ELEC 302 Lab 8
DC Generators

REFERENCE: Appropriate chapters of ELEC 316 text.

OBJECTIVE: The objective of this experiment is to observe the basic principals of operation of DC generators.

EQUIPMENT:

Power Supply Module (0-120Vdc)	EMS 8821
Resistance Module	EMS 8311
Prime Mover/ Dynamometer Module	EMS 8960
DC Motor/Generator Module	EMS 8211
Data Acquisition Interface (DAI)	EMS 9062
DAI 24V Power Supply	EMS 30004

INSTRUCTOR NOTE:

Prior to operation of the DC Motor /Generator ensure that the brushes are adjusted to the neutral point.

<div align="center">DC Motor/Generator neutral point adjustment.</div>

Connect terminals 4-N of the AC Power Supply to the armature of the DC Motor/Generator (terminals 1-2) through current input I1 of the DAI module. Connect the shunt windings (terminals 5-6) to the voltage input E1 of the DAI module. Turn on the Power Supply and adjust the voltage to achieve a current of approximately 0.2A on meter I1. Adjust the brush adjustment lever on the DC Motor/ Generator so that the voltage across the shunt winding (E1) is a minimum. Turn off the power supply and remove all leads.

INTRODUCTION:

In this experiment, you will observe the effect of changes in field current on the output voltage of a separately excited DC generator. You will also observe the behavior of shunt and compound generators under varying load conditions.

PRIOR PREPARATION:

Complete the following at a time determined by the laboratory instructor.

1. Sketch a typical magnetization curve (E_a vs. I_f) for a separately excited DC motor run at constant speed. On the same plot draw a family of curves for various values of armature current I_a.

2. Sketch the theoretical terminal voltage vs. armature current characteristics for a separately excited, shunt and compound connected DC Generator.

PROCEDURE:

Equipment Set-up

1. Verify the all components required in the equipment section are present at the EMS workstation.

2. Make sure the main power switch of the Power Supply is OFF and the voltage control knob is fully CCW. Set the voltmeter selector switch to position 7-N.

3. Mechanically couple the Prime Mover /Dynamometer Module to the DC Generator using the timing belt.

4. Connect the LOW POWER INPUTs for the Prime Mover /Dynamometer Module and the DAI to the 24V supply and turn it on.

5. Check that the DAI USB connector is attached to the computer. Start the computer and the LVDAM EMS application. On the *File* menu open file C:\Program Files\Lab Volt\Samples\E302_8.dai. The Metering window should display meters for E1, I1, I2, N, and T.

6. Select focus to the metering window by clicking on it. Select *Options -> Acquisition Settings*, set the *Sample Window* dialog box to *extended*. Then click OK, and close the box. Select *View ->* check *continuous refresh*.

7. In the metering window, select the torque correction function for meter T. Note that meter T now indicates the torque produced by the generator. It is equal in magnitude to the torque applied to the generators shaft but opposite in direction. Therefore, it has a negative polarity.

8. Construct the DC Generator armature circuit of Figure 1a, and the separately excited field circuit of Figure 1b. **Note: No electrical power is connected to the DC Generator armature circuit.**

9. Set the Prime Mover / Dynamometer controls as follows:
   - MODE switch …………………………….……Prime Mover
   - DISPLAY switch……………………….…………..…SPEED(N)

PART ONE: Separately Excited DC Genearator Magnetization Curve

10. On the Resistive Load Module, set the load resistance R_L to ∞ (no-load).

11. Turn on the main voltage power supply and adjust the Field Rheostat to obtain 0.4A field current on meter I2. **Do not exceed the shunt winding rating of 0.4 A.**

12. On the Power Supply set the voltage control knob so that the Prime Mover speed is 1000 rpm.

13. Open the *Data Table Application* use it to record the output voltage (E1), field current (I2), output (armature) current (I1), speed (N), and torque (T). On the DC Generator, use the FIELD RHEOSTAT to

reduce the field current in 0.05A steps until it is fully CCW. At each step adjust the voltage control knob on the power supply to maintain the Prime mover speed at 1000 rpm. For each field current setting record E1, I1, I2, N, and T in the data table.

14. When all data is recorded, turn the voltage control knob CCW, and turn off the main power supply. Store or print the data table for your report.

15. Open the *Graph window* by selecting it from the *Data Application* toolbar. Make the appropriate setting to obtain a plot of DC Generator output voltage (E1), vs. field current (I2). Use the edit graph function to title the graph "Lab 8 Plot 1 Vo vs. If (no load) ", name the x-axis "Field Current (amps)", and name the y-axis as "Output Voltage (volts)." Then save or print the graph for your report.

