ECE 331 - Homework #7

3 Phase Induction Motors and Generators. Due March 24th 4PM
Assume all voltages are line-to-neutral and all units are rms.

1) A three-phase, two-pole, 30hp, $120V_{LN}$, 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_{cul} = 400W
- Rotor copper losses = P_{cu2} = 200W
- Stator core losses = P_c = 140W
- Rotation losses = P_{rot} = 100W

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 radiands/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

2) A three-phase, two pole, 20hp, $120V_{LN}$, 60Hz, Y connected induction motor has the following parameters per phase:

- r_1 = 0.15 Ohm, x_1 = 0.25 Ohms
- r_2 = 0.10 Ohms x_2 = 0.30 Ohms

The stator core losses are 400W and the rotational losses are 200W. At no-load, the motor draws 10A with a power factor of 0.1 lagging. When the motor operates at a slip of 3%, find

- a) the input line current and power factor
- b) the developed electromagnetic torque in Nm
- c) the horsepower output
- d) the efficiency

3) Plot the torque-slip speed relationship for the motor in problem 2 for $-1 < s < +1$. (note: slip less than one corresponds to a generator)

4) Find r2 so that the starting torque is 70% of the peak torque.