Experiment #10: The DC Machine, Generator Mode

The DC machine used to be the machine of choice due to its controllability. However, it has several drawbacks, most significant of which is the commutator/brush arrangement which tends to wear out and produces sparking. Due to the use of electronic controllers, the AC machine has become the one most often used.

In this experiment we study the DC machine as a generator. There are several ways to connect the machine, and we shall study the most popular ways: separately excited, self excited, and the compound machine. Connected as a generator, there is no danger of the runaway speed encountered earlier with the machine connected as a motor. However, the prime mover in this case will be the DC dynamometer (DCD) connected as a DC motor, and there we have to be careful not to let the field get disconnected or removed accidentally as that would produce a dangerous situation.

Take notes in the lecture as that may be very helpful in understanding the operation of the machine and the various connections of the two field windings. Also, the basic theory of operation will be detailed.

In each case, power down completely before changing any wiring. Do this in all changes of wiring necessary to carry on the experiment steps outlined below. It is left up to you to decide what instruments need to be connected in each step of the experiment.

Experiment Outline:

1. Determine the OC operating curve of the generator. Drive the generator at its rated speed and be careful to increase the field current in one direction (without reversing its direction) till rated value is reached. Record terminal voltage of the generator and its field current. From this determine the OC characteristic at rated speed (this is also known as the magnetization curve).

2. Plot the OC characteristic and determine the critical resistance $R_0$. Measure the DC resistance of the field winding, $R_f$.

3. Connect the generator so it can start by itself as a self excited generator (to do this you need to recall the polarity of the field and output in step 1). Does it generate voltage as you increase its speed? If not, you may have connected it backwards. Correct the error and try again till it works as a self excited generator.

4. Discuss this step with the instructor first, then demonstrate the results. Connect a series resistance in the shunt field and predict the value needed so the generator could not be operated as a self excited generator. Show that the generator fails to generate. Prove this point by lowering the resistor to a value you predict would allow it to operate properly.
5. Use the shunt field only and separately excited. Run the machine at rated voltage, current and speed. Keep the speed constant throughout this step. Vary the load (keep \( I_f \) and speed constant) and take data for the output characteristic.

6. Repeat, this time as a self-excited generator. This time maintain a constant speed as the load is decreased.

7. Connect the machine as a compound generator. Excite the field separately, and connect the series field in additive then subtractive configuration. Record the data needed for the output characteristic.

8. Connect the machine as a compound self excited generator (the shunt field is placed in parallel with the armature) and repeat the above step for additive and subtractive series field combinations.

Present your report with all these results carefully shown and detailed. When observations are made, detail and explain the theory as much as you can.