1 Experiment No. 3

2 Experiment Title

External characteristic curve of self-excited DC Generator.

3 Objective

The objectives of this lab are as follows:

- To determine the relationship between terminal voltage V_T and load current I_L as the load is applied and varied.
- To investigate the factors contributing to the drop in terminal voltage when the generator is loaded.
- To identify the breakdown point on the characteristic curve.

4 Theory

The external characteristic curve of a self-excited DC generator represents the relationship between its terminal voltage V_T and load current I_L. It is observed that when a self-excited shunt generator is loaded, its terminal voltage V drops with an increase in load current. This drop in voltage is undesirable, especially when the generator is supplying current for light and power. In such applications, it is essential that V remains practically constant and independent of the load. This condition of constant voltage is almost impossible to achieve with a shunt generator unless the field current is automatically adjusted by a regulator. Without such regulation, the terminal voltage drops significantly as the load on the generator increases.

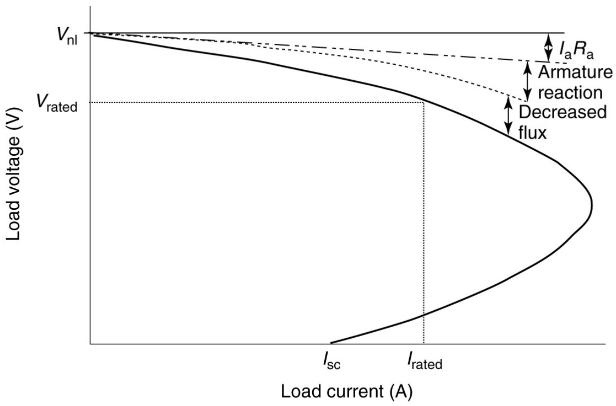

Figure 1: Characteristic curve of Self-excited DC Generator

There are three main reasons for the drop in terminal voltage of a shunt generator under load conditions:

1. **Armature Resistance Drop:**
   As the load current increases, more and more voltage is consumed in overcoming the ohmic resistance of the armature circuit. Hence, the terminal voltage is given by:

$$V = E - I_a R_a$$

   where:

   - V is the terminal voltage,
   - E is the induced e.m.f. in the armature under load condition,

- I_a is the armature current, and
- R_a is the armature resistance.

2. **Armature Reaction Drop:**
   As the load current increases, more and more voltage is consumed in the ohmic resistance of the armature circuit. Hence, the terminal voltage
   $$V_T = E_g - I_a R_a$$
   is decreased where E is the induced e.m.f. in the armature under load condition.

3. **Armature reaction drop:**
   Due to the demagnetising effect of armature reaction, pole flux is weakened and so the induced e.m.f. in the armature is decreased.

4. **Reduction in Field Current:** The drop in terminal voltage V due to 1. and 2. results in a decreased field current I_f which further reduces the induced e.m.f.

5 Required Apparatus

1. Variable Resistor (Ratings: Resistance: 5000Ω, Current: 0.31A),
2. Variable Resistor (Ratings: Resistance: $2 \times 200\Omega$, Current: 1.58A),
3. Variable Resistor (Ratings: Resistance: 50Ω, Current: 3.16A),
4. Three Phase Power Supply (Ratings: Voltage: 400V, Current: 10A),
5. Three Phase Power Supply (Ratings: Voltage: 400V, Current: 10A),
6. DC Multimeter (Ratings: Voltage: 600V, Current: 20A)
7. Three Phase Asynchronous Motor (Ratings: Power: 500W, Voltage: 400V/230V, Current: 1.8A/1.3A, Speed: 1380 rpm),
8. DC Generator (Ratings: Power: 300W, Voltage: 220V, Current: 1.4A)
9. Tacho-Generator (Ratings: Current: 0.07A max, Speed: 5000 rpm max).

