all readings by hand and actual reading from Op-Amp.

viii- Verify scaling factor in case of variable gain of the OP-AMP.

Assignment No. ....



Observation

$R_1 = 5.6 k\Omega$

$R_f = 10 k\Omega$

$V_1 = 2.93V$

$V_2 = 4.20V$.

$V_o = -12.73$ (Op-Amp)

$V_o = -12.88$ (By hand).

Assignment No. ....

Assignment No. ....

Lab # 05

To study the relationship between the input reference voltage and speed of the armature control DC motor in close loop with unity gain.

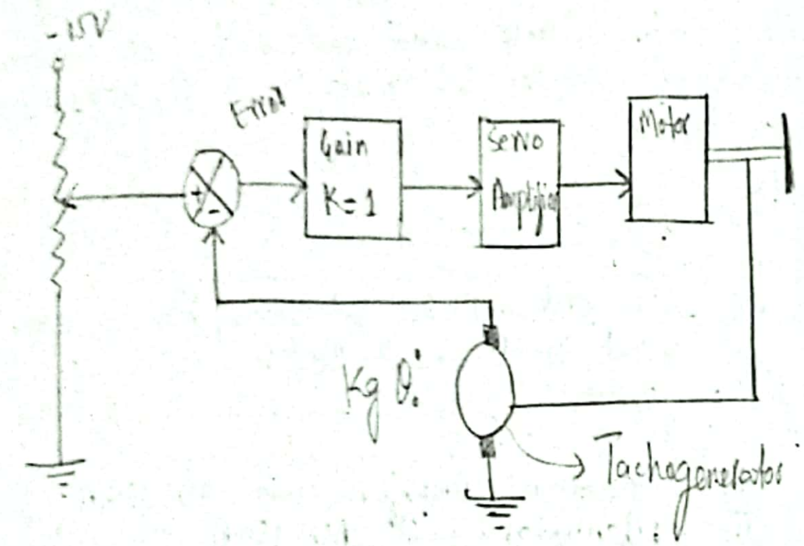
Objective:

To understand the relationship b/w i/p voltage and speed of DC Motor.

Apparatus:

i- Operational Amplifier unit OU 150A.
ii- Attenuator unit AU 150B.
iii- Power Supply unit PS 150E
iv- Motor Tacho unit MT 150E
v- Digital Multi-meter.
vi- Servo Amplifier SA 150D.
vii- Connecting wire.

Block Diagram:



Theory:

The speed of DC motor is a function of input voltage. Ideally if the forward path gain is very high only a small signal is required to operate the motor and then the motor speed will be such that the tachogenerator voltage substantially equals the reference voltage, so that the speed is controlled by the reference voltage. The steady state operating conditions of an ideal system may be represent by the following relations.

$$\dot{\theta}_o = KE \rightarrow (i)$$

Also $$E = V_{ref} - K_g \dot{\theta}_o \rightarrow (ii)$$

Put (ii) in (i)

$$\dot{\theta}_o = K(V_{ref} - K_g \dot{\theta}_o)$$

$$\dot{\theta}_o = KV_{ref} - KK_g \dot{\theta}_o$$

$$1 = \frac{KV_{ref}}{\dot{\theta}_o} - KK_g$$

$$\frac{KV_{ref}}{\dot{\theta}_o} = 1 + KK_g$$

Assignment No. ....

Observations:

V_{ref} (V)	V_f (V)	Error = $V_{ref} - V_f$ (V)
-7.07	2.39	4.65
-8.59	3.53	5.01
-9.51	4.21	5.28
-10.36	4.82	5.51
-11.06	5.32	5.68

Assignment No. ....

$$\dot{\theta}_o = \frac{K V_{ref}}{1 + K K_g}.$$

If K very large,

$$\dot{\theta}_o = \frac{V_{ref}}{K K_g}.$$

$$\dot{\theta}_o \propto V_{ref} \longrightarrow (A)$$

Equ (A) gives us relation which show relation between speed and input voltage.

