Tutorial 10

1. A 6-pole dc machine armature has 36 slots, 2 coil-sides/slot, 8 turns/coil and is wave wound. The pole shoes is 18 cm long and the mean air-gap diameter is 25 cm. The average flux density over one pole-pitch is 0.8 T. Find out the value of induced emf if machine rpm is 1200.

Sol^{n}. Here,

$$Z = 36 \times 2 \times 8 = 576$$

$A = 2$, wave winding.

$$\phi = \frac{\pi \times 0.25}{6} \times 0.18 \times 0.8$$

$$\phi = 0.0188 \text{ Wb}$$

Induced Emf, $E_a = \dfrac{\phi n Z}{60}\left(\dfrac{P}{A}\right)$

$$= \frac{0.0188 \times 1200 \times 576}{60} \times \left(\frac{6}{2}\right)$$

$$= 650 \text{ V.}$$

2. A two pole DC generator has average flux density per pole as 0.8 T. The radius and length of the rotor of the machine are 10 cm and 25 cm, respectively. The number of armature winding conductor is 20. If machine is running at 1000 rpm and the armature is wave wound, find the developed torque in N-m when armature current is 15 Amperes.

(2) Flux per pole, $\phi = \dfrac{\text{Area of pole face} \times \text{flux density}}{\text{No. of poles}}$

$$\phi = \frac{2\pi r \times l \times 0.8}{2}$$

$$\phi = \frac{2\pi \times 10 \times 10^{-2} \times 25 \times 10^{-2} \times 0.8}{2}$$

$$\phi = 0.0628 \text{ Wb/pole}$$

$\therefore E_a = \dfrac{\phi Z N P}{60\, a} \Rightarrow$

N = 1000

a = No. of parallel path = 2

Z = No. of armature winding conductor = 20

$$E_a = \frac{0.0628 \times 20 \times 1000 \times 2}{60 \times 2} = \underline{\underline{20.93 \text{ Volts}}}.$$

Torque, $\tau = K.\phi\, I_a = \dfrac{E_a . I_a}{\omega}$

$$\tau = \frac{20.93 \times 15}{\frac{2\pi}{60} \times 1000} = \underline{\underline{2.998 \text{ N-m}}}$$

3. A 4-pole wave-wound generator armature has 500 conductors and delivers 240 A. The brushes has been displaced through 3° (three degree) from the geometrical neutral axis. Calculate the cross-magnetizing ampere-turns per pole.

$$AT_c = \left(\frac{1}{P} - \frac{\beta}{\pi}\right)\frac{Z I_a}{2a}$$

$\rightarrow$ $a = 2$, for wave-wound

$\beta = 3^\circ$,

$P = 4$,

$Z = 500$

$I_a = 240$ A

$$\Rightarrow AT_c = \left(\frac{1}{4} - \frac{3}{180}\right)\frac{500 \times 240}{2 \times 2}$$

$$= \left(\frac{15 - 1}{60}\right)\frac{500 \times 240}{4}$$

$$= \frac{14}{60} \times \frac{500 \times \cancel{240}^{60}}{\cancel{4}}$$

$$= 14 \times 500 = 7000$$

4. A 24kW, 250V, 1600rpm, separately excited DC generator has an armature resistance of 0.1Ω. The machine is first run at rated speed and the field current is adjusted to give an open circuit voltage of 260 V. When the generator is loaded to deliver its rated current, the speed of the driving motor (prime mover) is found to be 1500 rpm. Assuming the field current remains unaltered, compute the terminal voltage of the generator?

(4) At no load, $E_a = V_t$

At rated speed, $E_a = K \times n$

$$260 = K \times 1600$$

$$K = \frac{260}{1600}$$

Rated load current, $I_L = \frac{24 \times 10^3}{250} = 96$ Amp

field current remains constant at 1500 rpm.

$\therefore$ $I_L = I_a \Rightarrow$ for seperately excited.

$$V_t = E_g - I_L R_a$$

$$V_t = K \times n - I_L R_a$$

$$V_t = \frac{260}{1600} \times 1500 - 96 \times 0.1$$

$$V_t = 234.15 \text{ volts}$$