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

A. Stolp, 12/6/09
rev, 11/26/12
rev, 12/8/17

## Objectives

1. 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 ~1770 rpm.
2. Determine Kφ for two field currents.
3. Run the DC motor with a constant field current plot the speed vs. armature voltage.
4. Observe the effect of losing the field current.
5. Find the armature resistance and expected armature currents and plot with actual.

## Part to bring or buy:

Electrolytic capacitor, 50 µF or above, **200 V or above**. You can get by without this part, but it's a little more work, so bring one if you have one. Bring your textbook.

## Equipment and materials to be checked out from stockroom:

Note: Your TA may have preprinted check-out lists of the following.

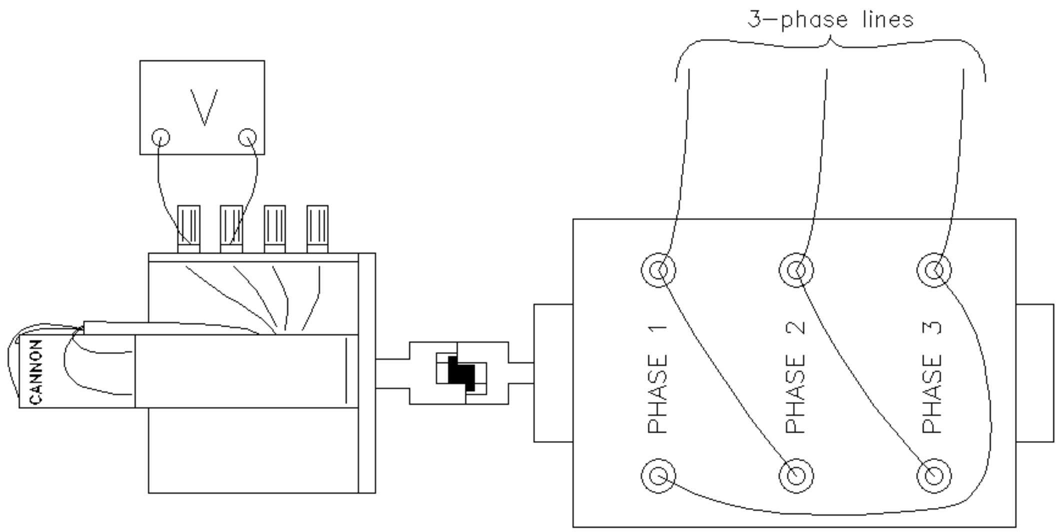
- Power wire kit
- 2 Multimeters
- B&K 1601 Power supply
- AC to DC rectifier box
- Vari-AC (Auto-transformer)
- Motor rack
- BOB (bucket of bolts)
- NSH-34 DC motor
- NPP34 3-phase induction motor
- Small servo motor with Cannon tachometer

## Calibrate Tachometer

Mount the 3-phase induction motor and the small servo motor with tachometer on the motor rack as shown on the next page. Give the motors plenty of slack at the coupling. You may need to use shims to make the two line up well. Also, if the servo motor shaft is bent (many are), you may have to try another one. Hook up a voltmeter to the green and yellow connections of the tachometer.

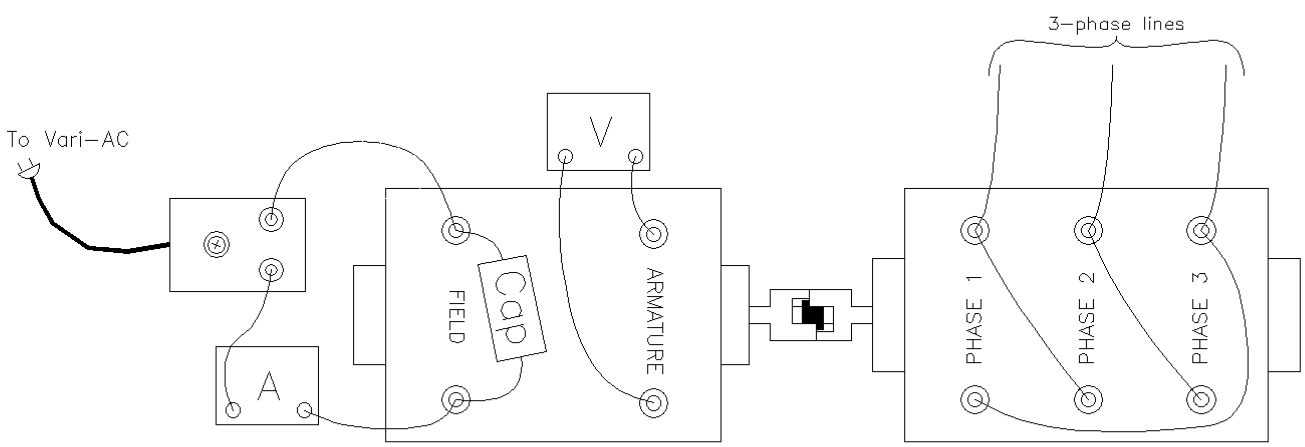
Turn off the 3-phase line breaker and hook up the 3-phase induction motor to the 3-phase lines (black, red, & blue) in Δ. Pay no attention to the connector colors of the motor. Turn on the 3-phase power and make sure everything is running smoothly. Now you have the tachometer spinning at a known speed of about 1770 rpm (your TA may have a better estimate for you and/or may have and alternate measurement method available). Record the tachometer voltage for later speed calculations. Turn off the 3-phase power.

Remove the small servo motor with tachometer and set it aside for now.




## Magnetization curve

Mount the DC motor on the motor rack with the 3-phase induction motor as shown below. 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.

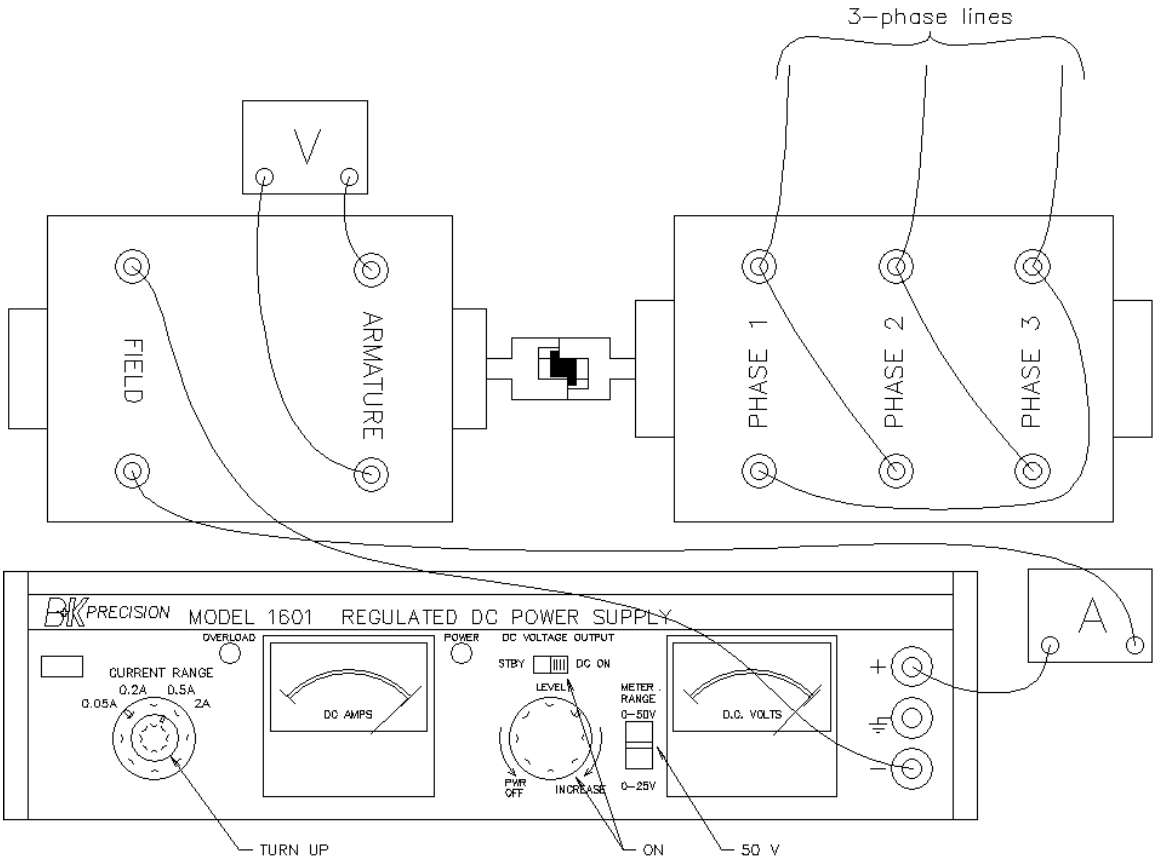



Plug the AC to DC rectifier box into the Vari-AC (Auto-transformer) and hook the DC side to the field winding though an ammeter. If you brought or bought an electrolytic capacitor, add it across the field winding (**Watch your polarity**). Hook a voltmeter to the armature winding. Turn on the 3-phase power and make sure everything is running smoothly. Now you have the DC motor spinning at a reasonably constant 1770 rpm and you can get data to plot a curve like that shown in Figure 8-30 (p.398) of your textbook.

Turn down, plug in, and turn on the Vari-AC. Take readings of the armature voltage as you vary the field current from 0 to 130 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.