6 Circuit Diagram

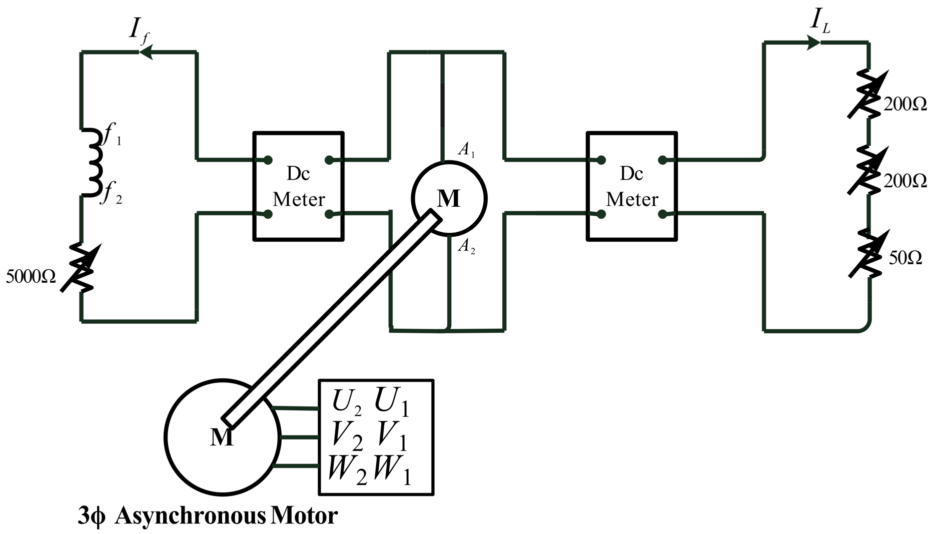

Figure 2: Circuit Diagram for self-excited DC Generator

7 Data Table

Table 1: Readings of Load Current (I_L), Terminal Voltage (V_T) and Field Current (I_f)

SI No.	**Load Current** I_L **(A)**	**Terminal Voltage** V_T **(V)**	**Field Current** I_f **(A)**
1.	0.000	220	0.079
2.	0.424	204	0.07
3.	0.445	202.74	0.075
4.	0.484	198.6	0.075
5.	0.540	194.6	0.071
6.	0.600	189.3	0.070
7.	0.647	185.5	0.068
8.	0.707	180	0.065
9.	0.787	170	0.063
10.	0.828	161.4	0.058
11.	0.865	156.0	0.057
12.	0.896	145.8	0.052
13.	0.940	139.2	0.050
14.	0.958	133.1	0.048
15.	0.962	130.3	0.047
16.	0.971	128.8	0.045
17.	0.973	126.3	0.044
18.	0.990	122.9	0.042
19.	1.012	118.5	0.040
20.	1.024	114.2	0.040
21.	1.045	110.6	0.00
22.	1.093	105.6	0.00
23.	1.100	99.6	0.00

8 Graph

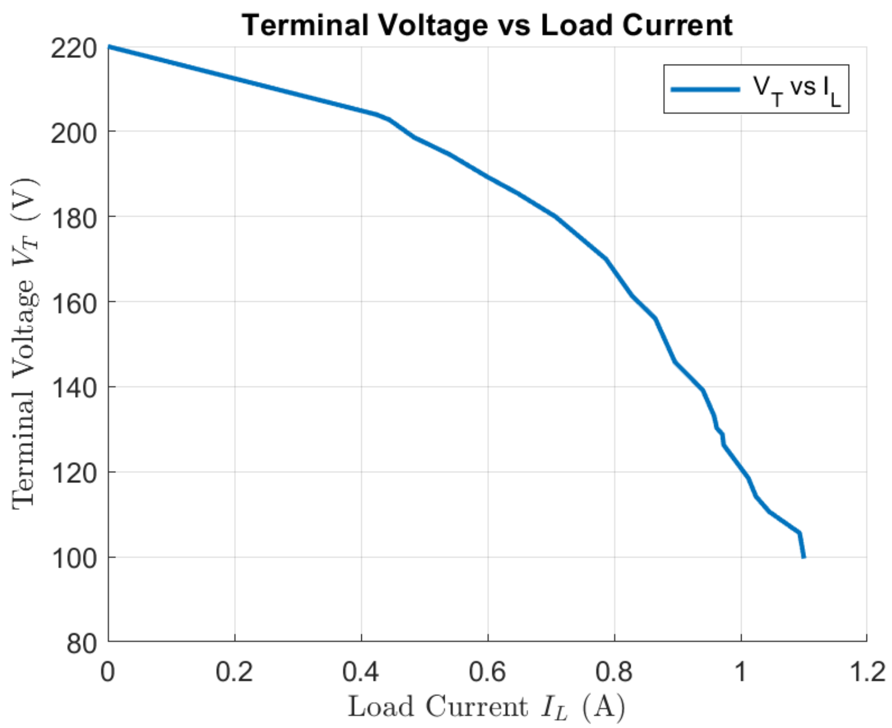

Figure 3: Terminal Voltage (V_T) vs. Load Current (I_L) characteristic curve

9 Discussion

In this experiment, the external characteristic curve of the self-excited DC generator was analyzed to understand its performance under various load conditions. The readings for terminal voltage V_T and load current I_L were recorded as the load resistance was gradually decreased.
It was observed that as the load resistance was lowered, the load current increased, resulting in a slight drop in terminal voltage. This behavior was consistent with Ohm's law, where the relationship between voltage, current, and resistance was expected. However, as the load current approached higher levels, significant voltage drops were noted, indicating the limitations of the generator's capacity to maintain a constant output.
The breakdown point of the characteristic curve was reached when the generator delivered current levels significantly above its normal operating range. Beyond this point, attempts to decrease load resistance resulted in decreased load current, contrary to the expected outcome. This unusual behavior was attributed to the severe armature reaction, which caused a drastic reduction in terminal voltage, overshadowing the effects of resistance changes.