BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

DHAKA, BANGLADESH

Course No: EEE 270

Course Title: Electrical drives and instrumentation sessional

Experiment No: 04

Experiment Name: SPEED CONTROL OF A DC SHUNT MOTOR AND OBSERVATION OF THE EXISTANCE OF BACK EMF.

Date of Performance: 16-07-2022

Date of Submission: 30-07-2022

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Objective:

The objective of this experiment is to demonstrate the methods of controlling the speed of a dc shunt motor and to observe the existence of back emf.

Equipments:

1. Two dc ammeters
2. Two rheostats
3. One dc voltmeter
4. DC motor

Theory:

Motor:

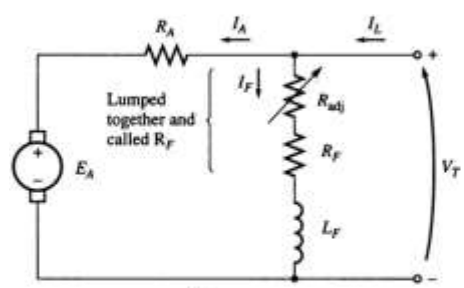
A motor is a device that converts electric power into motive power for rotating any load. It takes electric power as input and gives rotational energy as output.

D.C. Motor:

DC motors are DC machines used as a motor. It is connected to a DC voltage source. There are many types of DC motors. Shunt motor is one of them.

D.C. Shunt Motor:

A dc shunt motor is a dc motor in which armature and field windings are connected in parallel. The equivalent circuit of a dc shunt motor –



$$I_F = \frac{V_T}{R_F}$$

$$V_T = E_A + I_A R_A$$

$$I_L = I_A + I_F$$

Fig: Equivalent circuit of a shunt dc motor.

Speed of a dc motor may be given by the following equation:

$$N = \frac{K(V - I_a R_a)}{\phi}$$

where V is the applied terminal voltage, I_a is the armature current, R_a is the armature resistance, φ is the field flux and K is a constant which depends on the construction of the motor. Therefore, speed of a dc machine can be varied by the following methods:

1. *Flux control method:* There is an inverse relationship between speed and flux. So, by decreasing the field flux of a dc shunt motor, by inserting resistance in the field circuit, speed can be increased above the base speed.

2. *Armature rheostat method:* In this method, armature current I_a is varied by inserting a rheostat in the armature circuit and speed can be decreased below base speed.

3. *Terminal voltage control method:* By applying a variable dc voltage across the motor terminals, speed can be varied below or above the base speed.

Back EMF:

When the armature of the DC motor rotates under the influence of driving torque, the armature of the conductors moves through a magnetic field inducing an emf in them. The induced emf is in the opposite direction to the applied voltage and is known as the back emf. The existence of back emf can be observed by connecting a bulb with the terminals of the armature. While the armature is rotating, if supply is turned off, it will gradually stop rotation because of inertia. At that time, if a bulb is connected, we can see, the bulb is on. The light will slowly fade with the decrease of the speed of the armature and eventually both the speed and the light will die out. As, while rotating, the armature is producing an emf, the bulb can turn on. This emf is called back emf.

Circuit Diagram:

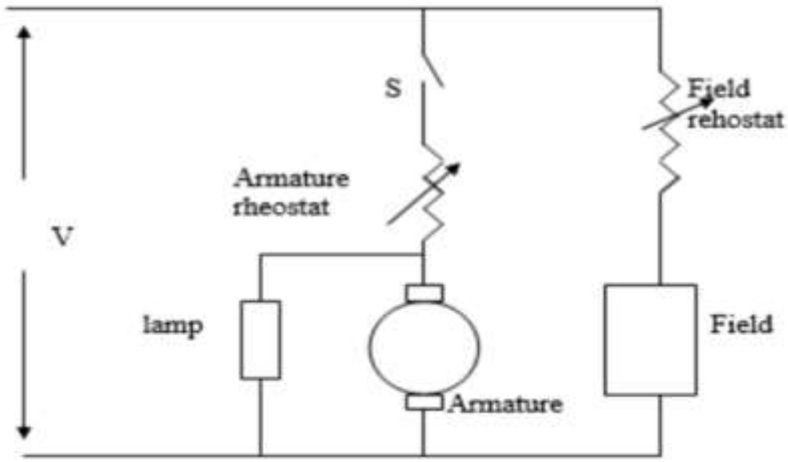


Fig: Experimental setup for speed control of a dc shunt motor.

