

# ECE 331 - Homework #4

## Chapter 4: AC Induction Motors

1) Using MATLAB or SciLab, show that a 3-phase stator produces a rotating magnetic field.

2-3) A three-phase, two-pole, 30hp, 120V, 60Hz Y connected induction motor draws a current of 30A from the line source at a power factor of 0.9. At this condition, the motor losses are:

- Stator copper losses =  $P_{cu1} = 500W$
- Rotor copper losses =  $P_{cu2} = 300W$
- Stator core losses =  $P_c = 240W$
- Rotation losses =  $P_{rot} = 200W$

Determine

- a) the power transferred across the air gap
- b) The internally developed torque in Nm
- c) the slip expressed in per unit and in rpm
- d) the mechanical power developed in watts
- e) the horsepower output
- f) the motor speed in rpm and radians/second
- g) the torque at the output shaft
- h) the torque needed to overcome rotational losses
- i) the efficiency of the operation in the stated conditions

4-5) A three-phase, two pole, 20hp, 120V, 60Hz, Y connected induction motor has the following parameters per phase:

$$r_1 = 0.1 \text{ Ohm}, x_1 = 0.35 \text{ Ohms}$$

$$r_2 = 0.12 \text{ Ohms}, x_2 = 0.40 \text{ Ohms}$$

The stator core losses are 500W and the rotational losses are 400W. At no-load, the motor draws 10A with a power factor of 0.1 lagging. When the motor operates at a slip of 2%, find

- a) the input line current and power factor
- b) the developed electromagnetic torque in Nm
- c) the horsepower output
- d) the efficiency
- 6) Plot the torque-slip speed relationship for the motor in problem 4-5.

BONUS! Explain how a rail gun that shoots pennies works.