EEE 270

(Electrical Drives and Instrumentation Sessional)

EXPT. NO. 04

NAME OF THE EXPERIMENT:

SPEED CONTROL OF A DC SHUNT MOTOR AND OBSERVATION OF THE EXISTANCE OF BACK EMF

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Date of Performance:	20-10-2020
Date of Submission:	10-11-2020

Objective

The objective of this experiment is to control the speed of a DC shunt motor by flux control and voltage control method. In the experiment, the existence of back EMF is also verified.

Introduction

Speed of a DC motor given by the following equation,

$$N = K(V - I_a R_a)\phi \text{ rpm} \quad \text{--- (1)}$$

where, V = applied terminal voltage

I_a = armature current

R_a = armature resistance

ϕ = field flux

K = a constant which depends on the winding and construction of the motor

Therefore, speed of DC motor can be varied by the following methods:

(1) Flux control method: Eqn(1) describes 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 By applying a variable dc voltage across the motor terminals, speed can be varied below or above the base speed.

Equipments:

1. Two c ammeters
2. Two rheostats (0-1000Ω)
3. One c voltmeter
4. DC motor

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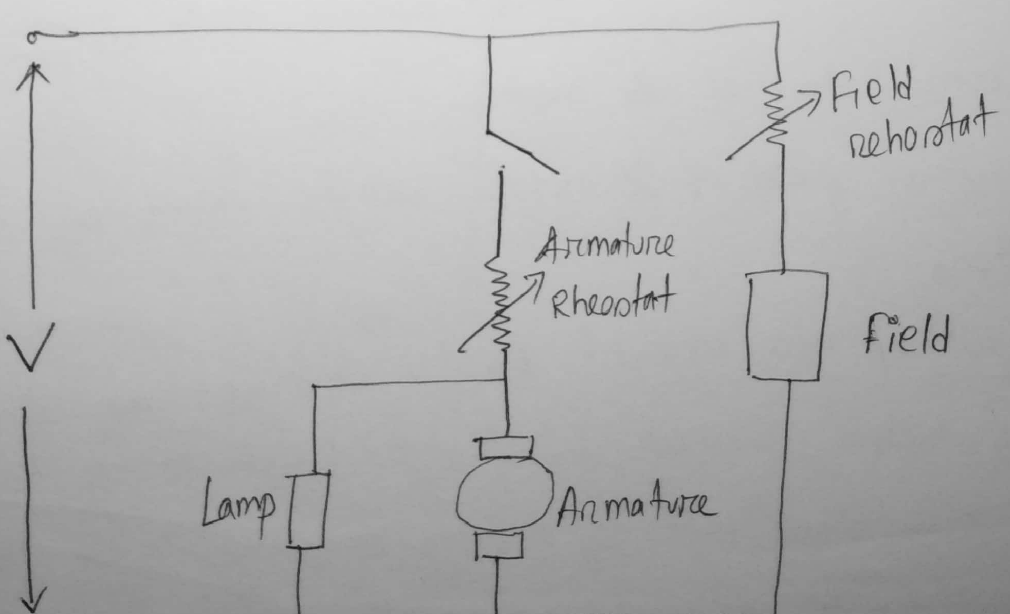
Experimental set-up:



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Experimental Data

Method 3 (Applying Variable DC voltage):

