Basic Electrical Engineering (TEE 101)

Lecture 51: Numerical Problem 1 _ DC Machine

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Content

This lecture covers:

Numerical on emf equation of DC Machine

Example 1. *A six-pole lap wound D.C. generator has 720 conductors, a flux of 40 m Wb per pole is driven at 400 r.p.m. Find the generated e.m.f.*

Solution. Number of poles, $p = 6$

Total number of conductors, $Z = 720$

Flux per pole, $\phi = 40 \text{ m Wb} = 40 \times 10^{-3} \text{ Wb}$

Speed of rotation, $N = 400$ r.p.m.

Number of parallel paths, $a = p = 6$ [Since the generator is *lap wound*.]

Generated e.m.f. E_g :

Using the relation, $$E_g = \frac{p\phi ZN}{60a} = \frac{6 \times 40 \times 10^{-3} \times 720 \times 400}{60 \times 6} = 192 \text{ V.}$$

Hence, **generated e.m.f. $E_g = 192$ V. (Ans.)**

Example 2. *A six-pole lap connected generator has a useful flux/pole of 0.045 Wb. If the no load voltage at 400 r.p.m. is 300 V, find the conductors on the armature periphery.*

Solution.

Number of poles, $p = 6$

Useful flux/pole, $\varphi = 0.045$ Wb

No load voltage, $Eg = 300$ V

Number of conductors, Z :

Number of parallel paths, $a = p = 6$ [Since the generator is *lap wound*.]

We know that, $$E_g = \frac{p\phi ZN}{60a}$$

$$300 = \frac{6 \times 0.045 \times Z \times 400}{60 \times 6}$$

$\therefore$ $$Z = \frac{300 \times 60 \times 6}{6 \times 0.045 \times 400} \quad i.e., \; Z = 1000.$$

Hence, **total number of armature conductors = 1000. (Ans.)**

Example 3. *An 8-pole wave connected D.C. generator has 1000 armature conductors and flux/pole 0.035 Wb. At what speed must it be driven to generate 500 V ?*

Solution. Number of poles, $p = 8$

Total number of armature conductor, $Z = 1000$

Flux/pole, $\phi = 0.035$ Wb

Generated voltage, $E_g = 500$ V

Number of parallel paths, $a = 2$ [Since the generator is wave wound.]

Speed of rotation, N :

Using the relation, $$E_g = \frac{p\phi ZN}{60a}$$

$$500 = \frac{8 \times 0.035 \times 1000 \times N}{60 \times 2}$$

$$\therefore \quad N = \frac{500 \times 60 \times 2}{8 \times 0.035 \times 1000} = 214.3 \text{ r.p.m.}$$

Hence, **speed of generator = 214.3 r.p.m. (Ans.)**

Example 4. *The armature of a 6-pole D.C. generator has a wave winding containing 650 conductors. Calculate the generated e.m.f. when the flux per pole is 0.055 Wb and the speed is 300 r.p.m. Calculate speed at which the armature must be driven to generate an e.m.f. of 550 V if the flux per pole is reduced to 0.05 Wb.*

Solution.

Number of poles, $p = 6$

Total number of conductors, $Z = 650$

Flux per pole, $\varphi = 0.055$ Wb

Speed of rotation, $N = 300$ r.p.m.

E.m.f. generated, $Eg = ?$

Generated e.m.f. (2nd case) = 550 V

Flux per pole (2nd case) = 0.05 Wb

Speed of rotation, $N = ?$

Case I. E.m.f. generated, Eg :

Case I. E.m.f. generated, E_g :

Using the relation, $E_g = \dfrac{p\phi ZN}{60a}$

$$= \frac{6 \times 0.055 \times 650 \times 300}{60 \times 2} \quad [\because \quad a = 2, \text{ as the generator is wave wound}]$$

$$= 536.25 \text{ V.}$$

Hence, **e.m.f. generated = 536.25 V. (Ans.)**

Case II. Speed of rotation, N :

$$E_g = \frac{p\phi ZN}{60a}$$

$$550 = \frac{6 \times 0.05 \times 650 \times N}{60 \times 2}$$

$$N = \frac{550 \times 60 \times 2}{6 \times 0.05 \times 650} = 338.46 \text{ r.p.m.}$$

Hence, **speed of rotation = 338.46 r.p.m. (Ans.)**

Thank You