SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : **23EEB201 THEORY OF DC MACHINES AND TRANSFORMERS**

II YEAR / 03 SEMESTER EEE

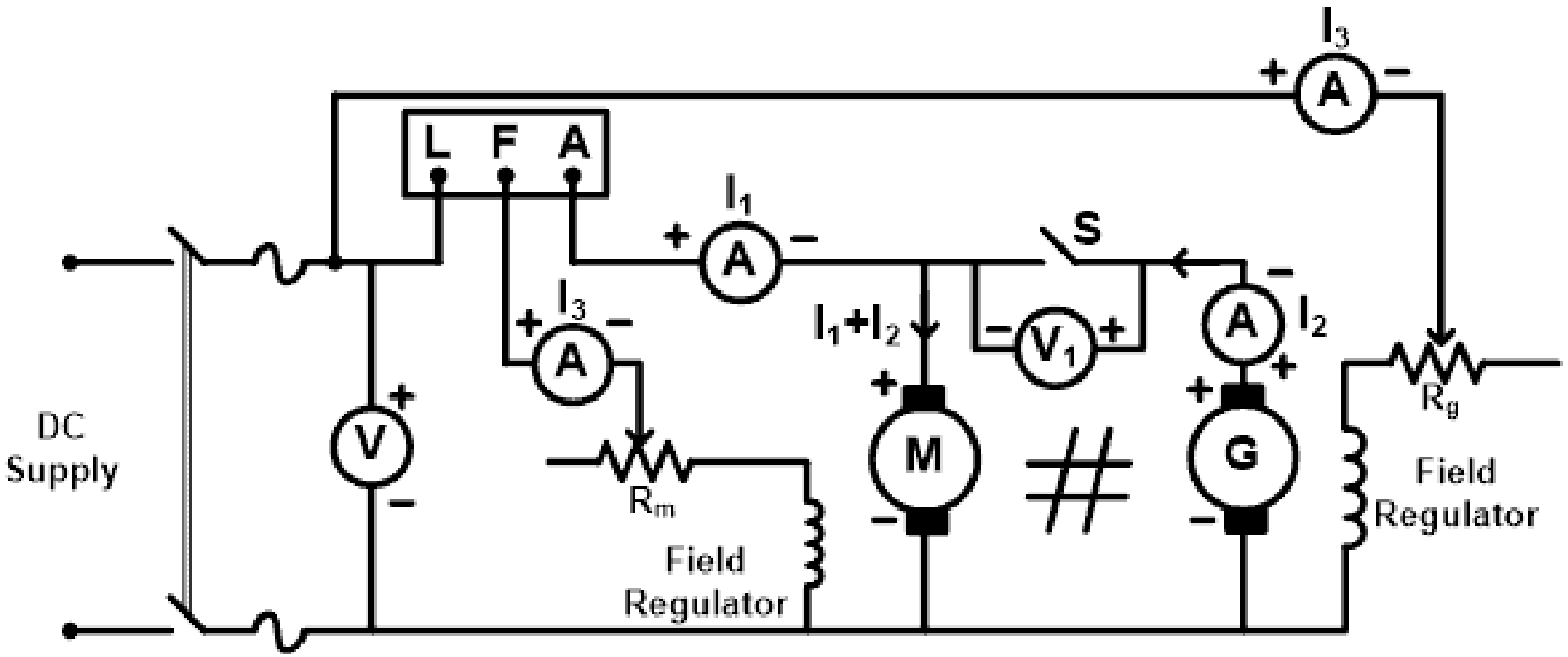
Unit 3 – HOPKINSONS TEST

INTRODUCTION

- The **Hopkinson test** is a useful method for testing the efficiency of a DC machine.
- It requires two identical machines, one acting as a generator and the other as a motor.
- The generator supplies mechanical power to the motor, which then drives the generator.
- This setup is why the Hopkinson test is also called the back-to-back or regenerative test.

- If there were no losses, no external power supply would be needed.
- However, due to generator output voltage drop, an extra voltage source is required to supply the correct input voltage to the motor.
- The external power compensates for internal losses in the motor-generator set.
- This is why the **Hopkinson test** is also known as the regenerative or heat run test.

Circuit Diagram of Hopkinson's Test



- The electrical supply is given to the first machine and this machine behaves as a motor.
- Initially, switch S is kept open. Hence, the input is supplied to the motor only.
- The speed of the motor is adjusted to the rated speed with help of a field regulator.
- The second machine behaves like a generator.
- When we give input to the motor, it will start rotating. And both machines are connected on the same shaft. So, the generator generates electrical power. The output of a generator is adjusted to rated power with the help of a field regulator.
- Still, the switch S is open. A voltmeter is connected across the switch. When the voltage generated by the generator is the same as the supply voltage, this voltmeter indicates zero reading. And at this stage, close the switch S.
- Now the generator will supply to the motor. And the electrical power supplied by the input is used to meet losses of both machines.
- When the generator is connected to a motor, the excitation of the generator is increased. It results in to increase in its EMF which becomes greater than the supply voltage. As the motor is loaded, the speed is decreased. The speed of the motor and output voltage of the generator is adjusted by the field regulators.

Efficiency of Motor

There are three types of losses in the motor;

- Armature copper loss (P_{am})
- Shunt field copper loss (P_{fm})
- Iron and mechanical loss (W_C)

The current that passes through the shunt field winding is I_3.

Hence, shunt field copper loss;

$$P_{fm} = VI_3$$

Total loss of motor;

$$P_{tm} = W_C + P_{am} + P_{fm}$$

$$P_{tm} = W_C + (I_1 + I_2)^2 R_m + VI_3$$

Total input power of motor;

$$Pi = V(I_1 + I_2) + VI_3$$

$$Pi = V(I_1 + I_2 + I_3)$$

$$\% \eta = \frac{Input\ power - Total\ loss}{Input\ power} \times 100$$

$$\%\eta = \frac{P_i - P_{tm}}{P_i} \times 100$$

Efficiency of Generator

The current that passes through the field winding of the generator is I_4.
Hence, the shunt field copper loss;

$$P_{fg} = VI_4$$

Total loss for generator;

$$P_{tg} = W_C + P_{ag} + P_{fg}$$
$$P_{tg} = W_C + I_2^2 Rg + VI_4$$

The output of generator;

$$P_O = VI_2$$

Hence, the efficiency of a generator;

$$\%\eta = \frac{Output}{Output + Total\ losses} \times 100$$

$$\%\eta = \frac{P_O}{P_O + P_{tg}} \times 100$$

Advantages

- The advantages of the Hopkinson test are as listed below.
- The power required to perform this test is very small for large machines. Hence, it is an economical method of testing.
- This test is performed to find the efficiency of the DC machine. By this test, the efficiency of the machine can be found at various load conditions.
- In this test, both machines are operating at rated load conditions. Therefore, the stray load losses are taken into account.
- The temperature rise is also estimated during this test.

Disadvantages

- The disadvantages of the Hopkinson test are as listed below.
- In the Hopkinson test, two identical machines are required. And it is very difficult to find two identical machines.
- The excitation of both machines is different. Therefore, it is impossible to separate iron losses.
- Both machines cannot be loaded evenly.
- Because of the variation in field current, it is difficult to operate both machines at rated speed.

Applications

The main purpose of the Hopkinson test is to determine the efficiency of electrical machines especially in case of coupling of motors and generators (also known as Motor-Generator Set) based on the combined iron losses of both machines which can’t be separated.

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