1.

SOLUTION

(a) The speed of the magnetic fields is

$$n_{\text{sync}} = \frac{120 f_{2e}}{P} = \frac{120(50\text{ Hz})}{6} = 1000\text{ r/min}$$

(b) The speed of the rotor is

$$n_m = (1-s)\ n_{\text{sync}} = (1-0.035)(1000\text{ r/min}) = 965\text{ r/min}$$

(c) The slip speed of the rotor is

$$n_{\text{slip}} = s n_{\text{sync}} = (0.035)(1000\text{ r/min}) = 35\text{ r/min}$$

(d) The rotor frequency is

$$f_{re} = \frac{n_{\text{slip}} P}{120} = \frac{(35\text{ r/min})(6)}{120} = 1.75\text{ Hz}$$

2.

SOLUTION

(a) The synchronous speed of this machine is

$$n_{\text{sync}} = \frac{120 f_{se}}{P} = \frac{120(50\text{ Hz})}{2} = 3000\text{ r/min}$$

Therefore, the shaft speed is

$$n_m = (1-s)\ n_{\text{sync}} = (1-0.05)(3000\text{ r/min}) = 2850\text{ r/min}$$

(b) The output power in watts is 50 kW (stated in the problem).

(c) The load torque is

$$\tau_{\text{load}} = \frac{P_{\text{OUT}}}{\omega_m} = \frac{50\text{ kW}}{(2850\text{ r/min})\left(\frac{2\pi\text{ rad}}{1\text{ r}}\right)\left(\frac{1\text{ min}}{60\text{ s}}\right)} = 167.5\text{ N}\cdot\text{m}$$

(d) The induced torque can be found as follows:

$$P_{\text{conv}} = P_{\text{OUT}} + P_{\text{F\&W}} + P_{\text{core}} + P_{\text{misc}} = 50\text{ kW} + 700\text{ W} + 600\text{ W} + 0\text{ W} = 51.3\text{ kW}$$

$$\tau_{\text{ind}} = \frac{P_{\text{conv}}}{\omega_m} = \frac{51.3\text{ kW}}{(2850\text{ r/min})\left(\frac{2\pi\text{ rad}}{1\text{ r}}\right)\left(\frac{1\text{ min}}{60\text{ s}}\right)} = 171.9\text{ N}\cdot\text{m}$$

(e) The rotor frequency is

$$f_r = s f_e = (0.05)(50\text{ Hz}) = 2.5\text{ Hz}$$

p.s. for a motor, the rated power is the output power