Machines Lab Report
Experiment No 3

V-I Characteristics of DC Generator

GROUP B10 : Nisha Brahmankar (16D070019)
Tanmay Patil (16D070020)
Unmesh Raskar (16D070021)

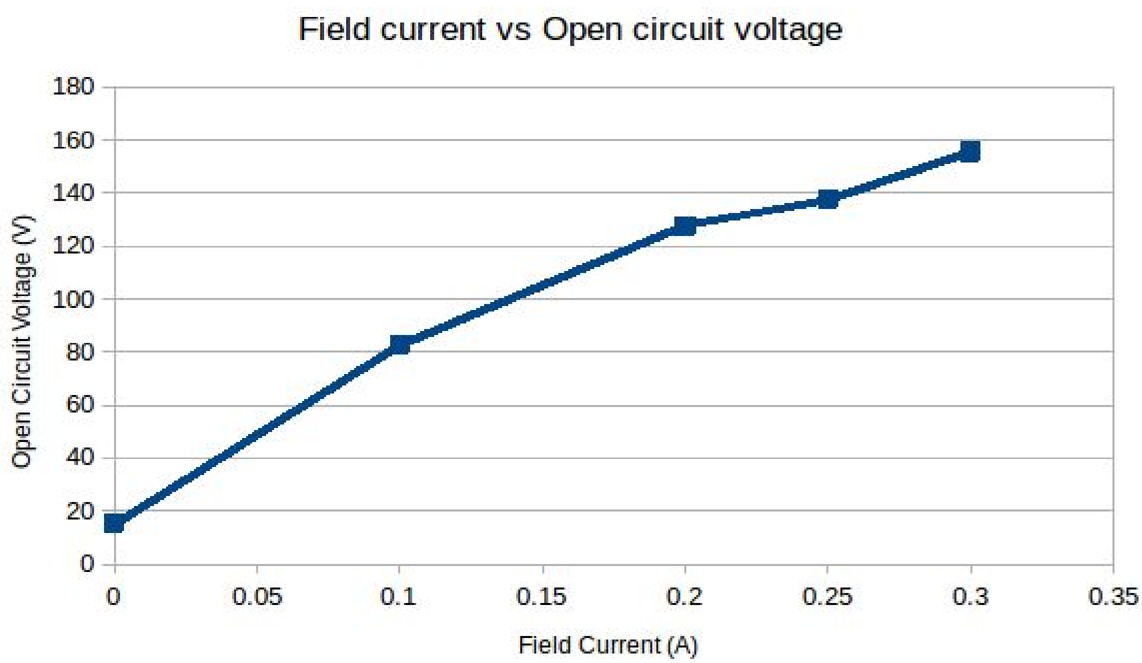
Aim : To obtain V-I characteristics of a DC Generators

Observations :

A. Open circuit voltage with field current

Field Voltage (V)	Field Current (A)	Open circuit Voltage (V)	Speed (rpm)
0	0	15.26	1500
70	0.1	82.7	1496
95	0.2	127.7	1500
120	0.25	137.6	1502
180	0.3	155.6	1500

