SNS COLLEGE OF TECHNOLOGY

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COIMBATORE-35

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME: 19EEB201 DC Machines and Transformers

II YEAR / III SEMESTER

Unit 3 – Testing of DC Motor

Topic 4: Hopkinson's Test

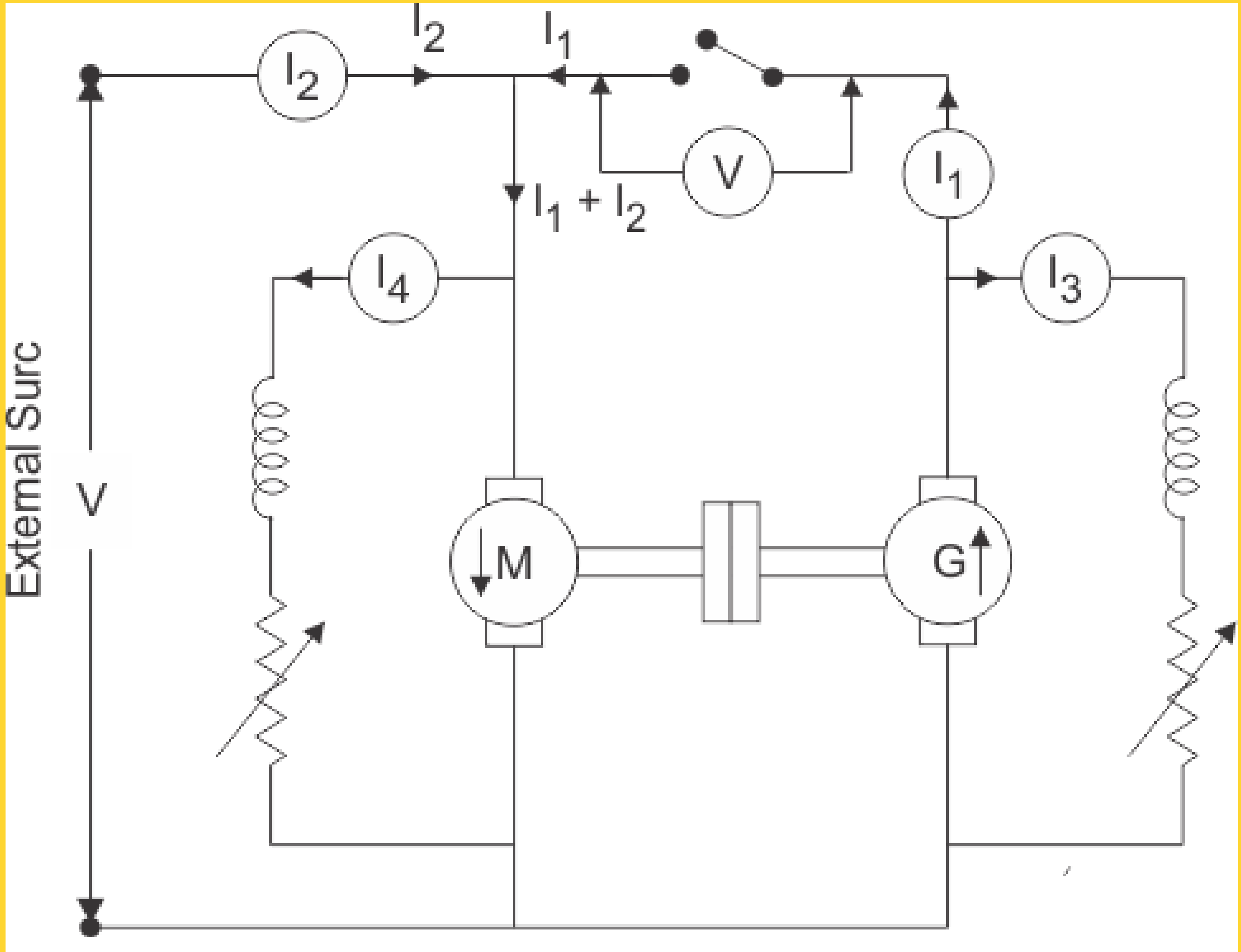
What We'll Discuss

TOPIC OUTLINE

Hopkinson's Test

Assessment

Hopkinson's Test



Hopkinson's Test of DC Machine

Hopkinson's Test is another useful method of testing the efficiency of a DC machine. It is a full load test and it requires two identical machines which are coupled to each other.

