

## Laboratory Tutorial#2

**2.1. Objective:** To illustrate the performance of a motor being controlled by a servo amplifier.

**2.2. Equipment Required:** Following equipment is required to perform above task.

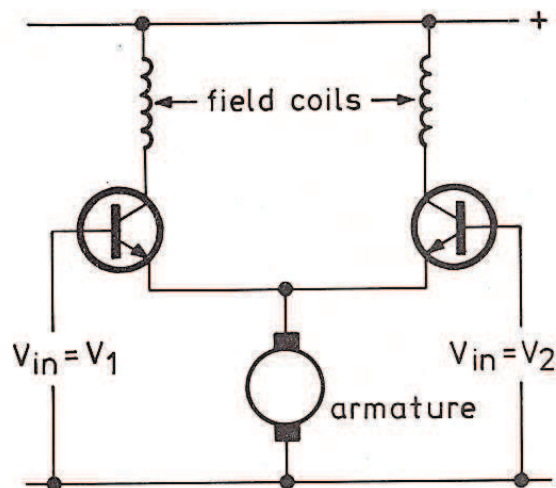
<u>Quantity</u>	<u>Apparatus</u>
1	AU150B Attenuator Unit
1	SA150D Servo Amplifier
1	PS150E Power Supply
1	MT150F Motor-Tacho Unit
1	LU150L Load Unit
1	Stop Clock
1	Multimeter

**2.3. Approximate Time Required:** One to two Hours

**2.4. Prerequisites:** Laboratory Tutorial#1.

### 2.5 Discussion

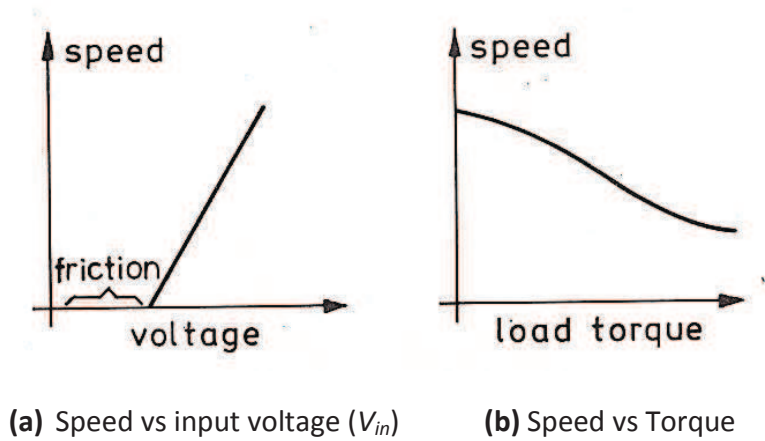
In later laboratory assignments we are going to show how an electric motor can be used in position and speed control systems. This assignment will illustrate the characteristics of the motor used in this kit and show how it can be controlled by the Servo Amplifier.



**Figure-2.1:** Armature control Arrangement

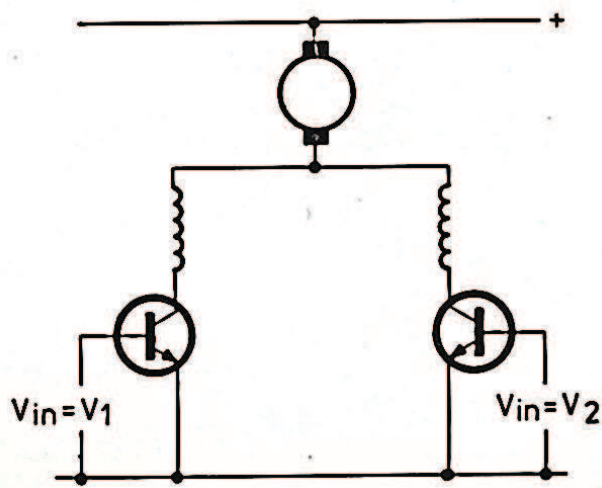
The motor has a split field winding, with current flow in each part of the coil being controlled by a transistor. This means the direction of rotation can be reversed, with input 1 on the Servo Amplifier

making the motor rotate in one direction and the input 2 in other direction, as in figure-2.1. As the motor accelerates the armature generates an increasing 'back-emf'  $V_b$  tending to oppose the applied voltage  $V_{in}$ . The armature current is thus roughly proportional to  $(V_{in}-V_b)$ . If the speed drops (due to loading)  $V_b$  reduces, the current increases and thus so does the motor torque. This tends to oppose the speed drop. This mode of control is called 'armature-control' and gives a speed proportional to  $V_{in}$ , as in figure-2.2 (a).