16. On the Resistive Load Module, set the load resistance R_L to 100Ω (300 || 300 || 300).

Warning
Due to the high armature currents possible in this lab, improper resistive loading can result in overheating of the resistance module. It is therefore necessary to use all three resistive banks of the resistance module in parallel to achieve the desired load resistance.

17. Repeat steps 11 through 14 using the new load resistance.

18. Open the *Graph window* by selecting it from the *Data Application* toolbar. Make the appropriate setting to obtain a plot of DC Generator output voltage (E1), vs. field current (I2). Title the graph "Lab 8 Plot 2 Vo vs. If (RL = 100) ", name the x-axis "Field Current (amps)", and name the y-axis as "Output Voltage (volts)." Then save or print the graph for your report.

PART TWO: Separately Excited DC Genearator Output Voltage vs Output Current

19. On the Resistive Load Module, set the load resistance R_L to ∞ (no-load).

20. Turn on the main voltage power supply and adjust the Field Rheostat to obtain 0.3A field current on meter I2. On the Power Supply, set the voltage control knob so that the Prime Mover speed is 1000 rpm.

21. Open the Oscilloscope application, select *view -> continuous refresh*. Select the output voltage E1, select DC coupling, and set the time base to 20ms/div, and observe the output voltage. Does it appear to have significant ripple? Close the oscilloscope application.

22. Open the *Data Table Application* use it to record the output voltage (E1), output current (I1), field current (I2), speed (N), and torque (T). Modify the settings on the resistive load as shown in the table below, at each resistive value re-adjust the voltage control knob to maintain a Prime Mover speed of 1000 rpm. For each resistive setting record E1, I1, I2, N, and T in the data table.

R_L Ω	R_L Ω	R_L Ω	R_L Ω	R_L Ω	R_L Ω
∞	400	200	100	67	57
	1200		1200		1200	600		600		600	300		300		300	600		300		600		300		600		300	1200		600		300		1200		600		300		1200		600		300

23. When all data is recorded, turn the voltage control knob CCW, and turn off the main power supply. Store or print the data table for your report.

24. Open the *Graph window* by selecting it from the *Data Application* toolbar. Make the appropriate setting to obtain a plot of DC Generator output voltage (E1), vs. output current (I1). Title the graph "Lab 8 Plot 3 Separately Excited DC Generator Vo vs. Io ", name the x-axis "Output Current (amps)", and name the y-axis as "Output Voltage (volts)." Then save or print the graph for your report.

PART THREE: Shunt Connected DC Genarator

25. Construct the shunt connected DC Generator circuit of Figure 2.
 Note that you can simply remove the field circuit at power supply terminals (8-N), and reconnect to the DC Generator armature circuit (1-2).

26. On the Resistive Load Module, set the load resistance R_L to ∞ (no-load).

27. Turn on the main voltage power supply and adjust the Field Rheostat fully CW (max. field current). On the Power Supply, set the voltage control knob so that the Prime Mover speed is 1000 rpm.

28. Repeat steps 22, and 23 to record the output voltage vs output current for the shunt connected generator.

Note that output voltage may increase slowly initially because of the shunt field. Wait for the voltage to completely stabilize before changing loads. If low output voltages persist raise the motor speed to 1500 rpm temporarily.

29. Open the *Graph window* and obtain a plot of DC Generator output voltage (E1), vs. output current (I1). Title the graph "Lab 8 Plot 4 Shunt DC Generator Vo vs. Io," name the x-axis "Output Current (amps)", and name the y-axis as "Output Voltage (volts)." Then save or print the graph for your report.

PART FOUR: Compound Connected DC Generator

30. Construct the shunt connected DC Generator circuit of Figure 3.
Note that you need only break the circuit at the E1 and I1 connection points and insert the series winding.

31. Repeat steps 26 through 28 to record the output voltage vs output current for the compound connected DC generator.

Note that output voltage may increase slowly initially because of the shunt field. Wait for the voltage to completely stabilize before changing loads. If low output voltages persist raise the motor speed to 1500 rpm temporarily.

32. Open the *Graph window* obtain a plot of DC Generator output voltage (E1), vs. output current (I1). Title the graph "Lab 8 Plot 5 Compound DC Generator Vo vs. Io," name the x-axis "Output Current (amps)", and name the y-axis as "Output Voltage (volts)." Then save or print the graph for your report.

33. Turn off the 24Vdc power supply, turn off the computer, and remove all leads. Leave the timing belt installed.

REPORT:

Your report should be completed in the format requested by the instructor. Specifically, it must contain the following items.