Procedure:

i- Make connections according to circuit diagram.

ii- Turn ON the power supply.

iii- Set the Vref to a fix value and note the corresponding value.

iv- Repeat the experiment for several readings.

Assignment No. ....

Assignment No. ....

Lab # 08.

To study the speed Vs applied Load characteristics of armature control DC motor in closed Loop with unity gain.

Objective:

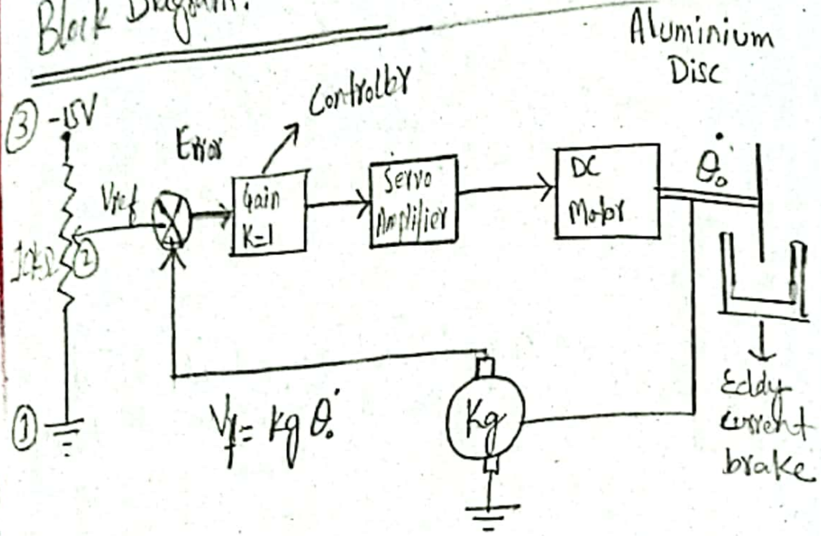
To understand that how Load effect the speed of DC motor in closed Loop.

Apparatus:

i- Operational Amplifier OU 150A
ii- Servo amplifier SA 150D.
iii- Power Supply PS 150E.
iv- Attenuator Unit AU 150B
v- Motor Tachogenerator MT 150F
vi- Magnetic brake.
vii- Digital Multimeter.
viii- Connecting wires.

Assignment No. ....

Block Diagram:



Assignment No. ....

Theory:

When a conductor moves in the magnetic field, emf is induced in it and according to len'z law the effect produced opposes its cause which produce it. In this case the cause of production of Emf is its own rotation. Hence, the speed of DC motor is reduces in this case when Load is applied on the disc of DC motor in the form of magnetic brake.

Procedure:

i- Mount all the units on base boarde and interconnect them according to the circuit diagram.

ii- Servo amplifier are connected according to the armature control DC motor.

iii- Turn ON the Power Supply.

Assignment No. ....

Observations

Brake Setting	Speed (V)	Error (V)	Vref (V)
1	8.1	6.7	-14.9
2	7.4	7.4	"
3	5.2	9.6	"
4	4	10.8	"
5	3.4	11.3	"
6	2.8	11.1	"
7	2.4	11.1	"
8	1.9	11.1	"
9	1.4	11.0	"
10	1.1	11.0	"

Assignment No. ....

iv- Set the Vref to -14.9V and don't change it.

v- Now apply load in the form of magnetic brake.

vi- Start applying brake from zero position to 10th position.

vii- Also note the corresponding readings for all the positions of brake.

viii- Draw the result of speed & brake setting on graph paper

Assignment No. ....

Lab # 10.

To study the speed Vs applied load characteristic of armature control DC motor in closed Loop with variable gain.