Graph :-



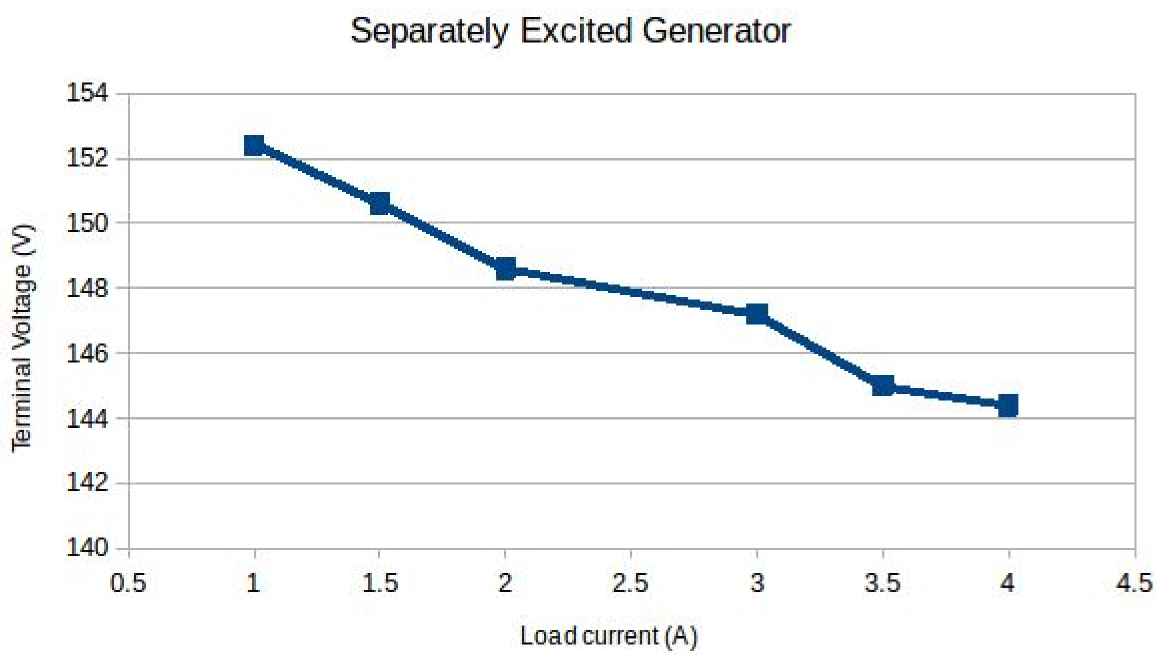
B. *Terminal voltage with load current*

1. <u>Separately Excited Generator</u>

   Armature voltage and current of motor were 175V and 1A at no load.
   On loading, Va = 180V and ia = 1.5A
   The field voltage and current of generator was 190V and 0.3A respectively.

Load	Terminal Voltage (V)	Armature current (A)	Speed (rpm)
0	155.6	0	1500
2	152.4	1	1495
4	150.6	1.5	1495
5	148.6	2	1499
7	147.2	3	1496
9	145	3.5	1500
10	144.4	4	1509

Graph :-



2. Self Excited Generator

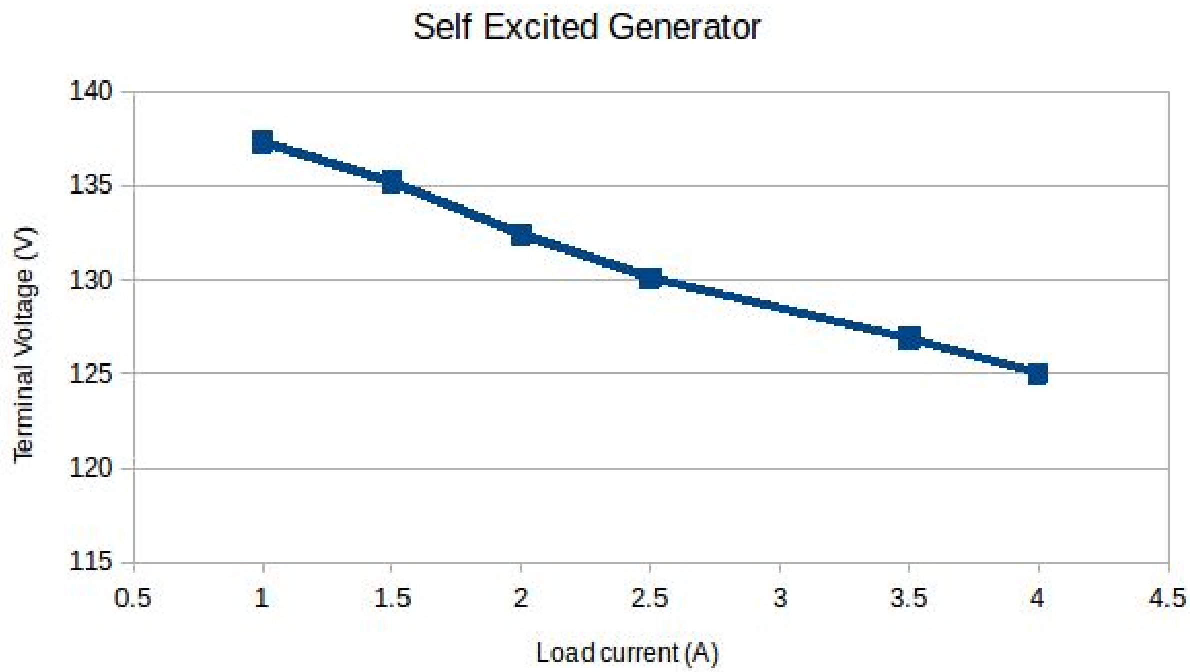
Armature voltage and current of motor were 175V and 1A at no load.

On loading, Va = 180V and ia = 1.5A

The field voltage and current of generator was 140V and 0.2A respectively.

Load	Terminal Voltage (V)	Armature current (A)	Speed (rpm)
0	140.6	0	1500
2	137.3	1	1500
4	135.2	1.5	1495
5	132.4	2	1499
7	130.1	2.5	1496
9	126.9	3.5	1500
10	125	4	1502

Graph :-



Conclusion :

(i) As the field voltage and hence field current of generator rises, the open circuit terminal voltage also rises as expected.
(ii) As the load increases, the load/armature current rises and correspondingly the terminal voltage decreases linearly with the load current for both the separately excited as well as self excited generator as expected from theoretical equations.

