EXPERIMENT NO: 05

TITLE: Speed control of DC Shunt motor.

OBJECTIVES: To study the speed control of DC shunt motor using

1) Armature voltage control
2) Field current control

APPARATUS:

Sr.No.	Item	Rating	Quantity
1	DC Motor		
2	3 Phase Dimmer		
3	Ammeters		
4	Voltmeters		
5	Rheostats		
6	Tachometer		

THEORY:

The equation governing the speed of a dc shunt motor is

$$N = \frac{V - IaRa}{z\phi} \frac{A}{P}$$

Where,
N = speed of the motor
V = armature voltage
Ia = armature current
Ra = armature resistance
Φ = field flux

In the above equation Ra is constant. So we can control the speed of motor in two ways. Firstly by changing the field flux Φ and secondly by changing the armature voltage V. In the both case we vary the speed of motor by introducing a rheostat in the field circuit and armature circuit respectively.
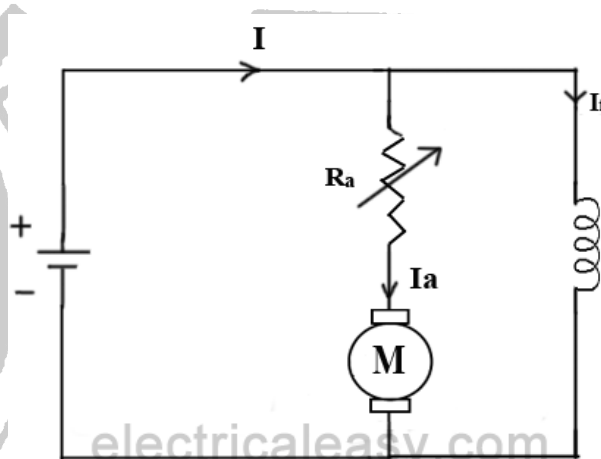
Armature voltage control:-

This method is based on the fact that by varying the voltage available across the armature, the back EMF and hence the speed of the motor can be changed. This is done by inserting a variable resistance R_C (known as controller resistance) in series with the armature.

$$E_b = V - I_a R_a$$

$$E_b \alpha\ I_a R_a$$

$$E_b \alpha\ N$$

Advantages of armature control method: -

i. Armature controlled motors offer nearly unmatched accuracy and control, along with a wide speed variation range.
ii. Constant field current and torque: With the armature control method, the field current and torque levels remain constant throughout the application.
iii. Fast and simple speed variation: Armature controlled DC motors are known for their exceptional speed control, which allows operators to vary the speed as necessary in both directions.

Disadvantages of armature control method:-

i. A large amount of power is wasted in the controller resistance since it carries full armature current Ia.
ii. The speed varies widely with load since the speed depends upon the voltage drop in the controller resistance and hence on the armature current demanded by the load.
iii. The output and efficiency of the motor are reduced.
iv. This method results in poor speed regulation.

Field Current Control:-

It is based on the fact that by varying the field fluxϕ, the motor speed (N α 1/ϕ) canbe changed and hence the name flux control method.
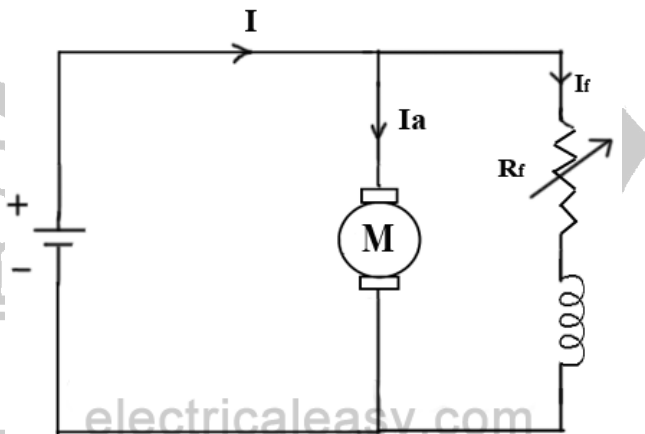
$$E_b = \frac{P\emptyset NZ}{60A}$$
$$E_b = V - I_a R_a$$

$$N = \frac{E_b \, 60A}{P\emptyset Z}$$

but, for a DC motor A, P and Z are constants.
Therefore, $N = K \frac{E_b}{\emptyset}$ (where, K=constant)

Advantages of field current control method:-

(i) This is an easy and convenient method.
(ii) It is an inexpensive method since very little power is wasted in the shunt field rheostat due to relatively small value of I_{sh}.
(iii) The speed control exercised by this method is independent of load on the machine.

Disadvantages of Field Current Control: -

  i.   Limits on speed: If your application requires you to adjust the motor below the normal speed, you may be better off choosing an armature controlled method. Field controlled DC motors can only operate above the normal speed. Higher speeds can also result in less torque.
  ii. Reduced stability: The field control method allows operators to obtain higher speeds than the norm. Yet its overall range can be lowered due to a lack of stability. With a weaker field, you may only be able to safely exceed certain speeds.
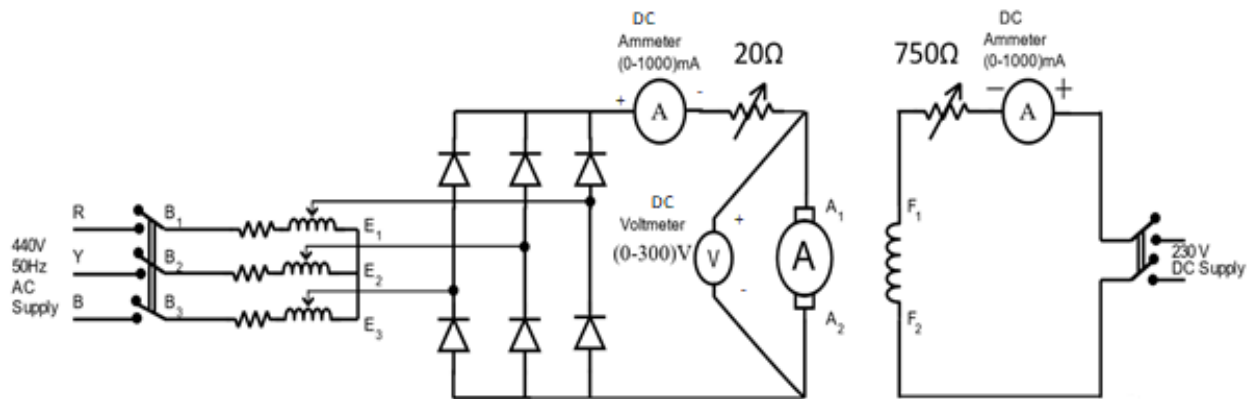
CIRCUIT DIAGRAM:

Fig 1: Speed control of DC shunts motor.

PROCEDURE:

1) Connect all components as per the circuit diagram.
2) Connect three phase 440V supply to Armature circuit.
3) Connect 230V DC supply to field circuit.
4) For armature voltage control, change the rheostat resistance connected in series with armature circuit, such that speed of motor changes.
5) Next, for field current control, change the resistance of rheostat connected in series with field circuit such that speed can controlled.
6) Measure the motor speed using Tachometer for different voltages by varying the resistance.

OBSERVATION TABLE:

A. Armature Voltage Control:

Sr.No	Armature Voltage (V)	Speed (rpm)
1.		
2.		
3.		
4.		
5.		

B. Field Current Control:

Sr.No	Field Current (I_f) (mA)	Speed (rpm)
1.		
2.		
3.		
4.		
5.		

CONCLUSION: