EE 330/330L Energy Systems (Spring 2012) Quiz #5

Name Key B

Instructions: **Closed book & notes**. Place answers in indicated spaces & show all work for credit.

Equations: $n_{\text{sync}} = \frac{120 f_e}{P}$, $n_{\text{slip}} = n_{\text{sync}} - n_m$, $s = \frac{n_{\text{sync}} - n_m}{n_{\text{sync}}} = \frac{\omega_{\text{sync}} - \omega_m}{\omega_{\text{sync}}}$, $n_m = (1-s)\, n_{\text{sync}}$, $\omega_m = (1-s)\, \omega_{\text{sync}}$,

$$f_r = s f_e,\ P_{\text{mech}} = \tau \omega_m,\ P_{\text{elec}} = \sqrt{3}\, V_T I_L \cos(\theta) = 3 V_\phi I_\phi \cos(\theta),\ 1\text{ hp} = 746\text{ W},\ \omega_m = n_m \left(\frac{\pi}{30}\right)$$

A 9.5 hp, 275 V_{rms}, 3-phase, Y-connected, 8-pole, 400 Hz, induction motor has a rated-load speed of 5780 RPM. Determine the synchronous speed (both in RPM and rad/s), rated slip (%), and rated output power (in Watts) & torque. At what frequency are the induced voltages and currents on the rotor?

$$n_{synch} = \frac{120 f_e}{P} = \frac{120(400)}{8} = 6000 \text{ RPM}$$

$$\omega_{synch} = n_{synch}\left(\pi/30\right) = 6000(\pi/30) = 200\pi = 628.31853 \text{ rad/s}$$

$$s = \frac{n_{sync} - n_m}{n_{sync}} = \frac{6000 - 5780}{6000} = 0.03\overline{6} = 3.\overline{66}\%$$

$$f_r = s f_e = 0.03\overline{6}(400) = 14.\overline{66} \text{ Hz}$$

$$P_{out} = (9.5 \text{ hp})\left(\frac{746 \text{ W}}{1 \text{ hp}}\right) = 7087 \text{ W}$$

$$\tau_{out} = \frac{P_{out}}{\omega_m} = \frac{7087}{5780(\pi/30)} = 11.708627 \text{ N.m}$$

$n_{\text{synch}} =$ 6000 RPM $\omega_{\text{synch}} =$ 628.32 rad/s $\text{slip}_{\text{rated}} =$ $3.\overline{66}\%$

$P_{\text{out}} =$ 7087 W $\tau_{\text{out}} =$ 11.709 N.m $f_{\text{rotor}} =$ $14.\overline{66}$ Hz