ECE 3600 homework Ind1

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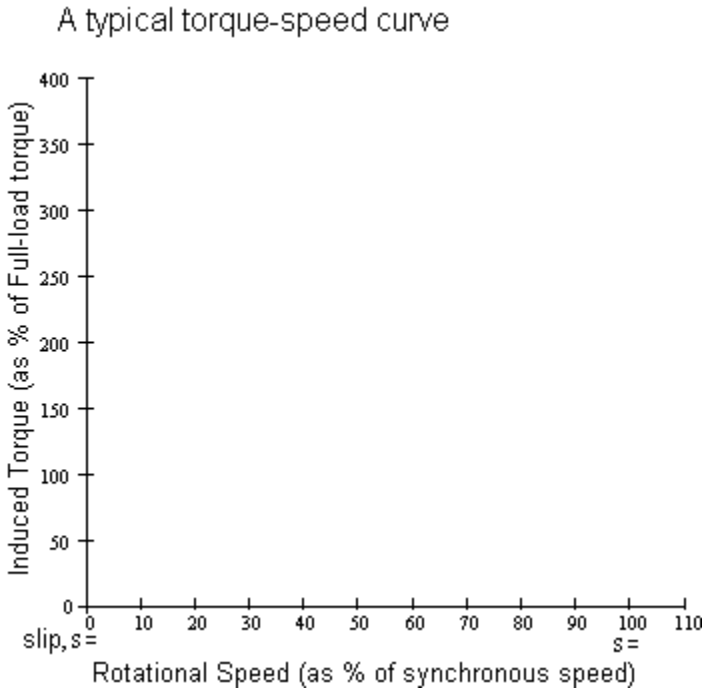
Name _____ 3-phase Induction motors 1

Answer the following questions in your textbook, starting on p.347.

7-1. What are slip speed and slip in an induction motor?

7-3. Why is it impossible for an induction motor to operate at synchronous speed?

7-4 Sketch and explain the shape of a typical induction motor torque-speed characteristic curve.



7-5. What equivalent circuit element has the most direct control over the speed at which the pullout torque occurs?

7-9. Why is the efficiency of an induction motor (wound rotor or squirrel cage) so poor at high slips?

7-16. Two 480-V, 100-hp induction motors are manufactured. One is designed for 50-Hz operation. and one is designed for 60-Hz operation, but they are otherwise similar. Which of these machines is larger?

7-17. An induction motor is running at the rated conditions. If the shaft load is now increased, how do the following quantities change?

a. Mechanical speed _____ d. Rotor current _____

b. Slip _____ e. Rotor frequency _____

c. Rotor induced voltage _____ g. Synchronous speed _____

Solve the following problems in your textbook, starting on p.348.

1. 7-3 A 480-V three-phase four-pole 60-Hz induction motor is running at a slip of 0.025. Find:
   a) The speed of the magnetic fields in revolutions per minute

   b) The speed of the rotor in revolutions per minute

   c) The slip speed of the rotor

   d) The rotor frequency in hertz

2. 7-4 A three-phase 60-Hz induction motor runs at 710 rpm at no load and at 670 rpm at full load.

   a) How many poles does this motor have?

   b) What is the slip at rated load?

   c) What is the speed at one-quarter of the rated shaft torque? (You may assume the torque-speed curve is linear in this region).

   d) What is the rotor's electrical frequency at one-quarter of the rated shaft torque?

3. 7-5 A 50-kW 440-V 50-Hz two-pole induction motor has a slip of 6 percent when operating at full-load conditions. At full-load conditions, the friction and windage losses are 520 W, and the core losses are 500 W. Find the following values for full-load conditions:

   a) The shaft speed n_m

   b) The output power in watts

   c) The load torque load τ_{load} in newton-meters

   d) The induced torque τ_{ind} in newton-meters

   e) The rotor frequency in hertz

4. A three-phase 60-Hz two-pole induction motor runs at a no-load speed of 3580 rpm and a full-load speed of 3440 rpm. Calculate the slip and the electrical frequency of the rotor at no-load and full-load conditions. What is the speed regulation of this motor [Equation (4-57)]?

Answers

1. a) 1800·rpm b) 1755·rpm c) 45·rpm d) 1.5·Hz
2. a) 10 b) 6.94·% c) 700·rpm d) 1.67·Hz
3. a) 2820·rpm b) 50·kW c) 169·N·m d) 173·N·m e) 3·Hz
4. 0.56·% 0.33·Hz 4.44·% 2.67·Hz 4.1·%