1. All data tables (5) and all plots (5).

2. Use a plotting application such as Matlab® or Excel® to combine the data for plots 1 and 2 onto one set of axis for comparison. Do likewise for the plot 3, 4, and 5 data (separate from the plot 1, 2 data). Using mathematical arguments discuss and compare the plots.

3. For each generator type (separate, shunt, and compound) determine the %Voltage Regulation and compare.
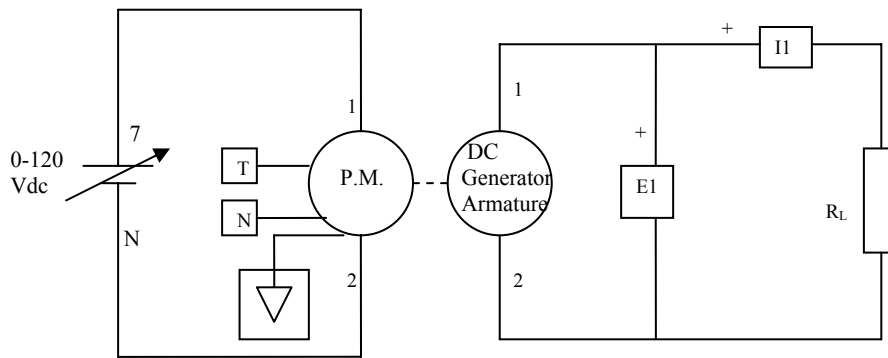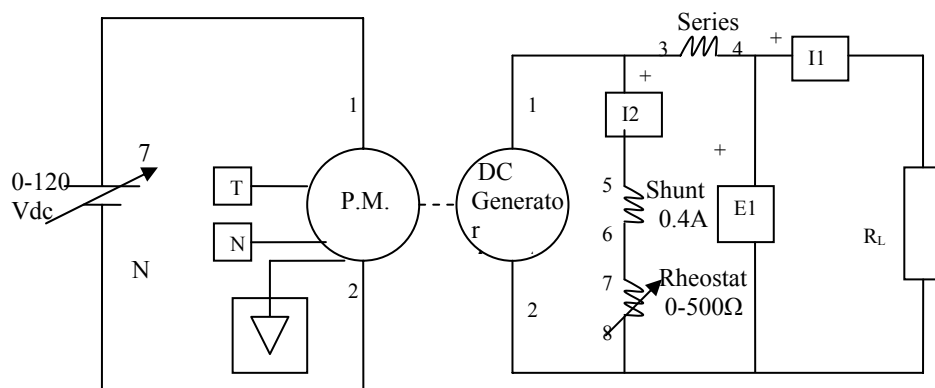
Figure 1a: DC Generator Armature Circuit
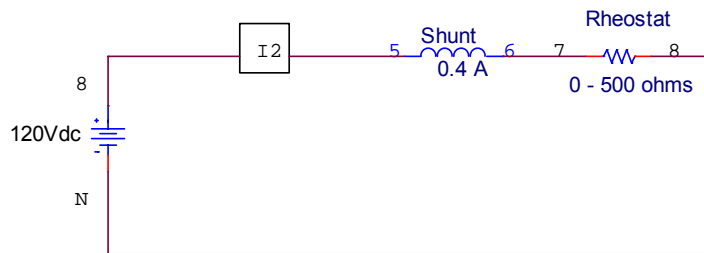
Figure 1b: DC Generator Field Circuit
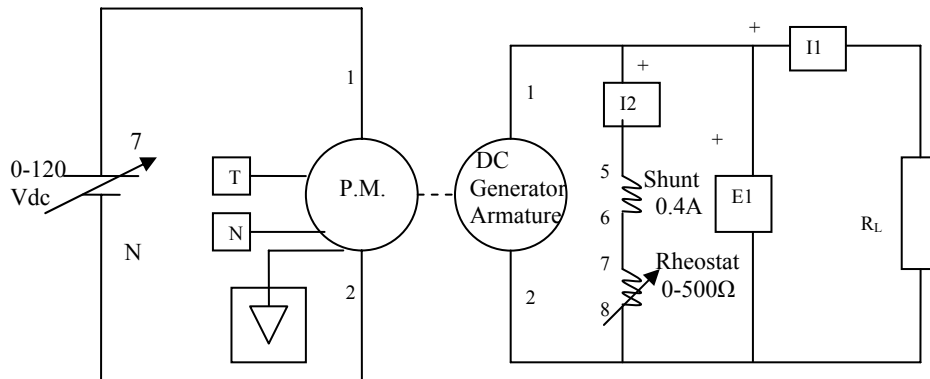
Figure 2: Shunt Connected DC Generator Circuit

Figure 3: Compound Connected DC Generator Circuit