Data Table:

Terminal Voltage Control:

Terminal Voltage, V(Volts)	Speed, N(rpm)
0	0
40	700
80	850
120	900
240	1100

Flux Control:

Field Current, I_F(Amps)	Speed, N(rpm)
0.28	1200
0.22	1300
0.20	1400
0.16	1700
0.14	1800
0.12	2000

Graph:

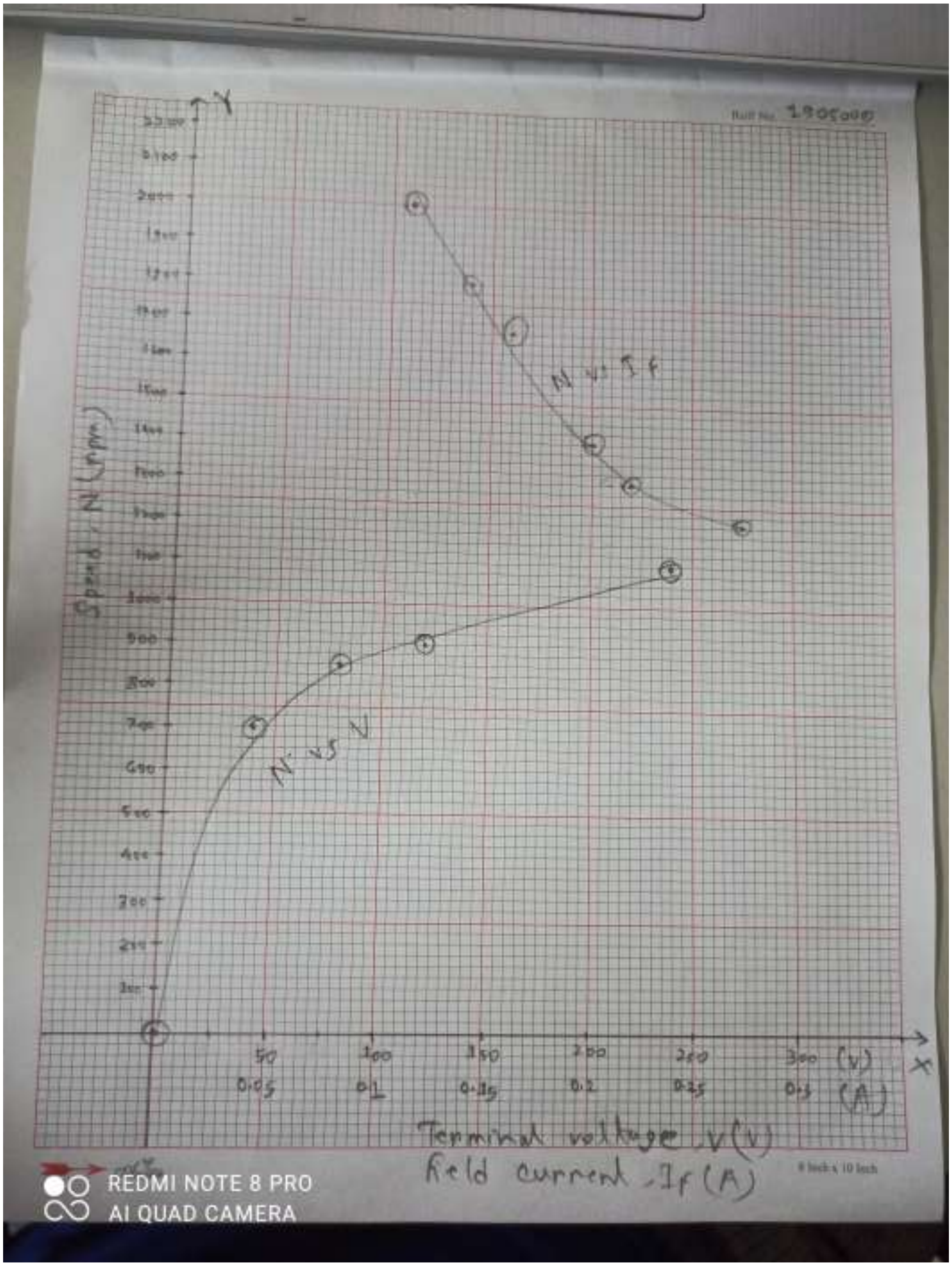


Fig: N vs I_F and V curves for a dc shunt motor.

Report:

1. **Plot N vs. I_F, I_a and V curves on the same graph paper.**

   Ans:

   We don't have any data for the N vs I_a curve. The previous page depicts the other two curves.

2. **Comment on the merits and demerits of various methods of speed control of a dc shunt motor.**

   Ans:

   Flux control method:

   Merits: This method is almost completely load independent. As a result, changes in load should have no effect on this method. Furthermore, power loss is lower with this method.

   Demerits: When the motor speed is very low, this method cannot be used. This method's results may become unpredictable at low speeds. At low speeds, decreasing flux may also cause a decrease in speed.

