Experiment No. 5 **Date:**

Aim:

To study DC servo mechanism.

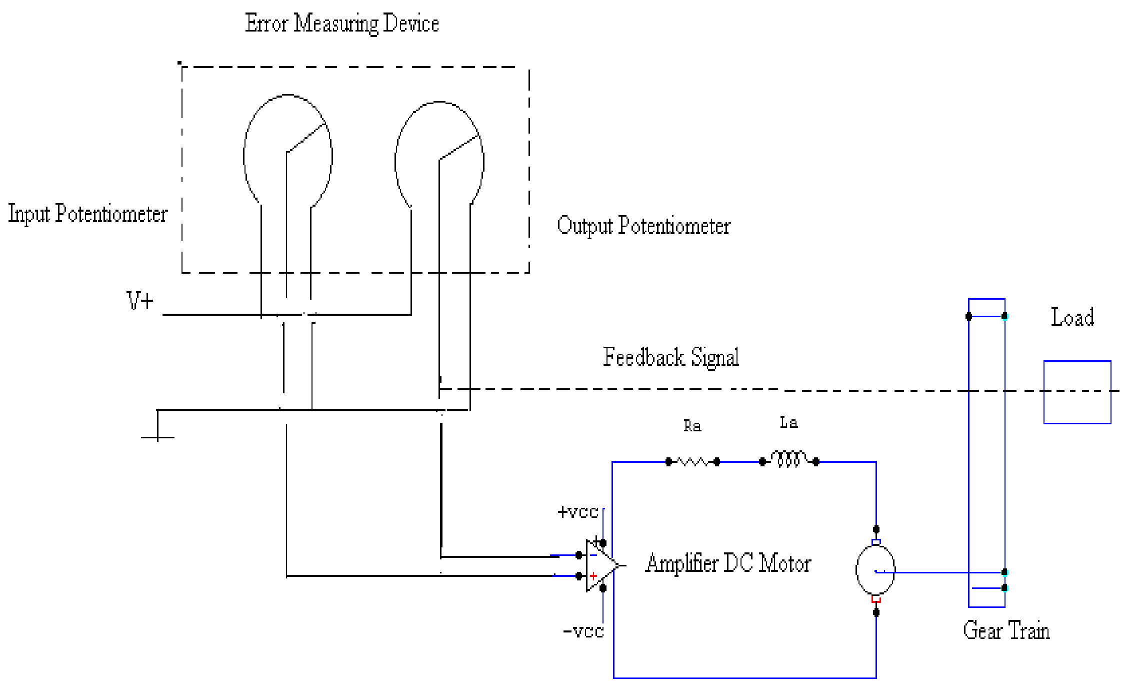
Apparatus:

D.C .position control kit,

Connecting cords.

Diagram:

DC Position System



Theory:

A servomechanism is a feedback control system in which the o/p is some mechanical position. Servomechanism are extensively used in industry
Ex. Automatic operation of machine tool, Servo voltage stabilizer.

Consider the servomechanism as shown in fig. the objective of this system is to control the position of mechanical load in accordance with the ref. position. Reference position is set by i/p reference potentiometer O/p position of the load is mechanically linked with o/p potentiometer. A pair of reference potentiometer & O/p potentiometer acts as error measuring devices. They convert the I./p & O/p position into proportional electric signal. The command I/p signal determines the angular position Θr of the wiper arm of the I/p reference potentiometer. This angular position Θr is the reference i/p to the system & the electric potential of the arm VR is proportional to the angular position of the arm.

$$VR = Ko\ \Theta r \qquad \text{where Ko--- constant}$$

The O/p shaft position determines the angular position Θc of the wiper arm of the potentiometer & VF is the electric potential of the arm proportional to the angular position Θc.

$$VF = Ko.\ \Theta c \qquad \text{where Ko= constant}$$

The potential difference e=VR-VF is the error signal.

The error signal is amplified by the amplifier & using proper power circuitry, is amplified to the armature circuit of the DC meter. The amplifier must have very high impedance because the potentiometer are essentially high impendence circuit & do not tolerate current drain. At the same time, the amplifier must have low O/p impendence since it feeds into the armature circuit of the motor.

If an error exists, the motor develops a torque to rotate the O/p load in such a way as to reduce the error to zero. For a constant field current, the torque developed by the motor is,

$$T = K_2\ ia$$

Where K_2 is the torque constant & ia is the armature current.

For the armature circuit,

$$La\ (Dia/dt) + Ra\ (ia)\ [d\Theta/dt] + K3 = K_1 e \qquad \text{----------(1)}$$

Where K_3 is the back Emf. constant of the motor & Θ is the angular displacement of the motor shaft. The equation for torque equilibrium is,

$$Jo\ [d^2\Theta/\ dt^2] + fo\ [d^2\Theta/dt] = T = K_2\ ia \qquad \text{-----------(2)}$$

Where Jo is the inertia of the combination of the motor, load & gear train referred to the motor shaft & fo is the viscous friction coefficient of the combination of the motor, load & gear train referred to the motor shaft. The transfer function between the motor shaft displacement & the error signal is obtained from eq. 1 & 2

Hunting:

Motor operation represents a slight problem in servomechanism. When the error signal is zero & power amplifier O/p is zero, the inertia of the motor tends to keep it going for a brief period, turning the O/p potentiometer past to zero position. As a result, the potentiometer develops an error voltage of the polarity opposite from the initial error voltage. The 180 polarized new error voltage is amplified & causes the servo meter first to stop & then to turn the opposite direction. This process is called as hunting or overshoot continues till the motor finally settles down & stops.

Damping:-

There are 2 ways of reducing the overshoot

1. Mechanical or friction breaking

2. Using electrical feedback

3. Electrical or electronic damping is achieved by means of negative feedback.

1. Mechanical damping uses a pressure wheel either on the motor shaft or in the gear box. By applying pressure to this friction break or in the gearbox. By applying pressure to this friction brake a small amount of drag is placed on the motor. When the servo motor reaches its new position, the friction is great enough to overcome the inertia of the motor & it stops exactly at the desired position.

Procedure:

1. Make power on to the unit.
2. Connect 5 pin motor connector to the unit, motor starts rotating.
3. Adjust the speed of motor by adjusting clock rate to the controller.
4. Make Fw/Rew I/p HI or LOW by connecting it to V+ or ground & note that motor reverses the direction depending on HI or LOW input.
5. Note the O/p pulse pattern of controller & verify truth table.
6. Connect Lo signal to RESET I/p of controller & observe the status of motor.
7. Keep clock rate minimum most possible & note number of steps for one revolution of the motor.
8. From this calculate step angle = 360/ no. of steps.

Result:

Conclusion: