University of Utah
Electrical & Computer Engineering Department
ECE 3600 Lab 5
DC Motor

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rev, 4/16/25

Objectives
1. Find the armature resistance, R_A, with an ohmmeter.
2. Spin the motor at a near constant speed, observe the effects of varying the field current, and plot the magnetization curve of this motor for this speed.
3. Determine $K\varphi$ for two field currents.
4. Run the DC motor with a constant field current and plot the speed vs. armature voltage.
5. Observe the effect of losing the field current.
6. Run the motor with a brake load.
7. Calculate the armature voltages two ways and compare them.

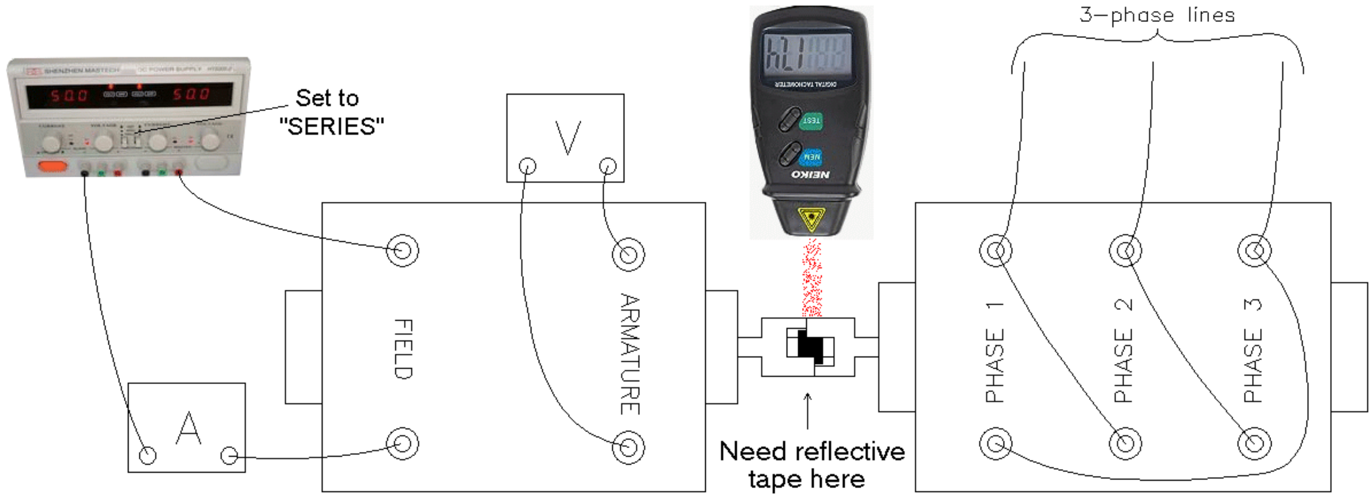
Equipment and materials to be checked out from stockroom:
Note: Your TA may have preprinted check-out lists of the following.
- Power wire kit
- 1 or 2 Fluke Multimeters
- AC to DC rectifier box (see lower drawing on p2)
- Vari-AC (Auto-transformer)
- Motor rack
- BOB (bucket of bolts)
- NSH-34 DC motor
- NPP34 3-phase induction motor
- Neiko Optical Tachometer
- Electric brake (see lower drawing on p2)

Measure R_A
Connect an ohmmeter to the armature winding of the DC motor. Take 8 readings of the resistance, each at a different shaft position and average them to find a good estimate of R_A.

Magnetization curve
Mount the DC motor on the motor rack with the 3-phase induction motor as shown on the next page Give the motors plenty of slack at the coupling. You may need to use a shim under the DC motor to make the two line up well.

To use the optical tachometer, there will need to be small piece of reflective tape on one of the motor couplers or rubber piece. If you can't find one of these, ask your TA to help you apply one. If there are two reflective tapes (say one on each coupler) then your rpm readings may be too high, like by a factor of 2.

Set up the system shown on the next page. I used the bench meter for the field ammeter and a Fluke as the armature voltmeter. Turn on the 3-phase power and make sure everything is running smoothly. Read the speed with the optical tachometer. Push "TEST" to read speed, "MEM" to see last reading, minimum & maximum. If the speed seems unreasonable high



(above 1800rpm), hold the tachometer further away from the spinning coupling and/or check for more than one reflective tape on th couplings. Now that you have the DC motor spinning at a reasonably constant speed, you can get data to plot a curve like that shown in Figure 8-30 (p.398) of your textbook. You may wish to record the data directly into a spreadsheet to facilitate plotting the curve.

Turn down the right-side voltage knob on the Mastech and turn both current knobs up to midway. Turn on the Mastech and make sure you get field current when you turn up the voltage. (If not, you may need a new current fuse in the ammeter.) Take readings of the armature voltage as you vary the field current from 0 to 120 mA (or as close as you can get). Specifically include readings at 50 and 100 mA. Make a plot of E_A vs. I_F now, or leave room in your notebook to add it later. Note the polarity of the armature voltage.

Calculate $K\varphi$ at I_F = 50 mA at 100 mA. Measure the field voltage (Mastech) when I_F = 100 mA and calculate R_F. Power off the Mastech, but leave it set at the voltage required for I_F = 100 mA.

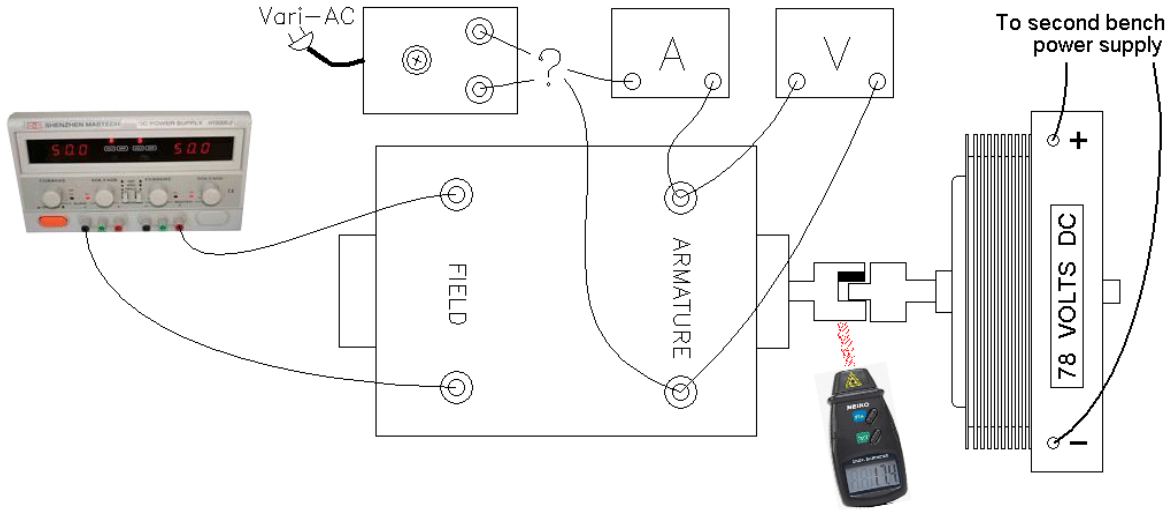
Motor Speed Plot

Change your setup to match the drawing on the next page. If you used the bench meter to measure field current and have 2 Fluke meters, you can leave the bench meter connected as is. Otherwise, set up the bench meter to measure the armature voltage and the Fluke to measure the current. Turn on the Vari-AC at a low voltage and check the voltage polarity at the armature. Match the polarity of the armature voltage to the polarity you measured before. **The wires may have to be crossed at the ? in the drawing!**. Turn down the Vari-AC.

Turn on the second bench power supply and manually rotate the brake. Feel the braking action as you vary the brake voltage. Turn down the second bench power supply to 0.

Turn on the DC field current to100 mA (or as close as you were able to get).

Vary the armature voltage between 0 and 125V and observe the changing motor speed. Take at least 6 readings of armature voltage, current and motor speed so that you can plot the no-load speed vs the V_T. Make the plot now or leave room to add it later. Leave the field current on.



Set the armature voltage to 115V, or as close as you can get. Find the current knob on the Mastech power supply. Slowly turn it down until it begins to limit the current to the field and the motor rapidly accelerates – then immediately turn it back up again. Note that without field flux the motor speed can run away. Comment in your notebook. Say why someone should keep a hand on the Vari-AC's power switch from now on and why the armature supply should always be turned off before field supply.

DC Motor Model

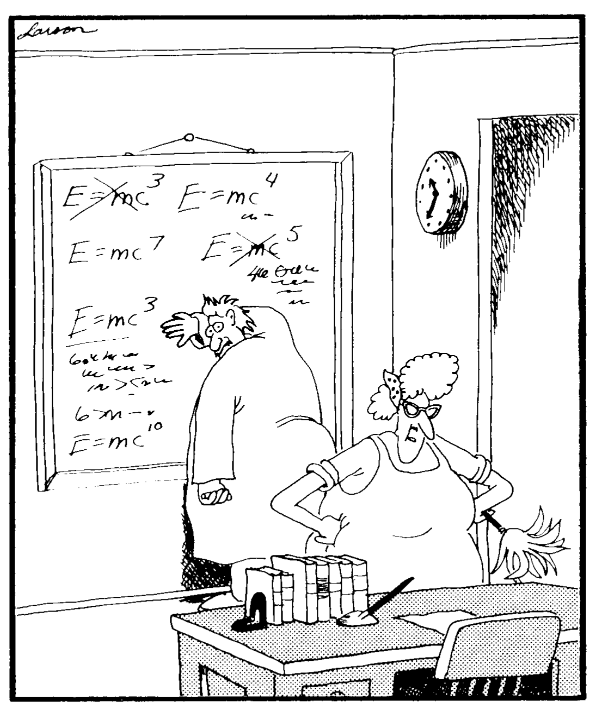
Make a table to record data in your notebook or in a spreadsheet, 1st column: brake voltage, 0, 5,10,...30V. 2nd column: V_T, which you will reset to close to 115V at each brake setting. 3rd column: armature current, record to at least 3 significant figures. 4th column: motor speed in rpm. 5th column: motor speed in rad/sec. 6th column: calculated E_A. From $K\varphi$. 7th column: calculated E_A from V_T - I_A R_A.

If, while taking the following readings, the motor ever stalls, immediately turn down the brake or armature voltage. Take readings to fill columns 2 - 4 of your table, then turn down the armature voltage. Make calculations to fill the remaining columns. Compare your E_A values. Draw the motor model and add numerical values, assuming I_F = 100 mA.

Calculate the P_{conv} at the lowest brake setting. Consider this rotational loss at the no-load speed. Calculate the rotational loss at the highest brake setting, assuming loss is proportional to speed. Calculate the brake torque and output power at the highest brake setting.

Check off, Conclude and Clean Up

Check off and conclude as always. Be sure to compare what you found in the lab to what you expect to see from theory.



"*Now* that desk looks better. Everything's squared away, yessir, squaaaaaared away."