One of these two machines is operated as a generator to supply the mechanical power to the motor and the other is operated as a motor to drive the generator.

Hopkinson's test is also called back-to-back test or regenerative test.

Hopkinson's Test

If there are no losses in the machine, then no external power supply would have needed. But due to the drop in the generator output voltage we need an extra voltage source to supply the proper input voltage to the motor.

Hence, the power drawn from the external supply is therefore used to overcome the internal losses of the motor-generator set. Hopkinson's test is also called regenerative test or back to back test or heat run test

The generator voltage is now made equal to the supply voltage by adjusting the shunt field resistance connected across the generator. This equality of these two voltages of generator and supply is indicated by the voltmeter as it gives a zero reading at this point connected across the switch. The machine can run at rated speed and at desired load by varying the field currents of the motor and the generator.

Hopkinson's Test

Calculation of Efficiency by Hopkinson's Test

Let, V = supply voltage of the machines.

Then,

$$Motor\ input = V(I_1 + I_2)$$

I_1 = The current from the generator

I_2 = The current from the external source

And, Generator output = VI_1……………..(1)

Let, both machines are operating at the same efficiency 'η'.

Then, Output of motor =

$\eta \times input = \eta \times V(I_1 + I_2)$

$$Input\ to\ generator = Output\ of\ the\ motor = \eta \times V(I_1 + I_2)$$

$$Output\ of\ generator = \eta \times input = \eta \times [\eta \times V(I_1 + I_2)] = \eta^2 V(I_1 + I_2)\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

From equation 1 an 2 we get,

$$VI_1 = \eta^2 V(I_1 + I_2)\ or\ I_1 = \eta^2(I_1 + I_2)$$

$$or,\quad \eta = \sqrt{\frac{I_1}{I_1 + I_2}}$$

Now, in case of motor, armature copper loss in the motor = $(I_1 + I_2 - I_4)^2 R_a$

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R_a is the armature resistance of both motor and generator.

I_4 is the shunt field current of the motor.

Shunt field copper loss in the motor will be = VI_4

Next, in case of generator armature copper loss in generator = $(I_1 + I_3)^2 R_a$

I_3 is the shunt field current of the generator.

Shunt field copper loss in the generator = VI_3

Now, Power drawn from the external supply = VI_2

Therefore, the stray losses in both machines will be

$$W = VI_2 - (I_1 + I_2 - I_4)^2 Ra + VI_4 + (I_1 + I_3)^2 R_a + VI_3$$

Let us assume that the stray losses will be same for both the machines. Then,

Stray loss / machine = W/2

Hopkinson's Test

Efficiency of Generator

Total losses in the generator,

$$W_G = (I_1 + I_3)^2 R_a + VI_3 + \frac{W}{2}$$

Generator output = VI_1

Then, efficiency of the generator,

$$\eta_G = \frac{output}{input} = \frac{output}{output + losses} = \frac{VI_1}{VI_1 + W_G}$$

Efficiency of Motor

Total losses in the motor,

$$W_M = (I_1 + I_2 - I_4)^2 R_a + VI_4 + \frac{W}{2}$$

$$Motor\ input = V(I_1 + I_2)$$

Then, efficiency of the motor,

$$\eta_M = \frac{output}{input} = \frac{input - losses}{input} = \frac{V(I_1 + I_2) - W_M}{V(I_1 + I_2)}$$

Hopkinson's Test

Advantages of Hopkinson's Test

The merits of this test are…

- This test requires very small power compared to full-load power of the motor-generator coupled system. That is why it is economical. Large machines can be tested at rated load without much power consumption.
- Temperature rise and commutation can be observed and maintained in the limit because this test is done under full load condition.
- Change in iron loss due to flux distortion can be taken into account due to the advantage of its full load condition.
- Efficiency at different loads can be determined.

Disadvantages of Hopkinson's Test

The demerits of this test are

- It is difficult to find two identical machines needed for Hopkinson's test.
- Both machines cannot be loaded equally all the time.
- It is not possible to get separate iron losses for the two machines though they are different because of their excitations.
- It is difficult to operate the machines at rated speed because field currents vary widely.

RECALL

1. Conduct a Hopkinsons test in the laboratory and plot the results

THANK YOU