**Figure-2.2:** Motor Characteristics (Armature control Mode)

Due to brush friction, a certain minimum input signal is needed to start the motor rotation. Figure-2.2 (b) shows how the speed varies with torque.



**Figure-2.3:** Field Control Arrangement

The connections on the Servo Amplifier also allow the armature to be connected in the collector circuits of the transistors, as in figure-2.3, and this configuration will be referred to as 'field control'. In this case back emf will have much less effect on the motor current. This means that the transistor current and therefore the motor current largely determined by the input signal  $V_{in}$ .

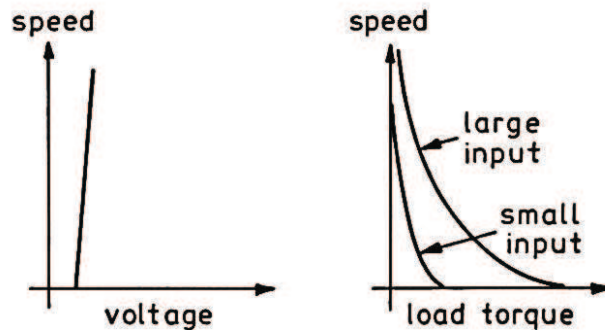


Figure-2.4: Motor Characteristics (Field control Mode)

Figure-2.4 (a) shows how with the motor unloaded, any small increase in input (above the minimum value) will cause a large increase in speed. This makes the motor difficult to control. Under load there is a very sharp fall in speed, as shown in figure-2.4 (b).