Objective:

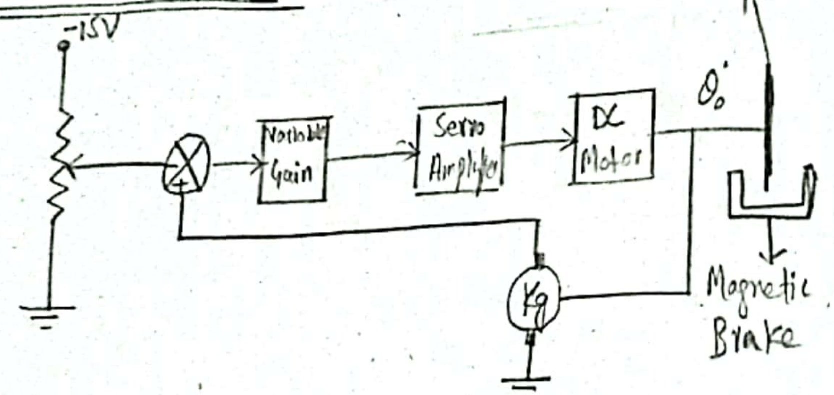
To understand the speed and applied load relation when we test it on different value of gain.

Apparatus:

i- Operational Amplifier OU 150A.
ii- Power Supply PS 150E
iii- Attenuator Unit 150B.
iv- Motor Tachogenerator unit 150F.
v- Magnetic brake.
vi- Servo amplifier SA 150D.
vii- Digital Multimeter.
viii- Connecting wires.

Assignment No. ....

Block Diagram:



Assignment No. ....

Theory:

According to lenz law the effect oppose the cause which produce it. In this experiment, the rotation of disc is opposed by emf generated because emf is produce by rotation of disc.

Now if we repeat the same experiment on different value of gain, the signal which drives the motor has different speed and if speed is different the applied load effect speed accordingly.

Procedure:

i- Mount all units on baseboard and connect according to circuit diagram.

ii- Set nobe of OU 150A to external.

Assignment No. ....

Observation

Assignment No. ....

iii- Select a particular Vref value.

iv- Now apply brake setting and note down corresponding values.

v- Change the gain to another value.

vi- Note down the corresponding values.

vii- Repeat same experiment for three values of gain.

viii- Plot all the value for one particular value of gain.

Assignment No.

Assignment No.

Lab # 11

Position control of Armature Control DC motor using PID controller

Objective:

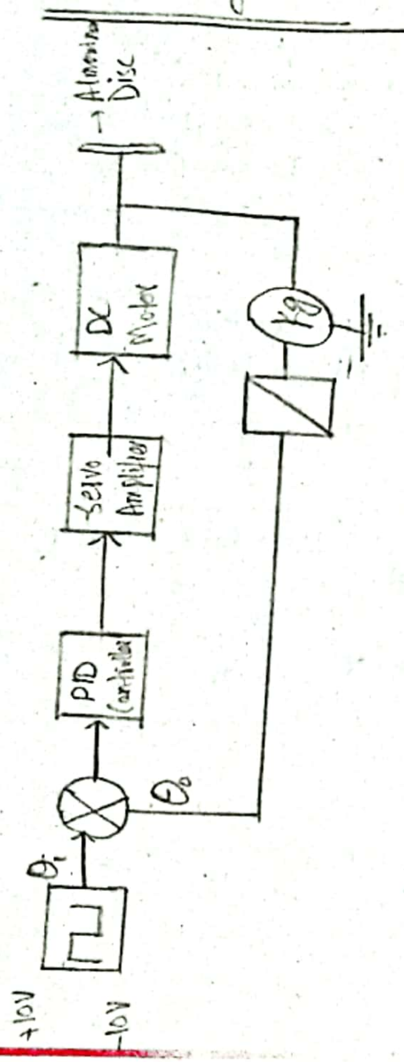
How we can control position of DC motor by using PID controller.

Apparatus:

i- Servo Analogue Fundamental Trainer.
ii- Mechanical unit.
iii- DC Motor.
iv- Output potentiometer.
v- Oscilloscope.
vi- Connecting wires

Assignment No. ....

Block Diagram:



Assignment No. ....

