**University of Utah**
**Electrical & Computer Engineering Department**
ECE 3600 Lab 4

# Induction Motor

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rev,

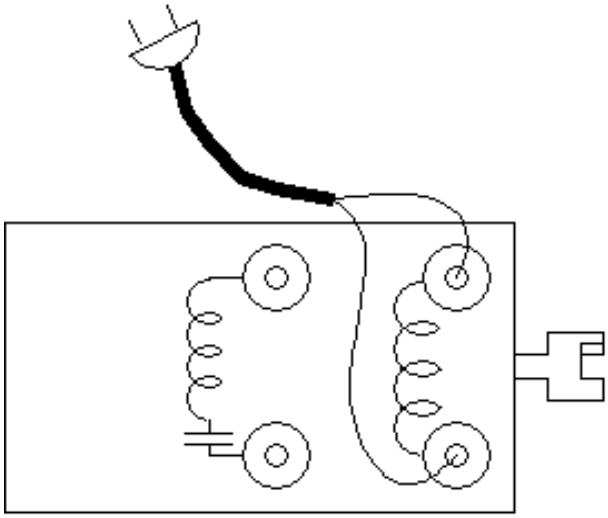
## Objectives

1. Learn about starting the single-phase induction motor.
2. Take a torque-speed for small induction motor using the dSPACE system. This part of the lab draws directly from ECE 5570, lab 5.

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

See the last page of this lab and cut out the check-out list. Check out those items your TA says you will need. He may modify this list if he intends to set up a couple of dSPACE systems himself for everyone to use in turn.

## Starting the Single-Phase Motor



Mount the blue single-phase induction motor on the motor rack. Connect the power cord to the main winding, as shown. Plug the cord into the power stip and turn it on. Notice that the motor doesn't turn. This is because one phase can only produce a magnetic field that swings back and forth 60 times per second, but does not rotate. Without a rotating magnetic field, the rotor may hum a bit, but it will not start rotating. Give the motor shaft a spin in either direction to get it started. Now it will continue to rotate because of the nature of the "dual rotating" magnetic fields discussed in class. After the motor spins up to full speed, turn off the power and let it come to a stop. Turn on the power again and manually start the motor in the opposite direction. Notice that it will work equally well in either direction, depending only on how it is started. This is typical of a single-phase induction motor. Turn off the power and let it come to a stop. Describe what you have just done in your lab notebook.

Now connect the second winding (with the capacitor) in parallel with the first and turn on the power. The motor will now spin up on its own. This is because the second winding is positioned at a 90° (actually 90°÷ number of pole pairs) with respect to the first and the current in the second winding is out of phase with the first. The capacitor in series with the second winding provides the needed phase shift. Note the direction of rotation. If you dare, carefully disconnect the second winding while the motor is running and note that the motor continues to run with no problem. Otherwise refer back to how the motor ran with only one winding before, once started. Turn off the power and let it come to a stop. Describe what you have just done in your lab notebook, noting that the second winding could be used just for starting, if desired.

Swap the connections to one of the windings, turn on the motor and note the direction of rotation. Turn off the power and let it come to a stop. Repeat this until you have tried all four possible connections. Describe what you have just done in your lab notebook and draw some conclusions about connections and starting direction.

## The Torque-Speed Curve of an Induction Motor

Note: If you have taken ECE 5570 you may skip this part of the lab by simply showing your TA your 5570 lab notebook and/or report. Don't skip the "Conclude" section. If you don't have any documentation, sorry, you'll have to do it again.

Check with your TA to see if you will be setting up your own dSPACE experiment or if he will let you use one that he has set up.

**Setting up the dSPACE**

Before you turn on the computer, ask your TA to help you make the dSPACE connections that need to be made with the computer off.

Turn on the computer and access: http://www.ece.utah.edu/nsf_5570 . Find lab 5 on this page and open the dSPACE Tutorial. This will show you how to set up the dSPACE system. Your TA may help you here.

Download the Experiment files for Lab 5

Open the Lab 5 Handout PDF file and find section 2.1 Preliminary Testing. This is the "usual testing procedure" as outlined in ECE 5570 Lab 1.

- Be sure to read the dSpace tutorial for basic hardware and software setup.
- Use the tutorial instructions to load the ECE5570_lab1 experiment from the class website. (If you don't use the Lab 1 experiment files you may not be able to perform the checks below. Ask your TA if this will be required or only done in case of problems.)
- Connect the encoder (part on bracket used to measure rotational position) input cable from the I/O breakout box (low box with lots of connections and a big cable to the back of the computer) port INC1 to the encoder plug on the encoder bracket.
- Run the system and check the operation of the encoder by manually spinning the motor noting a change in encoder position in the layout window. (This may not be available in the Lab 5 layout window.)
- Connect a BNC cable from DACH1 to a channel on the dual linear amplifier (big aluminum box). (The following may not be available in the Lab 5 layout window.) Set the voltage in the layout for +10 V, click run in the layout and measure the resulting voltage at the output of the amplifier. It should be ~10 V.
- Repeat testing for a BNC cable connected to DACH2 and the remaining output of the linear amp.
- Finish hooking up the system by attaching leads from the motor to the amplifier.

**dSPACE Experiment**
If you haven't already done so, open the Lab 5 Handout PDF file. Skim through the first section taking care not to get too tied up in the equations. The equations you have seen in our class are similar to the steady-state version, but we use different subscripts for the various parts.

Your TA will help you do a modified version on ECE 5570 - Lab 5, concentrating on the torque-speed curves. Your TA will help you with a Butterworth filter file. Once you have plots of torqe/rotational inertia, don't worry about the other parameters. Be sure to record what you do as well as you results in your lab notebook.

## 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 saw in your text and in class. Guess the class (A,B,C,or D) of this motor from the shape of its torque-speed curve.

If the TA set up the dSPACE stations for you, please offer to help clean up before leaving.

| NAME | |
|---|---|
| DATE | |
| CLASS | ECE 3600 SECTION 001 |
| QUANTITY | DESCRIPTION |
| 1 | Power wire kit |
| 1 | Power strip |
| 1 | "Suicide" cord |
| 1 | Single-phase induction motor (blue) |
| 1 | 5570 lab 5 induction motor |
| 1 | Encoder in a bracket |
| 1 | Dual power amplifier |
| 1 | dSPACE kit with encoder cable and I/O breakout box |
| 1 | Motor rack |
| 1 | BOB (bucket of bolts) |
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