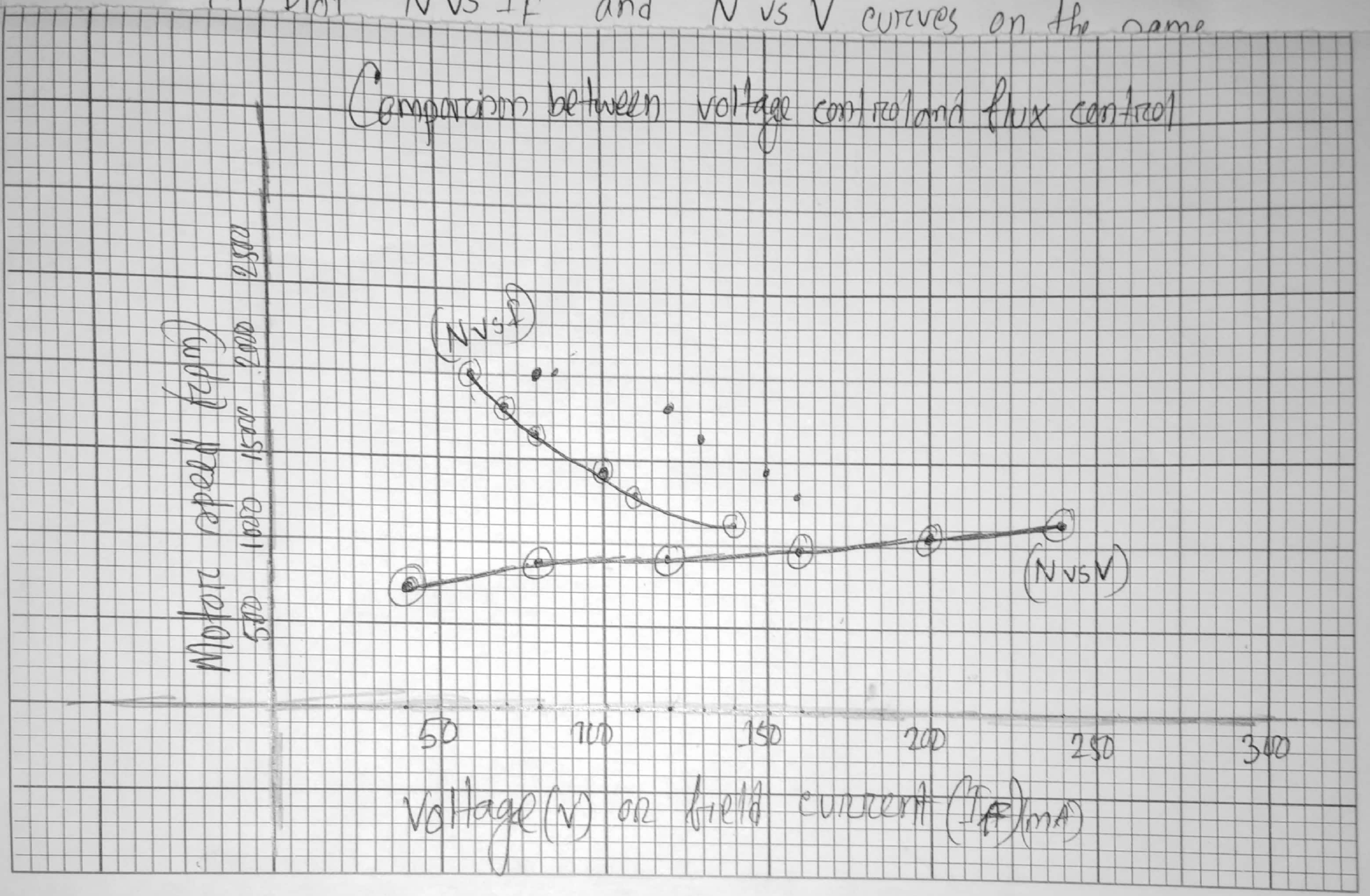
V(V)	N(rpm)
40	700
80	850
120	900
160	950
200	1050
240	1180

Method 1 (Flux Control method):

I_F(A)	N(rpm)
0.28	1150
0.22	1300
0.20	1450
0.16	1650
0.14	1800
0.12	2000

Reports:

(1) Plot N vs I_F and N vs V curves on the same



of speed control of a dc shunt motor

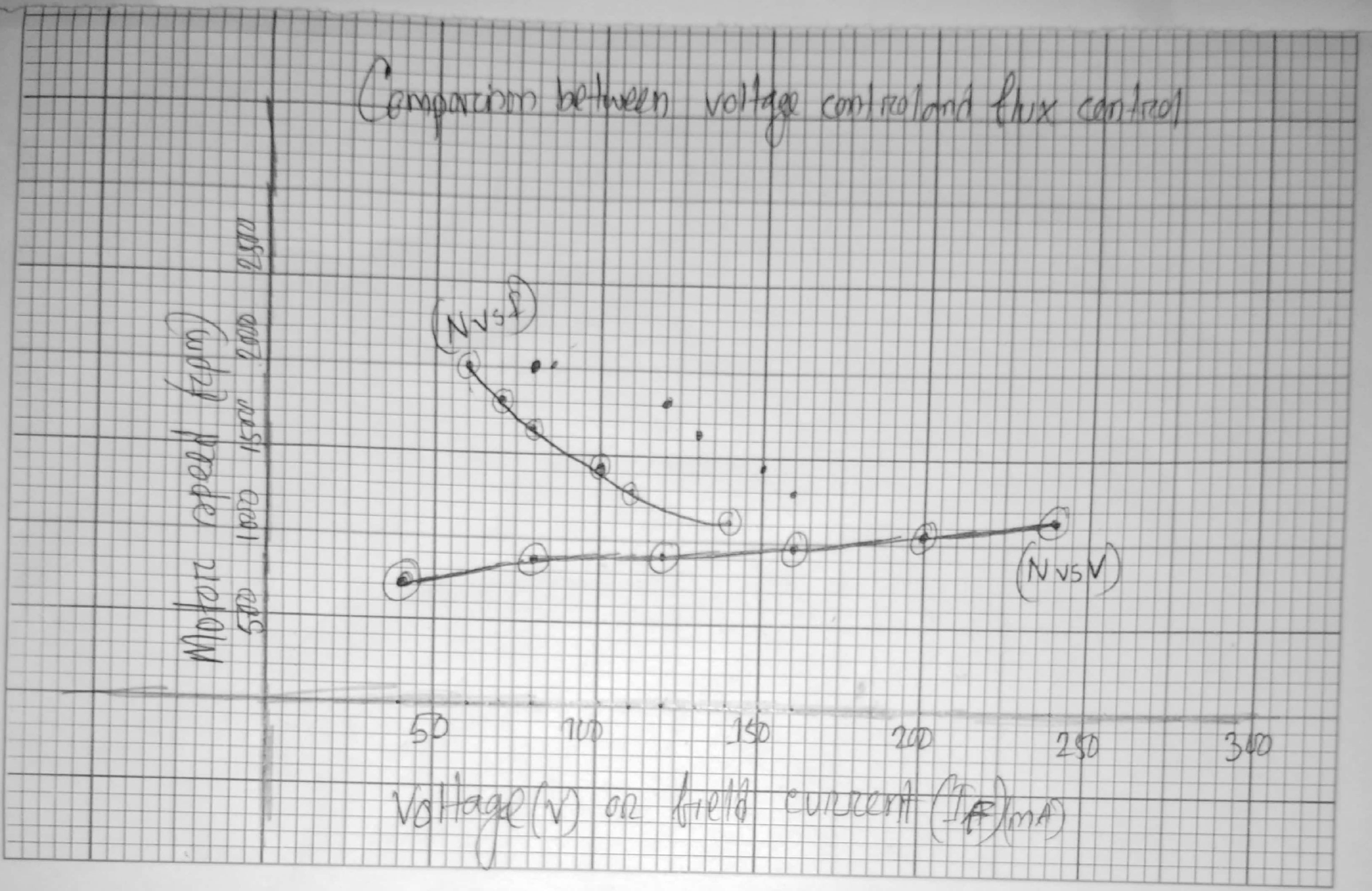
(1) Flux control method

Merits:

(a) This method is easy, convinent, more efficient, and ~~econ~~ economical

(b) As the shunt field is very small, the power loss in the shunt field is also very small.

(c) The speed control exercised by this method is indepent of the load on the machine.



