Problem 1

(a) $E_b = V_s - I_a R_a = 220 - 6 \times 0.32 = 218.08\,(V)$

$\omega = 1800\ rpm = 1800 \times \frac{2\pi}{60} = 188.4\,(\frac{rad}{s})$

$E_b = k_a \phi \omega$

$k_a \phi = \frac{E_b}{\omega} = \frac{218.08}{188.4} = 1.157\,(Wb)$

torque $T = k_a \phi I_a = 1.157 \times 6 = 6.94\,(N.m)$

$P = T\omega = 188.4 \times 6.94$

$= 1308\,(W)$

$= \frac{1308}{746.}\,hp = 1.75\,hp.$

(b). $E_b' = 220 - 62 \times 0.32 = 200.16\,(V)$

$\omega' = \frac{E_b'}{k_a \phi.} = \frac{200.16}{1.157} = 173\,(\frac{rad}{s})$

$= 173 \times (\frac{60}{2\pi})\ rpm = 1652\ rpm$

$T' = k_a \phi I_a = 1.157 \times 62 = 71.73\ (N.m)$

$p' = T'\omega' = 12410\,(W) = 16.6\,hp$

Problem 2.

(a). $E_b = 550 - 0.36 \times 75 = 523\ (V)$

$\omega = 3000\ rpm = 3000 \times \frac{2\pi}{60}\ (\frac{rad}{s})$

$= 314\ (\frac{rad}{s})$

$E_b = k_a \phi \omega$.

$k_a \phi = \frac{E_b}{\omega} = \frac{523}{314} = 1.666\ (Wb)$

$T = k_a \phi I_a = 1.666 \times 75 = 124.9\ (N \cdot m)$

(b). same torque, same current $I_a = 75A$

because $T = k_a \phi I_a$.

speed reduces. 20%, back emf E_b

reduces 20%, because $E_b = k_a \phi \omega$.

$E_b' = 0.8 E_b = 0.8 \times 523 = 418.4\ (V)$

$418.4 = E_b' = 550 - (\Delta R_a + 0.36) \times 75$

$\therefore \quad \Delta R = 1.395\ \Omega$.

Problem 3.

$$E_b = 220 - 0.2 \times 50 = 210\ V$$

$$P_{mechanical} = P_{electrical} = I_a E_b.$$

$$= 50 \times 210 = 10500\ (W)$$

$$= \frac{10500}{746}\ hp. = 14.1\ (hp.)$$

$$\omega = 1200 \times \frac{2\pi}{60} = 125.68\ \frac{rad}{s}$$

$$T = \frac{P.}{\omega.} = \frac{10500.}{125.68} = 83.5\ (N \cdot m)$$

Problem 4.

(a) $E_b = 550 - 0.15 \times 112 = 533.2\ (V)$

$$\omega = 820 \times \frac{2\pi}{60} = 85.8 \left(\frac{rad}{s}\right)$$

$$k_a\phi = \frac{E_b}{\omega} = \frac{533.2}{85.8} = 6.21\ (Wb)$$

$$T = k_a \phi I_a = 6.21 \times 112 = 695.5\ (N \cdot m)$$

$$P = T\omega = 695.5 \times 85.8 = 59675\ (W)$$

$$= \frac{59675}{746}\ hp = 80\ hp.$$

(b). $T' = k_a\phi I_a' = 6.21 \times 84 = 521.6\ (N \cdot m)$

$$E_b' = 550 - 84 \times 0.15 = 537.4\ (V)$$

$$\omega' = \frac{E_b'}{k_a\phi} = \frac{537.4}{6.21} = 86.5\ \frac{rad}{s}$$

$$= 86.5 \times \frac{60}{2\pi} = 826\ rpm.$$

$$P' = T'\omega' = 521.6 \times 86.5 = 45138\ (W) = 60.5\ hp$$