Objective: To study the performance characteristics of D.C motor speed control with open loop and close loop.

Apparatus Used:

FEATURES AND SPECIFICATIONS:

- Speed control of a 12V, 4W permanent magnet D.C motor.
- Speed range to 0 to 3000 rpm.
- Opto-interrupter based speed sensing.
- 4-digit speed display in rpm.
- Electronic tachometer for feedback.
- Separate unit for motor in a see- through cabinet.
- Smooth, non- contact eddy current brake for loading.
- Built-in 3/2 digit DVM for signal measurements.
- Built-in TC regulated interval power supply.

THEORY:

Accurate speed control is a requirement in many industrial and process control systems. The main characteristics of such a system are its steady state error and disturbance rejection properties. Speed control of a D.C motor is also one of the basic systems covered in a first course on automatic control system. Facilities are available to directly measure the principle performance factors of the speed control system, viz. steady state error and load disturbance rejection as a function of the forward path gain.

An important feature of the unit is the built-in absolute speed measurement through optical pickup from a slotted disk followed by a frequency counter. Variable loading of the motor is achieved by a built-in eddy current brake. The motor unit, housed in a cabinet with transparent panels, provides a good view of the mechanical arrangements.

In order to evaluate the system performance, it is necessary to compute the overall transfer in terms of the different blocks.

$$\frac{\theta(s)}{V(S)} = \frac{km}{s(sT+1)}$$

Where km is the motor gain constant and T is the time constant. Considering motor speed wωrad/sec (=dθ/dt) as the output variable, the forward path transfer function may be written as,

$$G(s) = \frac{\omega(s)}{Ve(s)} = Ka\,\frac{Km}{sT+1}$$

$$H(s) = \frac{V_t(s)}{\omega(s)} = K_T$$

This yields the closed loop transfer function of the complete system as,

$$\omega(s) = \frac{K_A}{sT+ka+km+1}.K_m = \frac{\frac{K_A K_M}{\frac{K_A K_M K_T}{T}}}{s\left[\frac{T}{K_A K_M K_T+1}\right]} + 1$$

TRANSIENT RESPONSE:

For a step input V_R(s) = R/S,

$$\omega(s) = \frac{R}{S}\frac{\frac{K_A K_M}{T}}{S+K_A K_M K_T/T}$$

Taking inverse Laplace Transform,

$$\omega(t) = R.\frac{K_A K_M}{K_A K_M K_T+1}$$

The transient r5esponse has an exponential character similar to capacitor charging through a resistor. Further, the effective time constant T_{eff} decreases with increasing K_A making the motor response faster.

The effective time constant may be determined from a recording of the step response using either pen recorder or a storage CRO.

DISTURBANCE REJECTION:

One of the most important features of a feed back control system is its ability to reduce the effect of external disturbances. From fig, the disturbance transfer function for VR=0, may be written as

$$\frac{\omega(s)}{\omega_D} = \frac{1}{G(S)H(S)+1} = sT + \frac{1}{sT+1+K_A K_M K_T}$$

For unit step disturbance $\omega_{D(S)} = \omega_{D(s)}$, the steady state output speed is given by

$$\omega_s = \frac{\Omega}{K_A K_M K_T + 1}$$

Figure:

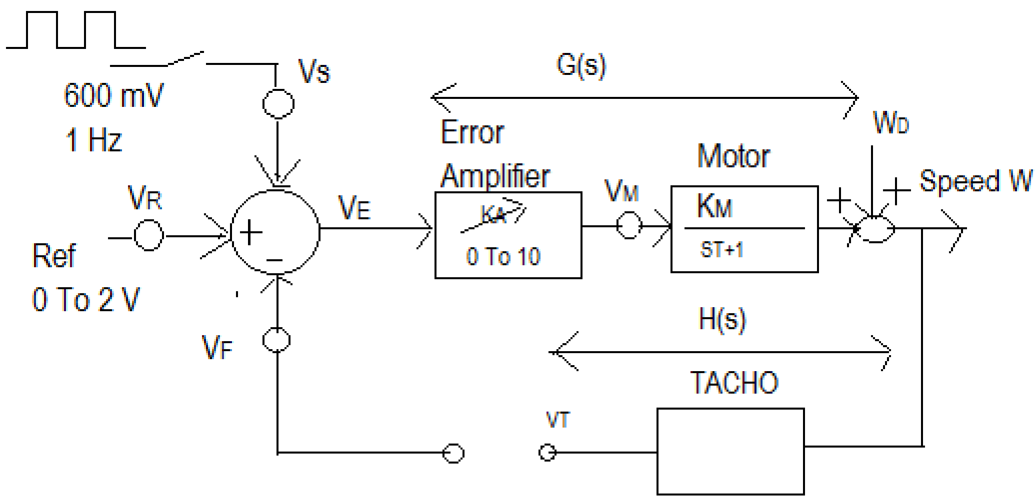

Fig : Bloch Diagram

OBSERVATIONS:

- $V_R = 1\ volt$
- FOR OPEN LOOP SYSTEMS:

S.NO.	K_A	N_{rpm}	V_T(volt)	V_M	$K_A = V_M/V_R$

- **FOR CLOSED LOOP SYSTEM:**

S.NO.	K_A	N_{rpm}	V_T(volt)	V_M

RESULT:

Graph is plotted between the speed (N) and motor voltage V_M and between the tachogenerator and speed (N).

PRECATIONS:

1. Amplifier gain must adjust properly.
2. Multimeter should be in D.C mode before taking the voltage readings.
3. Readings must be taken properly.