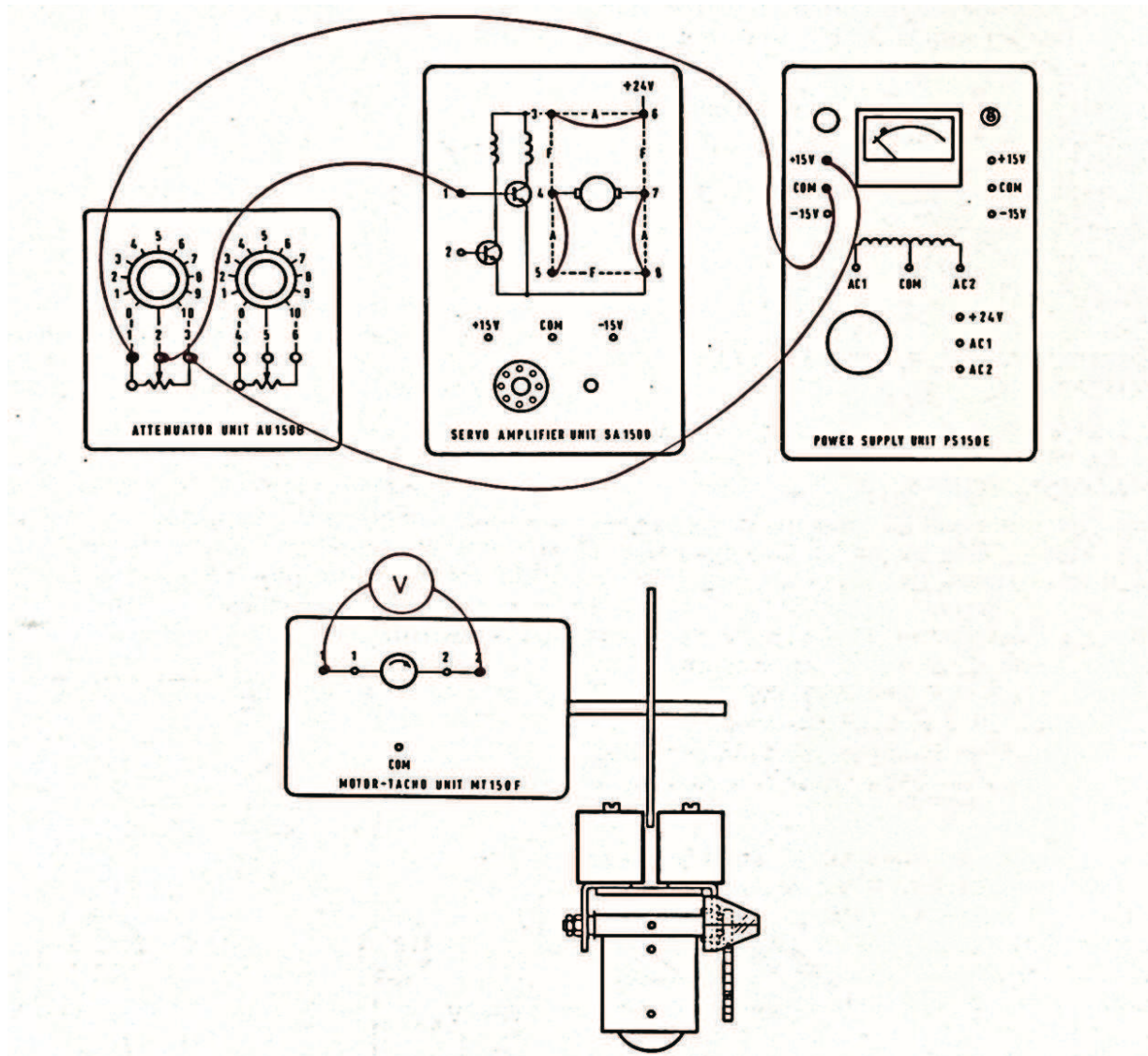


Figure-2.5: Experimental set up (Armature Control Mode)

## 2.6 Experimental Set Up

The first experiment will be to obtain the characteristic of the motor connected for armature control, as in figure-2.5. By using one of the potentiometers on the Attenuator unit, it is possible to obtain a variable input signal  $V_{in}$ . The kit provides a tacho-generator coupled to the motor. To obtain values of speed, it will be necessary to calibrate this generator by finding the factor  $K_g$ , which is the volts generated per thousand rev/min.

Connect the voltmeter across the tacho outputs and switch on the power. Turn the slider on the potentiometer till there is a reading of 1V on the voltmeter. Count the turns of the geared 30:1 low speed shaft in one minute. Tabulate your result as in table-2.1.

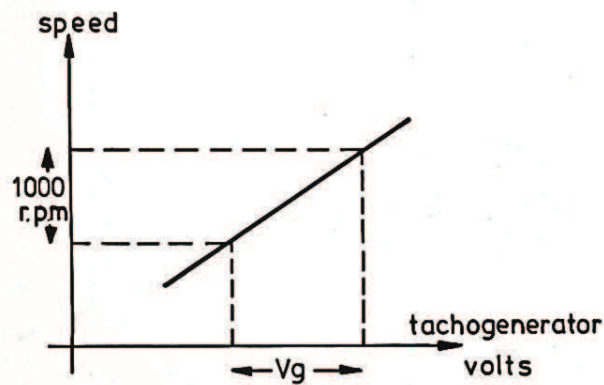


Figure-2.6: Tachogenerator volts vs speed

Repeat this reading with a 2V generator output. Then repeat for 3V, 4V, 5V, 7V and 10V and plot the graph of your results, as in figure-2.6, of speed against Tachogenerator volts. The calibration factor

$K_g = \frac{V_g}{N}$  should be about 2.5V to 3V per 1000 rev/min.

S.No	Tachogenerator volts ( $V_g$ )	$V_{in}$	No. of rotations of low Speed Shaft ( $a$ )	Speed in rev/min $N=30 \times a$

Table-2.1: Armature control d.c Motor Speed characteristics

To measure the torque/speed characteristics, fix the brake so that it passes over the disc smoothly while the motor is running. Then set the brake at position 10 with the ammeter on the power supply unit not exceeding 2 amp. Note the value of the input voltage. Take the Tachogenerator readings over the range of the brake down to zero position and tabulate your results as in table-2.2.

$V_{in} =$				
S.No	Brake Position	Tachogenerator volts ( $V_g$ )	No. of rotations of low Speed Shaft ( $a$ )	Speed in rev/min $N=30 \times a$
$V_{in} =$				
S.No	Brake Position	Tachogenerator volts ( $V_g$ )	No. of rotations of low Speed Shaft ( $a$ )	Speed in rev/min $N=30 \times a$

**Table-2.2:** Armature control d.c Motor Torque Characteristic

Now reset the brake back to maximum position and reduce the input voltage so that the motor is slowly rotating. Take readings over the brake range tabulating the further results. Plot the two sets of results, as in figure-2.2 (b), of speed against torque for the two input voltage values.

**Conclusion/Comments:**