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

(1) Flux control method

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Demerits:

(a) Only speeds higher than the normal speed can be obtained since the total field circuit resistance cannot be reduced below R_{sh} - the shunt field winding resistance.

(b) There is a limit to the maximum speed obtainable by this method. It is because if the flux is to much weakened, commutation becomes poorer.

(iii) Variable DC voltage method

Merits:

(a) This method avoids the disadvantages of poor speed regulation and low efficiency as in armature control method.

Demerits:

(a) Since we apply the input voltage in the motor with the help of fit switchgear stepwise, the speed adjustment is not smooth in this voltage control method. So we need to have an additional field speed adjusting system in the motor.

(b) It is expensive. Therefore, voltage control method of speed control is employed for large size motors where efficiency is of great importance.

(3) Why is a starter required for a dc shunt motor?

Ans: Whenever a DC motor starts it requires a current that is equal to 5-6 times its load current to start. Thus it is required to reduce the voltage when the motor starts. This Job is done with a starter. In it's simplest form, The starter of a dc motor works like a variable resistance in series with the armature circuit. Its work is to reduce the starting voltage up to such a value so that the increased current doesnot burn the armature windings. As the rotating armature of dc motor picks up speed, the starter resistance is gradually reduced to almost zero. At full speed the motor starts running normally, i.e. the Job of starter finishes here. So it can be said that starters are used to protect DC motors from damage that can be caused by very high current and torque during startup. They do this by providing external resistance to the motor, which is connecting in series to the motor's armature winding and restricts the current to an acceptable level.

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

Ans: To understant it's way of operating, let's have a closer look at the diagram. Considering that supply is given and the handle is taken stud No.1, then the circuit is complete. and the line current that starts flowing through the starter. In this situation we can see that the current will be divided into 3 parts, flowing through ~~3~~ 3 different points.

(i) 1 part flows through the starting resistance ($R_1+R_2+R_3+\ldots$) and then to the armature.

(ii) A 2nd part flowing through the field winding F.

(iii) A 3rd part flowing through the no voltage coid in series with the protective resistance R.

So the point to be noted here is that with this particular arrangement any change in the shunt field circuit does not bring about any change in the no voltage ~~coid~~ coil as the two circuits are indepedent of each other.

Four point Starter:

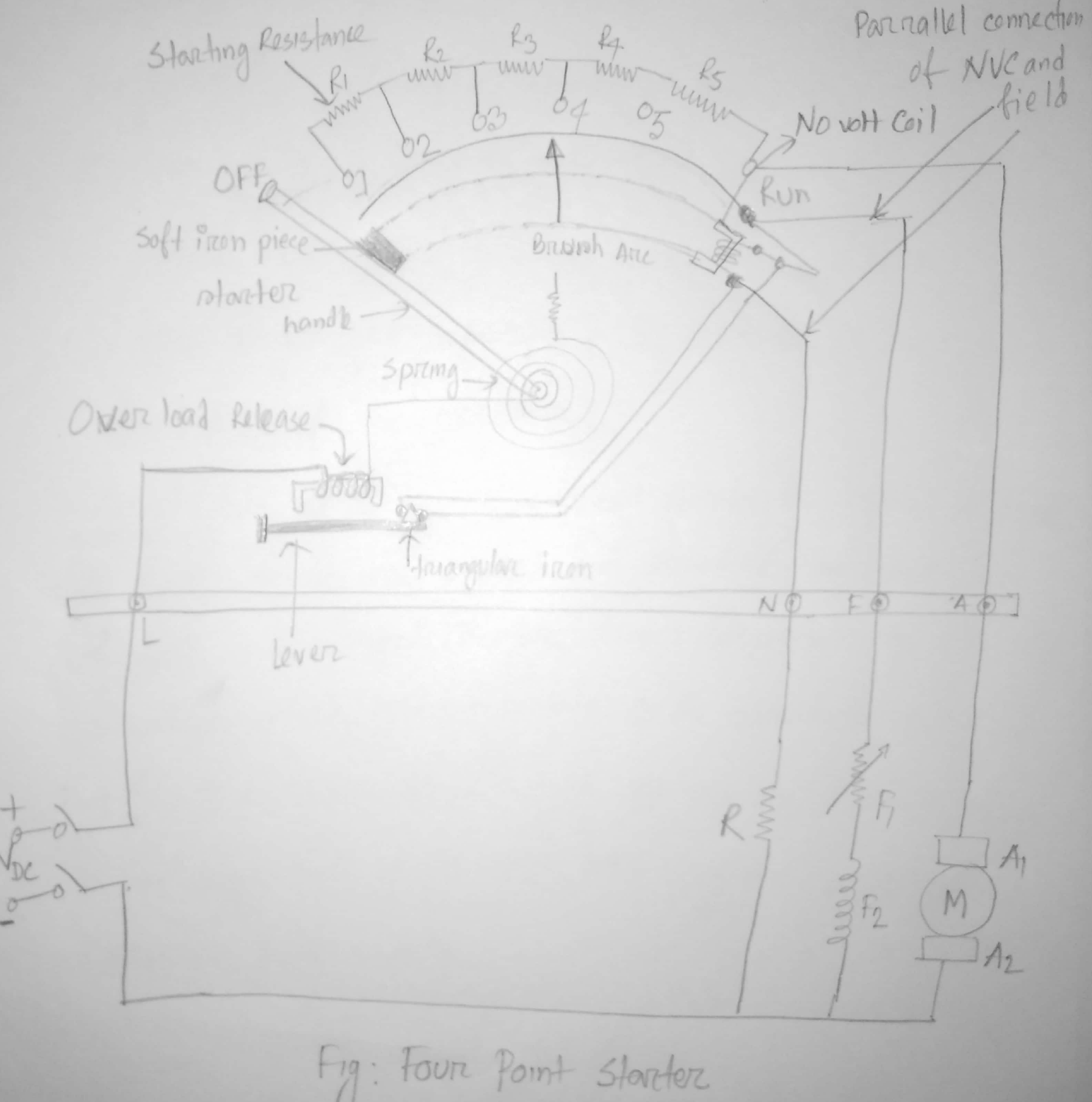

Fig: Four Point Starter

This essentially means that the electromagnet pull subjected upon the soft iron bar of the handle by the no voltage coil at all points of time should be high enough to keep the handle at it's RUN position, or rather prevent the spring force from restoring the handle at it's original OFF position irrespective of how the field rheostat is adjusted.

(5) How do you get a proof of the existence of back EMF is step 3 of the procedure?

Ans: When dc voltage V is applied across the motor terminals, the field magnets are excited and armature conductors are supplied with current. Therefore, driving torque acts on the armature which begins to rotate. As the armature rotates, back EMF E_b is induced which opposes the applied voltage V. The magnitude of the back EMF is given by the same expression shown below:

$$E_b = \frac{NP\phi Z}{60A}$$

Where E_b is the induced EMF of the motor known as Back-EMF, A is the number of parallel path through the armature between the brushes of opposite polarity, P is the number of poles, N is the speed, Z is the total number of conductors in the armature and ϕ is the useful flux per pole.

Now when we open the switch S, the motor doesn't stop instantaneously. As a result, there produces some Back EMF for which the light didn't instantaneously turn off in step 2.

Discussion:

The two curve N vs I_f and N vs V obtained from experimental data value were almost near to theoretical value. That is why almost a perfect like theorietical graph is obtained in this experiment. From the experimental data, it can be said that the motor speed can be controlled above the base speed with the help of flux control method. This is because during the flux control method, the speed remained above the rated speed which is approximately 1100 rpm. On the other hand, variable voltage method can be used to control the speed below the base speed. This experiment also helped to determine the presence of Back EMF as the bulb used in this experiment did not go off as soon as the switch was opened.