   Armature rheostat method:

   Merits: This method provides excellent accuracy and control. It can also operate at a variety of speeds. Because the field winding and resistance remain constant, this method has little effect on the field current.

   Demerits: In this method, we must insert a rheostat in the armature connection, which results in power loss. The rheostat's resistance can be set to a high value, which will consume a significant amount of power.

   Terminal voltage control method:

   Merits: This method has no negative effects on speed regulation or efficiency.

   Demerits: This method provides less control and accuracy. This method requires an additional field speed adjusting system to function properly.

3. Why is a starter required to start a dc shunt motor?

Ans: A dc motor must be protected from physical damage during the starting process in order to function properly. Because the motor is not turning when starting, EA = 0 V. Because the internal resistance of a normal dc motor is very low in comparison to its size, a very high current flows. Even if such currents are only present for a brief moment, they can cause severe damage to a motor. This is why a starter is needed. The starter provides a high resistance, preventing excessive current from flowing and damaging the motor. Furthermore, it prevents the resistance from becoming too high, allowing the vehicle to accelerate quickly.

4. Draw an elaborate view of a four-point starter and briefly mention its functions.

Ans:

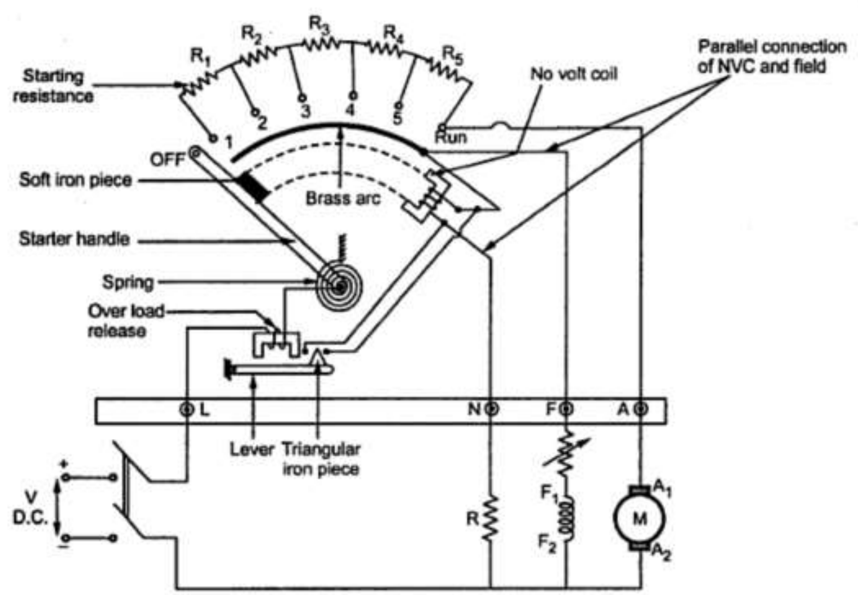


Fig: Four-point starter.

Functions: When the starter handle is moved to the starting resistor terminal, the motor is connected across the supply. Current flows from terminal L to the OLR (over-load release) and then to the starter handle. The current flowing from the handle is now divided into three distinct paths.

- A portion of the supply current is routed to the armature (terminal A) via a series of starter resistors,
- A portion of the supply current flows through the motor's field winding (terminal-F), and
- The remaining part of the supply current flows through the NVC (terminal-L').

It should be noted that changes in field current have no effect on the electromagnetic pull force exerted by the NVC coil on the handle. Because the NVC circuit (NVC current path) is distinct from the field circuit (field current path). Because of this independence, when the field circuit is accidentally left open while starting the motor, a protective resistance is connected in series with the NVC to regulate current flow. As a result, the starting current of the motor is regulated, and any change in field excitation has no effect on the NVC coil, keeping the starter handle in the ON position throughout the motor's operation. As a result, the four-point starter serves as a current control and protection device.

5. **How do you get a proof of the existence of back emf in step 2 of the procedure?**

   <u>Ans</u>:

   When we connect a lamp to the motor, it will continuously glow while the motor is running. If the switch is opened to turn off the power, the lamp should turn off immediately. However, this does not occur. The light gradually fades and then goes out. Because of inertia, the motor takes some time to come to a complete stop. Because the rotating armature generates back emf, the lamp does not turn off instantly. This is evidence of the existence of back emf.

Discussion:

- Because high voltage was used in this experiment, connections were made with care.
- The supply voltage was not kept above the rated voltage for too long in order to avoid damaging the windings.

- Because this method was not used in this experiment, the speed vs armature current curve could not be plotted.
- Tachometer was used to measure the speed of the motor.
- Because of the tachometer's scaling, there may be some discrepancies in the readings.