Experiment#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.

Quantity	Apparatus	
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.

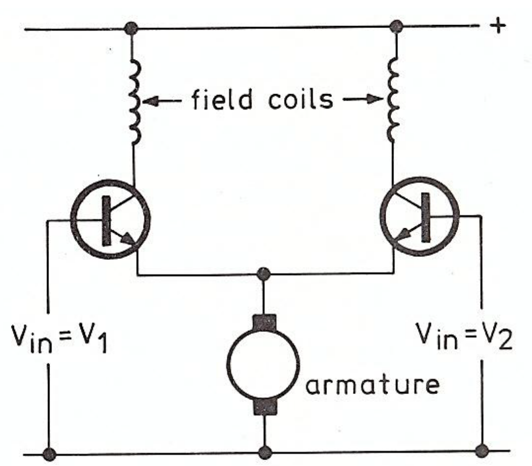
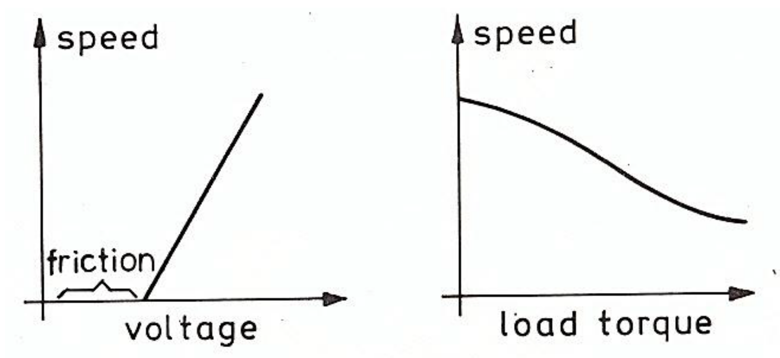


Figure-2.1: Armature control Arrangement

The motor has a split field winding, with current flow in each part of the coil being controlled by a transistor. This mean 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).



(a) Speed vs input voltage (V_{in}) **(b)** Speed vs Torque

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.

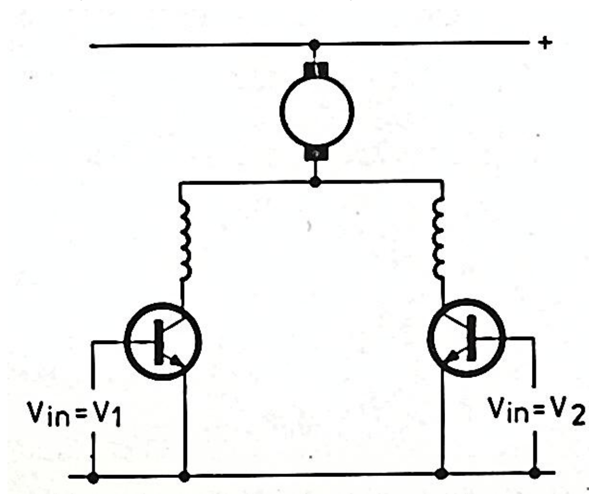


Figure-2.3: Field Control Arrangement

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}.

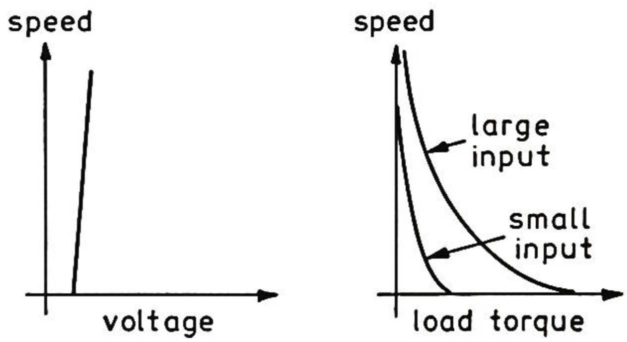


Figure-2.4: Motor Characteristics (Field control Mode)

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).

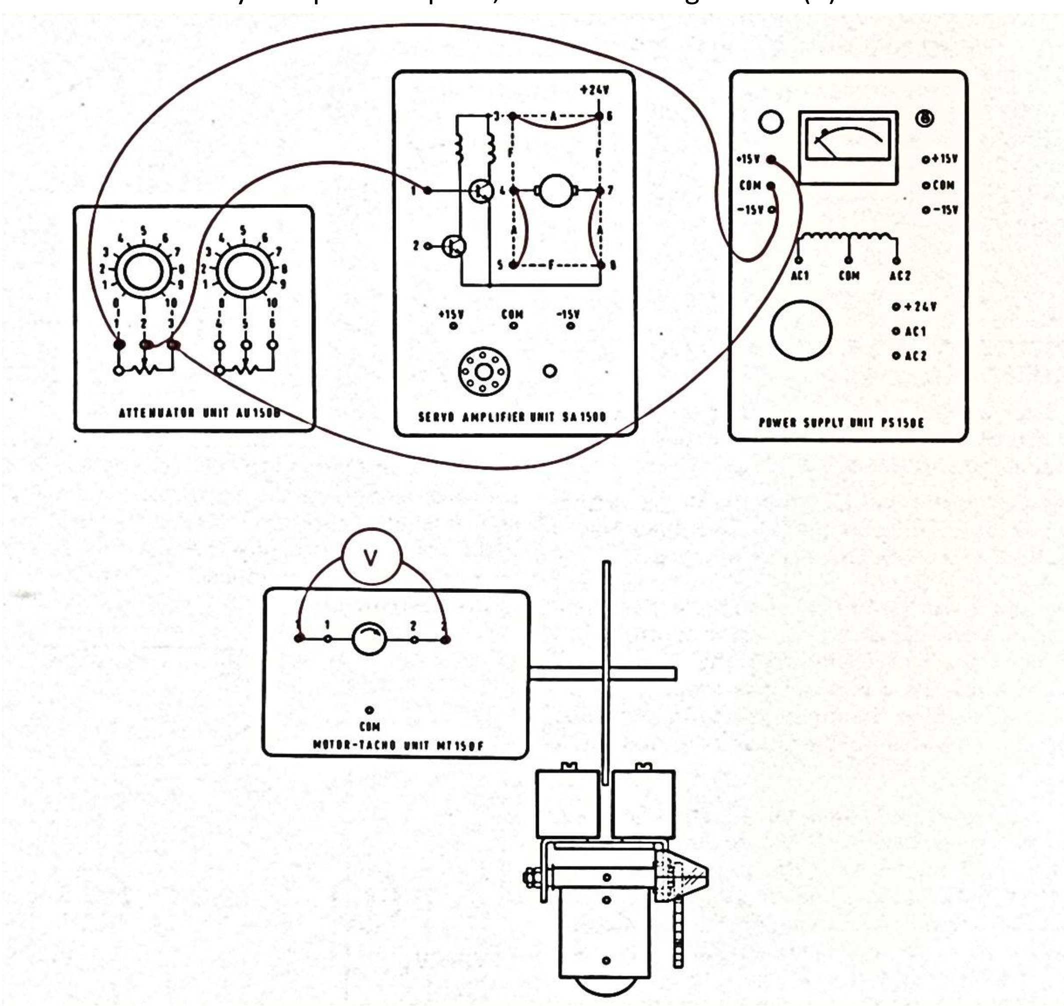


Figure-2.5: Experimental set up (Armature Control Mode)

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.

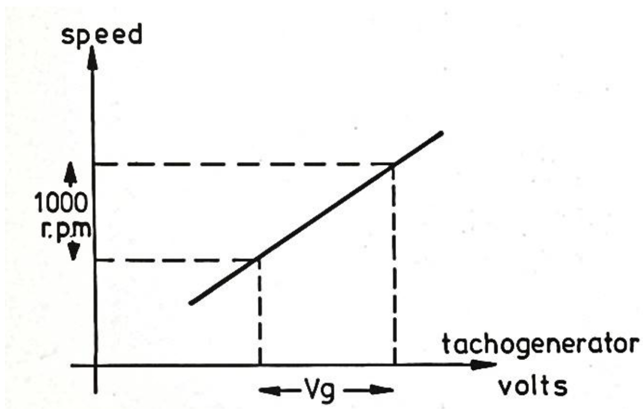


Figure-2.6: Tachogenerator volts vs speed

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