Post-lab Questions :

1. **Of the two machines which one did you choose to operate as motor? Justify your answer.**
   ANS : The two machines we had were of different power ratings. One was rated 1.1kW while the other was 1.5kW. As we are observing the characteristics of DC generator, the prime mover, here motor, should be able to provide at least the rated power to the generator. If we use 1.1kW machine as motor, it will provide less than 1.1kW power to generator rated 1.5kW. Hence we use the 1.1kW machine as generator and 1.5kW machine as motor.

2. **Assume that a given machine has the following nameplate ratings: 220V, 1.5 kW, 1500 rpm dc generator. What do these numbers imply?**
   ANS : The values 220V, 1.5kW and 1500 rpm are the rated values for the optimum usage of a dc generator. 220V is the supply voltage to be given to the generator for it's optimum operation. Voltages above this value ma damage the machine. 1.5kW is the power generated by the generator when all the things are at their rated values. The speed of the generator under full load conditions when everything else is at rated values is 1500 rpm.

3. **There are motors without any rotor windings (e.g. stepper motor). Explain how the torque is produced in these machines.**
   ANS : In a stepper motor a torque is developed when the magnetic fluxes of the rotor and stator are displaced from each other. The stator is made up of a high permeability magnetic material. The presence of this high permeability material causes the magnetic flux to be confined for the most part to the paths defined by the stator structure in the same fashion that currents are confined to the conductors of an electronic circuit. This serves to concentrate the flux at the stator poles. The torque output produced by the motor is proportional to the intensity of the magnetic flux generated when the winding is energized.

4. **How is the voltage induced in the armature (coil is rotating in a magnetic field) which is ac, converted to dc?**
   ANS : The split rings used act as mechanical rectifiers and convert the alternating current in the armature coil to an unidirectional current at the load.

5. **What is the effect of armature reaction?**
   ANS : The armature flux interacts with main flux giving rise to armature reaction. The armature flux opposes the main flux which decreases the net flux used to generate voltage. Hence due to armature reaction the terminal voltage of a generator falls.

6. **'Saturation of the magnetic material is a blessing in the case of self excited generator' Is this statement true? Justify your answer.**
   ANS : Yes, this statement is indeed true. The operating point is given by the point of intersection of field resistance line and the magnetisation curve. If there was no

saturation in the magnetisation curve, the field resistance line and the magnetisation curve won't intersect. Hence, the voltage will keep on building up, the flux will keep on increasing and eventually damage the generator. Thus, it is said that "*Saturation of the magnetic field is a blessing in the case of self excited generator*".

7. **In separately excited dc machine, the field winding carries a constant current. Hence, it dissipates power. Suggest a method to eliminate this power loss.**
   ANS : We can eliminate this power loss by using shunt (self-generated) DC generator. In a shunt generator, the field windings are excited using terminal voltage itself. Hence the losses are comparatively low.

8. **What may happen if load terminals are short circuited in (a) separately excited generator (b) self excited generator?**
   ANS : (a) In a separately excited generators, if load terminals are short circuited, huge currents will flow through the armature because of the induced terminal voltage and very low resistance of the armature coil. This may result in damaging of the armature. (b) But in a self excited dc generator, if the load terminals are short circuited then the terminal voltage will become '0'. It will also imply that the voltage across the field windings is '0'. Thus there will be no flux hence no voltage induced. The generator will shut down.

9. **You have been given the plot of Efficiency Vs input power of the prime mover. Explain how will you obtain the plot of efficiency Vs output power of the generator. How will you obtain this plot incase the plot of Efficiency Vs input power of the prime mover is not available?**
   ANS : We can measure the output power generated corresponding to the input power of the prime mover. The efficiency of the generator will be :

$$\eta_{Generator} = \frac{Generator\ Output}{\eta_{Prime\ mover} * Prime\ mover\ Input}$$

Demo :

- We were first shown the various parts (Stator Windings, Rotor Coil, Split Rings, Brushes). Then the mounting of the coils to make an electromagnet and placement of the armature coil, split rings and brushes(at neutral access points) was shown while explaining the function of each part.

- We were then shown the flux pattern set up, the forces acting on the armature coil and the emf induced. A simulation of the rotation and generation of voltage was then shown.

- We were then told that the current required to setup the stator flux is very high and to reduce this we use a solid core between the two stator poles instead of just air. But a problem that arises with this extra moving part is that it will have eddy currents. A laminated solid core is used to overcome this.