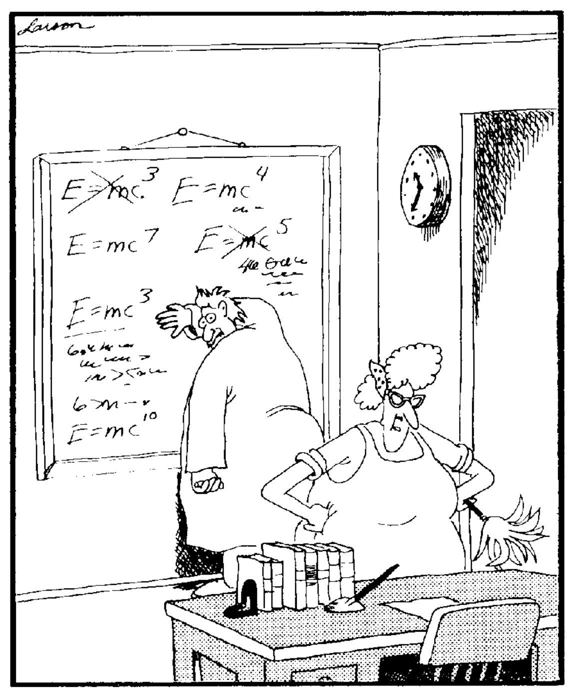
**If you don't have a filter capacitor on the field winding:** The DC motor field and the ammeter may not be "averaging" the field current quite the same way, so you'll need to repeat one reading with a true DC field current. Turn down the Vari-AC and turn off the 3-phase power. Change the DC field power source as shown in the next figure and adjust the B&K to provide 50 mA (or as close as you can get). Turn on the 3-phase power and record the armature voltage. Turn off the 3-phase power. Recalculate $K\varphi$ at $I_F = 50$ mA.




## DC Motor Speed and Model

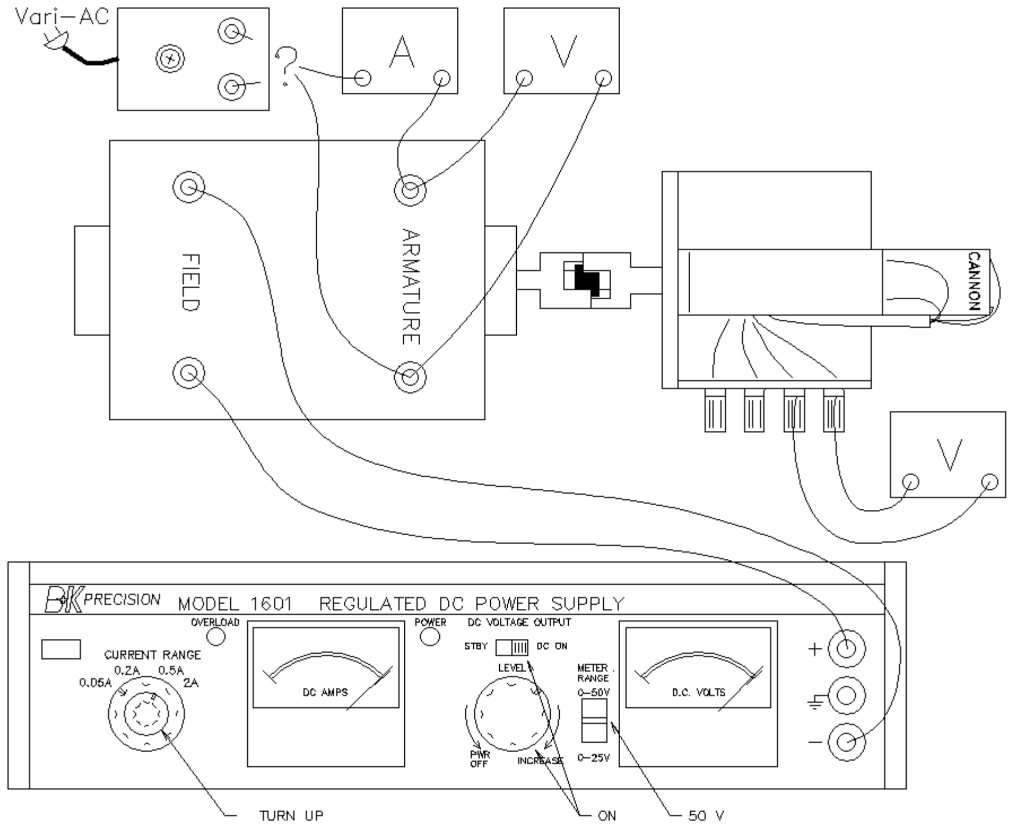
If you haven't already done so, set up the DC field as shown in the drawing above and adjust the B&K to provide 50 mA (or as close as you can get).

Proceed to the next page.




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

Move the ammeter so that it can measure the armature current and set up the DC motor as shown. 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!**. Replace the 3-phase induction motor with the small servo motor with tachometer and hook up a voltmeter to the green and yellow connections of the tachometer.




At an armature voltage of 50 V or less, briefly disconnect the field winding and observe what happens to the motor speed. Comment in your notebook. Say why someone should keep a hand on the Vari-AC's power switch from now on and why the field supply should always be turned off before the armature supply.

Take readings of the tachometer voltage and the armature current as you vary the armature voltage from 0 to 100 V. Turn down the armature voltage.

Convert your tachometer voltages to rpm values, using your previous measurement at ~1770rpm and assuming a linear relationship between voltage and rpm. Make a plot of speed vs. armature voltage now or leave room in your notebook to add it later.

Use the $K\varphi$ you found earlier and armature voltages to find $R_A$ at several speeds. Average the values to find your best estimate of $R_A$. Draw the motor model.

Calculate the expected armature currents for the measured speeds. Plot calculated and actual armature currents vs. speed.

**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.