EE 330/330L Energy Systems (Spring 2012) Quiz #6

Name Key B

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

A four pole DC generator has a triplex lap-wound armature with 40 coils and 16 turns per coil. At 1600 RPM, it is rated for 16 kW at 100 V. At the rated load, determine the output current I_L, current per conductor I_{cond}, and induced torque τ_{ind}. Under no-load (i.e., open circuit) conditions, find the required magnetic flux ϕ needed to achieve the rated output voltage. Assume losses are negligible.

$P_{rated} = P_{out} = V_T I_L \Rightarrow I_L = \frac{16\times10^3}{100} = 160\,A$

Per (7-26) $\#\text{ current paths} \equiv a = m\,\underbrace{P}_{\text{triplex}} = 3(4) = 12$

Per (7-44) $I_{cond} = \frac{I_A}{a} = \frac{160}{12} = 13.\overline{3}\,A$

Neglecting losses $P_{conv} = P_{out} = \tau_{ind}\,\omega_m$

$\hookrightarrow \tau_{ind} = \frac{16\times10^3}{1600(\pi/30)} = 95.493\,N\cdot m$

Per (7-37) $E_A = V_T = \frac{ZP}{2\pi a}\,\phi\,\omega_m$ (for no-load)

where, per (7-22), $Z = 2C N_C = 2(40)16 = 1280$ (C: # coils, N_C: # turns)

$$\phi = \frac{V_T(2\pi a)}{ZP\,\omega_m} = \frac{100(2\pi 12)}{1280(4)1600(\pi/30)}$$

$$= 0.0087891\ wb = 8.7891\ mWb$$

$I_L =$ 160 A $\quad I_{cond} =$ 13.$\overline{3}$ A $\quad \tau_{ind} =$ 95.493 N·m $\quad \phi =$ 8.7891 mWb