ELG2331: Chapter 17

17.15

$$500 = \frac{240 - 3 - 36 \times 0.6}{K_a \phi}$$

$$K_a \phi = 0.431$$

$$n = \frac{240 - 3 - 36 \times 0.6}{0.431 \times \frac{21}{36}} = 893 \text{ rpm}$$

17.16

$$E_b = V_a - I_a R_a = 220 - 0.2 \times 50 = 210 \text{ V}$$

$$P = E_b I_a = 210 \times 50 = 10.5 \text{ kW} = 14.07 \text{ hp}$$

17.19

$$I_f = \frac{230}{75} = 3.07 \text{ A}$$

$$i_a = i_L - i_f = 46 - 3.07 = 42.93 \text{ A}$$

$$\omega_n = 1120 \times \frac{2\pi}{60} = 117.28 \text{ rad/s}$$

At no load

$$117.28 = \frac{230}{K_a \phi}$$

$$K_a \phi = 1.96$$

At full load

$$\omega_n = \frac{230 - 0.5 \times 42.93}{K_a \phi} = 106.4 \text{ rad/s}$$

The back emf is

$$E_b = 230 - 0.5 \times 41.93 = 208.5 \text{ V}$$

The power developed

$$P_{dev} = E_b I_a = 8.952 \text{ kW}$$

The power available at the shaft

$$P_{sh} = P_{dev} - P_{rot} = 8952 - 500 = 8.452 \text{ kW}$$

The torque at the shaft

$$T_{sh} = \frac{P_{sh}}{\omega_n} = \frac{8.452}{117.3} = 72.1 \text{ N - m}$$

Ignore part b.

17.20

$$i_f = \frac{200}{100} = 2\text{ A}$$
$$i_a = i_L - i_f = 5 - 2 = 3\text{ A}$$

Copper loss

$$P_{copper} = i_f^2 R_f + i_a^2 R_a = 400.9\text{ W}$$

The input power

$$P = 5 \times 200 = 1000\text{ W}$$

The power loss

$$P_{loss} = 1000 - 400.9 = 599.1\text{ W}$$

The speed is

$$\omega_n = 955 \times \frac{2\pi}{60} = 100\text{ rad/s}$$

The back emf

$$E_b = 200 - 3 \times 0.1 = 199.7\text{ V}$$
$$K_a\varphi = 1.997$$

When $i_L = 40$ A, $i_f = 2$ A, so $i_a = 38$ A

$$E_b = 200 - 38 \times 0.1 = 196.2\text{ V}$$
$$\omega_{\text{n}} = \frac{E_b}{K_a\phi} = 98.25\text{ rad/s}$$

The power absorbed

$$P = E_b i_a = 196.2 \times 38 = 7456\text{ W}$$

The copper loss

$$P_{loss} = i_f^2 R_f + i_a^2 R_a = 544.4\text{ W}$$

The input power

$$P_{in} = 40 \times 200 = 8\text{ kW}$$

And

$$P_{sh} = 7456 - \frac{98.25}{100} \times 599.1 = 6867.4\text{ W}$$
$$T_{sh} = \frac{6867.4}{98.25} = 69.9\text{ N - m}$$

The efficiency

$$\eta = \frac{P_{sh}}{P_{in}} = 85.84\%$$