Swinburnes Test and Direct Load Test

1 Aim of the Experiment

To predetermine the efficiency of a DC machine for different loads and to obtain the speed-torque characteristic of the DC Motor.

2 Swinburne's Test

The losses at no load in the motor armature are iron losses, friction and windage losses and copper losses. The input to motor is Vt Ia , reducing the armature copper losses we get the no-load losses, W = $V_a I_a . I_a^2 R_a$ will give iron, friction and windage losses.
In this experiment, we would couple a DC generator also for the purpose of measuring speed. Thus the rotational losses of all the four machines as well as the field losses of the generator have to be accounted for.

2.1 As a generator:

$$\text{Generator output} = V_t I_l$$
$$\text{Armature current } I_a = I_l + I_f$$
$$\text{Armature copper losses} = I_a^2 R_a$$

Note that here Ra is the armature circuit resistance when hot.

$$\text{Shunt field copper losses} = V_t I_f$$
$$\text{Total losses} = W_0 + I_a^2 R_a + V_t I_f$$

$$\text{Efficiency} = 1 - (W_0 + I_a^2 R_a + V_t I_f)/(V_t I_l + W_0 + I_a^2 R_a + V_t I_f)$$

2.2 As a motor:

$$\text{Generator input} = V_t I_l$$
$$\text{Armature current } I_a = I_l + I_f$$

$$\text{Efficiency} = 1 - (W_0 + I_a R_a + V_t I_f)/(V_t I_l)$$

5 Observations for Speed Control

S.No.	Excit -ation	Speed (N)	Arm. Current (I_a)	Arm. Voltage (V_a)	Arm.Cu losses $I_a^2 R_a$	Iron and Friction Losses $V_a I_a - I_a^2 R_a$	Back emf $V_a - I_a R_a$	
	Normal							

Table 1: Observation Table

3 Direct Load Test

The speed and torque of a DC Motor are related by the following expression:

$$torque = KV/R - K^2(speed)/R \tag{1}$$

where,

K = Motor constant
V = applied voltage
R = armature resistance

The DC motor, with a constant supply voltage, is loaded using the DC generator whose field is kept constant. The load resistance across the generator is changed, thereby changing the load on the DC motor.

4 Procedure for Swinburne's Test

1. Connect machines as per the circuit diagram.
2. Keep the armature resistance and field resistance of the motor at maximum and minimum positions respectively.
3. Start the motor and run it at rated speed by decreasing the armature resistance.
4. Measure the speed, the field current, the armature current and voltage.
5. Calculate the efficiency as a motor and as a generator at these rated conditions.

7 Observations for Direct Load Test

S.No.	Armature Current	Speed

Table 2: Observation Table

6 Procedure for Direct Load Test

1. Connect the machines as per the circuit diagram.
2. Keep the armature rheostat and the field rheostat of the motor at the maximum and minimum resistance positions respectively.
3. Keep the generator field resistance maximum.
4. Switch on the EM clutch and start the motor. Decrease the armature resistance to run

the motor in the rated speed.
5. Increase the field of the generator to a constant value below the rated value.
6. Measure the speed and the voltage across generator armature. Calibrate this voltage to get speed.
7. Now, change the load resistance across the generator making sure the armature current of the motor does not exceed its rated value.
8. At each step measure the armature current of the motor and the speed.
9. Torque = (armature current of motor)*K.

8 Report

1. In an A4 sheet of paper, write your name and roll number, and also the name of the experiment.
2. Include the data from the excel sheet where the experimental data is stored.
3. Include the relevant plots.