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

Name Key A

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 7.5 hp, 250 V_{rms}, 3-phase, Y-connected, 6-pole, 400 Hz, induction motor has a rated-load speed of 7650 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?

$n_{synch} = \frac{120 f_e}{P} = \frac{120(400)}{6} = 8000\ RPM$

$\omega_{synch} = (8000\ \frac{rev}{min})(\frac{1\ min}{60\ sec})(\frac{2\pi\ rad}{1\ rev}) = 266.\overline{6}\pi = 837.758\ rad/s$

$s = \frac{n_{sync} - n_m}{n_{sync}} = \frac{8000 - 7650}{8000} = 0.04375 = 4.375\%$

$f_r = s f_e = 0.04375(400) = 17.5\ Hz$

$P_{out} = 7.5\ hp\left(\frac{746\ W}{1\ hp}\right) = 5595\ W$

$\tau_{out} = \frac{P_{out}}{\omega_m} = \frac{5595}{7650(\pi/30)} = 6.98409\ N.m$

$n_{synch} =$ 8000 RPM $\omega_{synch} =$ 837.758 rad/s $slip_{rated} =$ 4.375%

$P_{out} =$ 5595 W $\tau_{out} =$ 6.984 N.m $f_{rotor} =$ 17.5 Hz