Theory:

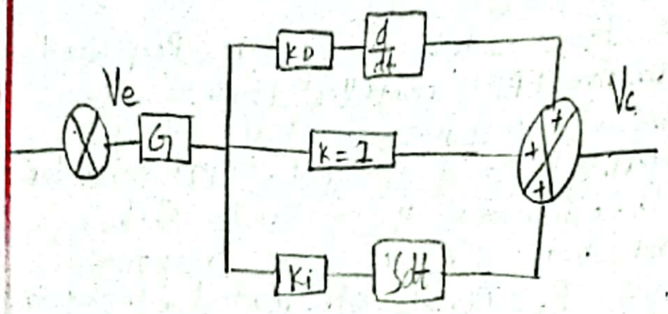
From control theory the Proportional derivative (PD) controller improves the transient response. Similarly, the Proportional and Integrator (PI) controllers will eliminates the steady state error but give a slow response. While Proportional + Differential + Integrator (PID) controller gives the best response.

A very versatile control signal can be obtained by combining components depending on the error, the derivative of the error and on the integral of the error.

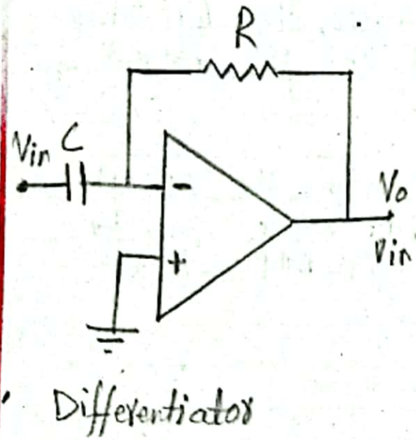
With capacitor as i/p, the OP-AMP act as differentiator while capacitor in feedback, the OP-AMP act as integrator.

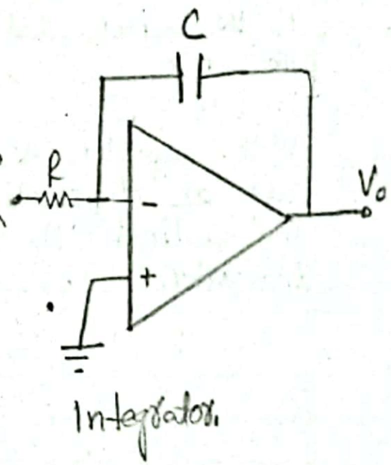
Assignment No. ....

PID Circuit:



$$V_c = G_1 \left(V_e + K_D \frac{d}{dt} V_e + K_i \int V_e dt \right)$$





Assignment No. ....

Procedure:

i- Make the connections on the servo analogue fundamental Trainer according to circuit diagram.

ii- If the $K_D = 0$ and $K_i = 0$, the response of signal is not good.

iii- By increasing K_D the transient response get improved.

iv- By increasing K_i the steady state error get reduces.

v- The figure showing waveforms on oscilloscope is attached.

Assignment No. ....

Assignment No. ....

Lab #: 12

Introduction to Magnetic Levitation.

Objective:

To observe the trajectory followed by freely suspended ball in magnetic field.

Apparatus:

i- Magnetic Levitation System 33 → 210
ii- Ball.
iii- Tracking PID arrangements.
iv- Computer.
v- MATLAB Simulink software.

Assignment No. ....

Assignment No. ....

Theory.

Magnetic Levitation or magnetic suspension is a method by which an object is suspended with no support other than magnetic fields.

The principle of magnetic levitation is that a vehicle can be suspended and propelled on a guidance track made with magnets. The vehicle on top of the track may be propelled with the help of a linear induction motor. Magnetic levitation can create frictionless, efficient, far-out sanding technologies. Both magnetic attraction and repulsion are used to move the train car along the guideway.

Procedure:

i- First of all make the arrangement for tracking PID arragement setup.

ii- The upward force applied on free

Assignment No. ....

Assignment No. ....

suspended ball is magnetic force.

iii- The force acting downward is gravity.

iv- When both forces have same effect.

v- The path followed by ball is sinusoidal wave.

vi- The path can be shown in MATLAB simulink Software.

Assignment No. ....

Assignment No. ....

Lab # 13