ECE 330 HW 10

Textbook problem 6.1 (Use 100kW and 1.2Ω synchronous reactance instead of the given values.)

Textbook problem 6.4

Special problem #1
A 3-phase, 4-pole, 60Hz, round rotor, Y-connected synchronous machine is delivering 5,700 Watts (3-phase) to a network at 480 Volts (line to line). When the rotor (field) current is 5 Amps, the machine is overexcited (delivering VARS). In this condition, the generator line current is 8 Amps, and the torque angle is 30 degrees (electrical).
(a) What is the maximum amount of real power this machine can deliver if the network voltage remains at 480 Volts and the rotor (field) current remains at 5 Amps? (Answer = 11,400 W)
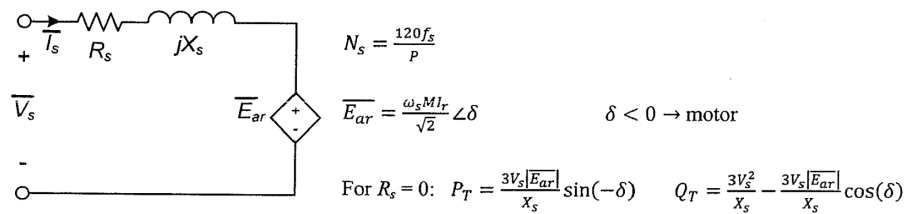(b) What is the synchronous reactance of this machine? (Answer = 35.71 Ohms)

Textbook problem 7.3

Special problem #2
A 460 Volt (line to line), 60 Hz, 3-phase, Y-connected, 4 pole Induction motor is running at rated voltage, current and speed. The actual machine speed is 1720 RPM. The stator resistance and leakage reactance may be neglected. When the motor runs at no load, the speed is approximately 1800 RPM and the stator line current (magnitude) is 6 Amps. The rotor resistance referred to the stator (R'_r) is 0.8 Ohms. The rotor leakage reactance referred to the stator (X'_{lr}) is 2.0 Ohms.
(a) What is the frequency of the rotor currents at this operating point? (Answer = 2.67 Hz)
(b) What is the rated line current? (Answer = 16.45 Amps)
(c) What is the starting line current if started at full rated voltage? (Answer = 128.9 Amps)
(d) What is the rated torque? (Answer = 62 NM)

Formulas that will be on the quizzes for homework and final exam

$$N_s = \frac{120 f_s}{P}$$

$$\overline{E_{ar}} = \frac{\omega_s M I_r}{\sqrt{2}} \angle \delta \qquad \delta < 0 \rightarrow \text{motor}$$

For $R_s = 0$: $\quad P_T = \frac{3 V_s |\overline{E_{ar}}|}{X_s} \sin(-\delta) \qquad Q_T = \frac{3 V_s^2}{X_s} - \frac{3 V_s |\overline{E_{ar}}|}{X_s} \cos(\delta)$

$$T^e = \frac{P_m}{\omega_m} \qquad \omega_m = \frac{2}{P} \omega_s \qquad \text{(for synchronous machine, } P_m = P_T \text{ in formulas above)}$$

$$s = \frac{\omega_s - \frac{P}{2} \omega_m}{\omega_s}$$

$$f_r = s f_s$$

$$P_{AG} = 3 |\overline{I_r}'|^2 \frac{R'_r}{s} \qquad P_m = (1-s) P_{AG} \qquad T^e = \frac{P_m}{\omega_m}$$

1