

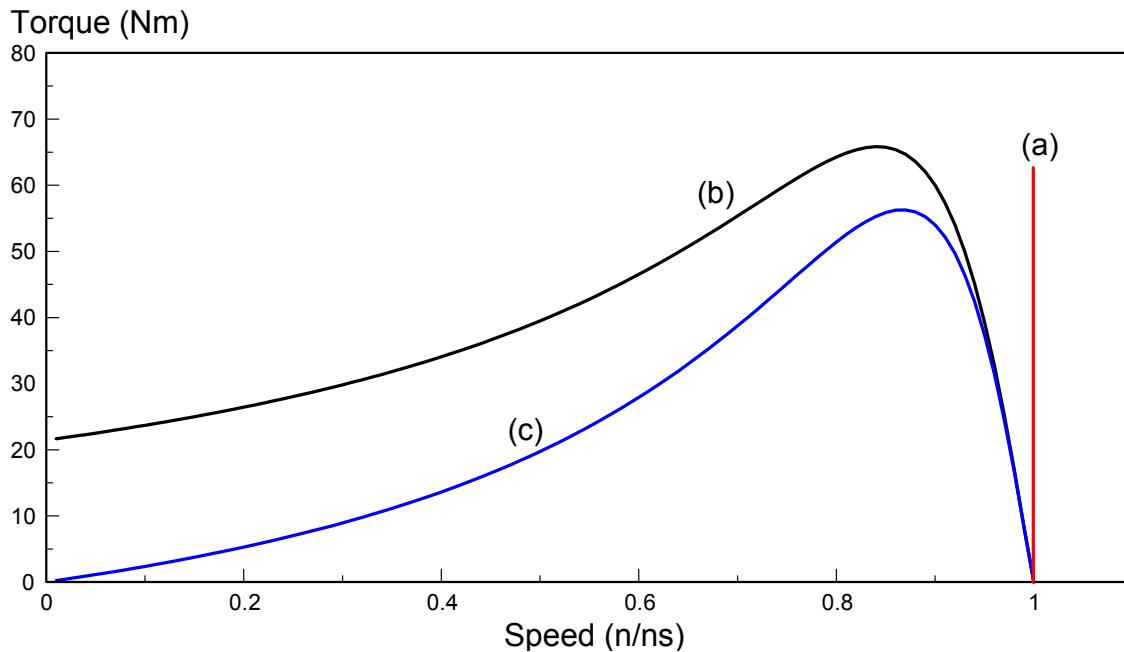
# ECE 331: Test #3 Name \_\_\_\_\_

Induction & Synchronous Motors: April 11, 2014

1) The torque vs. speed relationship for a 3 phase induction motor, 1 phase induction motor, and a 3 phase synchronous motor are shown below.

1a) Which curve is which? (answer = a, b, or c)

3 Phase Induction Motor	1 Phase Induction Motor	3 Phase Synchronous Motor

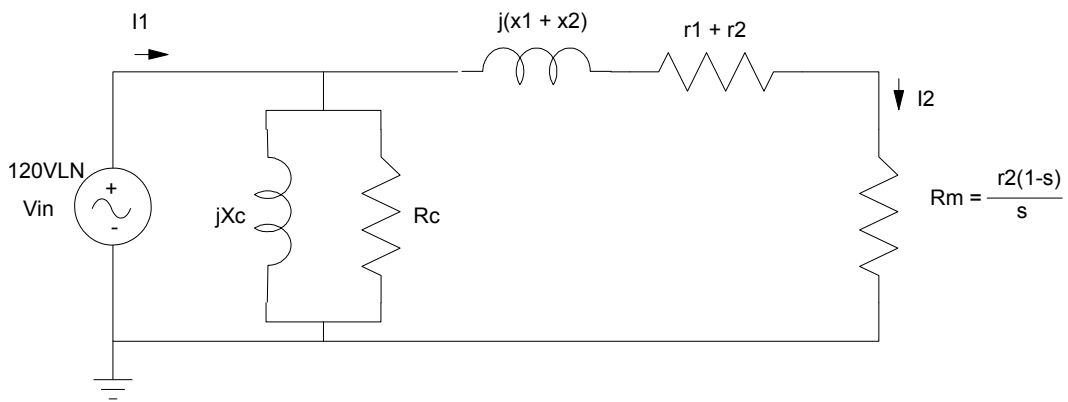


1b) Assume synchronous speed is 3600 rpm. If the motors initially have no load (Torque = 0Nm) and then are loaded with 30Nm of torque, how fast will each motor run (approximately)?

3 Phase Induction Motor	1 Phase Induction Motor	3 Phase Synchronous Motor

2) A 3-Phase Induction Motor has the following specifications

- $jX_c = j500$
- $R_c = 2000$
- $r_1 = r_2 = 2$  Ohms
- $jx_1 = jx_2 = j4$  Ohms
- $V_{in} = 120V_{LN}$
- Synchronous speed =  $60\text{Hz} = 377$  rad/sec
- Slip = 5% ( $s = 0.05$ )

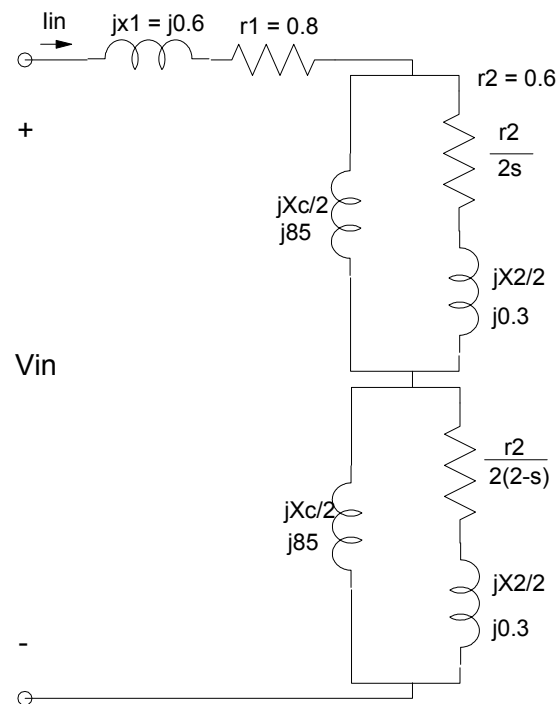


Determine  $I_1$ ,  $P_{in}$ , and  $P_m$  (the power to  $R_m$ )

$I_1$	$P_{in}$	$I_2$	$P_m$

3) A single-phase induction motor has parameters shown below. Determine the results from the DC test, locked rotor test, and no load test.

	$V_{in}$	$I_n$	Power
No-Load Test $s = 0$	$120V_{LN}$ 60Hz		
Locked Rotor Test $s = 1$	$20V_{LN}$ 60Hz		
DC Test	12V DC		



4) An AC synchronous motor

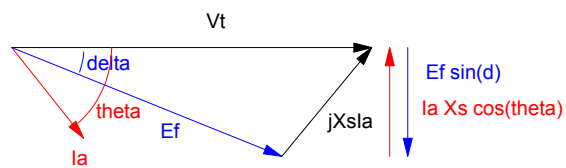
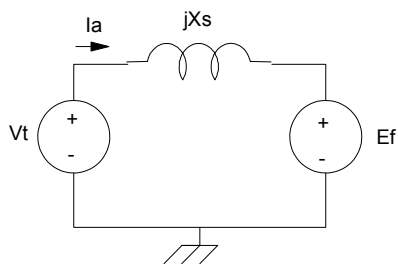
Determine the slip angle, delta, and the line current ( $I_a$ ) for a 3-phase, 2 pole (60Hz) synchronous motor when delivering 30kW of power

- $V_t = 220V_{LN}$
- $E_f = 300V$
- $X_s = 4 \text{ Ohms}$
- $P_o = 30kW$

$$P = 3 \cdot V_t I_a \cdot \cos(\theta)$$

$$P = 3 \cdot \left( \frac{-V_t E_f}{X_s} \right) \cdot \sin(\delta)$$

Slip Angle (delta)	$I_a$ (amplitude & phase)



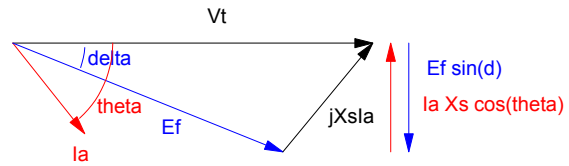
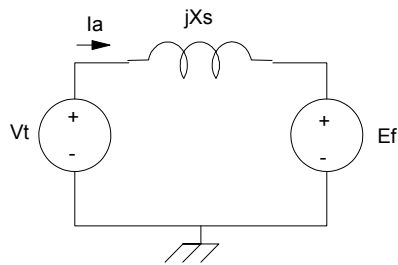
5a) An AC Synchronous Generator: Determine the maximum power an AC synchronous generator can produce and the maximum torque you can apply to the generator. Assume 3-phase, 2 pole (60Hz) induction motor/generator with

- $V_t = 220V_{LN}$
- $E_f = 300V$
- $X_s = 4 \text{ Ohms}$

$$P = 3 \cdot V_t I_a \cdot \cos(\theta)$$

$$P = 3 \cdot \left( \frac{-V_t E_f}{X_s} \right) \cdot \sin(\delta)$$

Max Torque (Nm)	Max Power (Watts)



5b) What happens if you apply more torque than this?

BONUS! Artificial light has been sold for over 2000 years starting with the oil lamp and progressing to LED lights. Based upon the cost to produce one Lumen, what is the rate of inflation for the past 2000 years?