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ELG3311: LABORATORY

Experiment #6

DC GENERATOR

November 2004

1. <u>OBJECT</u>

To experimentally determine the equivalent circuit parameters for a separately excited DC generator.

2. <u>BACKGROUND</u>

The descriptions of DC machines, derivation of their equivalent circuits and analysis of the resultant characteristics are given in chapters 8 and 9 of the textbook.

Definition of "Output Characteristics": The object of a generator is to produce electric power from the mechanical power transmitted by the shaft. The usual requirement is to produce a constant output voltage against variations in output current. The product of these two quantities is the power. The output characteristic of a generator is a plot of output voltage vs. output current current. The variation of output voltage with respect to output current changes is a measure of performance. Different excitation methods result in different output characteristics, each of which may have advantages and disadvantages. Typical characteristics are illustrated in Chapter 8 and 9 of the textbook.

"Full Load" and "No Load" Tests: The machine parameters will be determined under no load conditions, meaning the output current is zero. Using these "No Load" test results, the performance of the machine is predicted under full load. Full Load means the machine is loaded to its rated capacity.

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3. <u>PROCEDURE</u> 3.1 Initial Procedures: 3.1.1 Motor:

This is the machine that drives the generator being tested. Depending on your workstation you may be using one of the following three motors (check the number at your workstation).

| Workstation | Prime Mover |
|-------------|-------------------|
| 3 and 4 | Synchronous Motor |
| 5 and 6 | Induction Motor |

Connect the motor according to the diagram shown in Figure 1 for your own workstation. Ask your instructor to check your preparation and initial circuit connections before proceeding further. Note the motor rating below.

Manufacturer: Power Output: Speed: Line Voltage: Load Current:

3.1.2 Generator Connections:

Record appropriate data on the Generator in the space below.

Manufacturer: Output Power: Output Voltage: Output Currant: Speed: Field Current: Field Voltage:

<u>Circuit Connections</u>:

Connect the motor according to the diagrams shown in Figure 1 and appropriate to your location. Check the number at your workstation and ask the instructor for directions.

Connect the generator excitation and load circuits as shown in Figure 2. Take care in selecting meters of proper voltage and current

Ask your instructor to check your preparation and initial circuit connections <u>before proceeding</u> <u>further</u>.

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3.2 NO-Load Test

3.2.1 Magnetization Curve (determining Kf)

Connect the field circuit to a suitable dc power supply according to the machine voltage rating and the circuit shown in Figure 2. Start up and run the machine at rated speed and measure the open circuit armature voltage as a function of shunt field current, I_f . Start with zero current and increase excitation by increasing the voltage applied to the shunt field winding. Limit the field current up to the rated value. At rated current record V_f , the voltage across the shunt field winding. Take about 10 readings continually increasing the current and do not decrease the current incrementally to avoid the hysteresis effect. Take 10 readings also as you decrease the current back to zero. Plot the readings as you proceed noting the residual magnetism, the hysteresis and the shape of the curve. Plot the data carefully on a graph. Turn off power to the motor as well as the generator.

| For Increasing I _f . | | | | | | | | | | |
|---------------------------------|--|--|--|--|--|--|--|--|--|--|
| I_{f} | | | | | | | | | | |
| V _{out} | | | | | | | | | | |
| For Decreasing I _f : | | | | | | | | | | |
| I _f | | | | | | | | | | |
| V _{out} | | | | | | | | | | |

Determine, $K_{\underline{f}}$, as the average value of the slope of V_{out} vs $I_{f.}$

3.2.2 Resistance Measurements (determining Ra, Rf)

Measure the armature resistance (R_a) by passing approx. rated DC current through armature and measuring the voltage drop with the machine at standstill. Use a resistor bank to limit the current with the 12O V supply. Turn the rotor slowly by hand and average any variation. Similarly, easure the field voltage, V_f and field current, I_f . Record your measurements below and calculate R_a and R_f .

$$I_a=\qquad A\ ,\qquad \qquad V_a=\qquad V\ ,$$

$$I_f = \qquad A \ , \qquad \qquad V_f = \qquad V \ ,$$

$$R_a = \frac{V_a}{I_a} = \Omega, \qquad \qquad R_f = \frac{V_f}{I_f} = \Omega,$$

3.3 <u>Full-Load Test</u>

This test determines the machine's performance as seen by the load. For a dc generator the load is a resistive circuit, which receives electric energy at a certain voltage, V_L , and a current, I_L . The functional relationship between V_L and I_L depends on the mode of operation (generator or motor) and the machine field connection (shunt, series or compound). In the following test the machine must be connected as a separately excited generator. In this case $V_L = V_a$ and $I_L = I_a$.

After getting your instructor's approval, start the prime mover (motor) and adjust its speed to the rated value. This value of rated speed should be maintained and recorded during the entire period of measurements.

Apply dc voltage to the field winding of the generator and adjust the field current, I_f to get rated output voltage. Note this value of I_f and the speed of the prime mover.

Adjust the load resistance bank to get a load current of up to rated value in five equal steps. At each step note the value of load current and load voltage. The generator field current, I_f , and speed must be kept constant during these measurements. Record and plot the measured load voltage and current.

| For constant $I_f =$ | | | А | ar | d constar | nt speed = | rpm | | | |
|----------------------|--|--|---|----|-----------|------------|-----|--|--|--|
| $V_{\rm L}$ | | | | | | | | | | |
| IL | | | | | | | | | | |

Remove the load and reduce the generator field current. Switch off the power supply to the motor armature.



Synchronous motor used as a prime mover (Locations 2, 6, and 4)



Induction motor used as a prime mover (Locations 1, 3, 5)

Figure 1: Prime Mover Connections



Figure 2 Connections for the Separately Excited Generator