ELEMENTS OF ELECTRICAL ENGINEERING
Course Code : UE25EE141A/B

PES UNIVERSITY

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ELEMENTS OF ELECTRICAL ENGINEERING

EMF EQUATION OF A SEPARATELY EXCITED DC GENERATOR & ITS EQUIVALENT CIRCUIT

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EMF Equation of a DC Generator - Derivation

Let P = Number of poles in the stator

ϕ = Flux per pole in Weber

Z = Total number of conductors in the Armature winding

A = Number of parallel paths in the armature winding

N = Speed of the rotor in RPM

Number of parallel paths depends on the type of armature winding.

For a lap wound armature winding, A = P

For a wave wound armature winding, A = 2

EMF Equation of a DC Generator – Derivation (contd..)

Consider one revolution of a conductor.

Total change in the flux in one revolution = $d\phi$ = Pϕ Webers

Time taken to complete one revolution = dt = $\frac{60}{N}$ seconds

Hence, Average EMF per conductor, $e_C = \frac{d\emptyset}{dt} = \frac{P\emptyset N}{60}$ Volts

EMF of the DC Generator, E_g = EMF of any one parallel path

$$= e_C * \left(\frac{Z}{A}\right)$$

$$= \frac{\emptyset Z N}{60} * \frac{P}{A} \quad \text{Volts}$$

Numerical on DC Generator – EMF Equation

The armature of 4-pole DC generator has 47 slots, each containing 6 conductors. The armature winding is wave connected, and flux per pole is 25mWb. At what speed must the machine be driven to generate an EMF of 250V.

Soln :

Given, $P = 4$; $\phi = 25\ mWb$; $E_g = 250V$

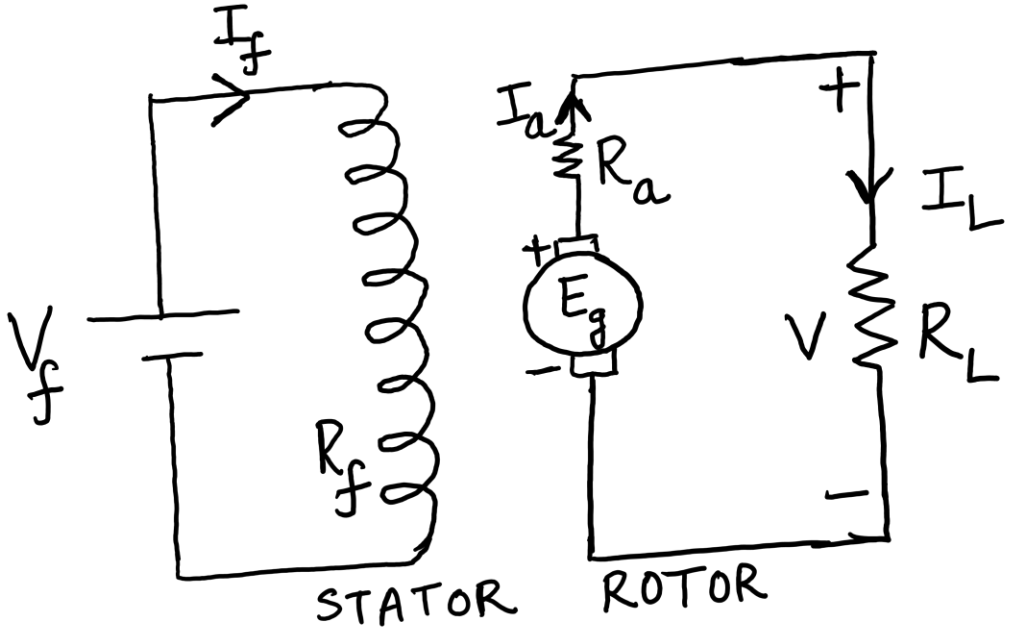
Total number of conductors, $Z = 47 \times 6 = 282$

wave wound $\Rightarrow A = 2$

$$\text{Induced EMF, } E_g = \frac{\phi Z N}{60} \times \frac{P}{A}$$

$$\Rightarrow \text{Speed, } N = 1064\ rpm$$

Equivalent Circuit of a Separately excited DC Generator



$$I_f = \frac{V_f}{R_f}$$

$$I_L = \frac{V}{R_L}$$

$$I_a = I_L$$

$$E_g = V + I_a R_a$$

$$\left.\begin{matrix}\text{Electrical Power} \\ \text{developed}\end{matrix}\right\} = E_g I_a$$

$$\left.\begin{matrix}\text{Electrical Power} \\ \text{output}\end{matrix}\right\} = V I_L$$

$$\text{Armature cu loss} = I_a^2 R_a$$

ELEMENTS OF ELECTRICAL ENGINEERING

Text Book & References

Text Book:

1. "Basic Electrical Engineering" S.K Bhattacharya, 1st Edition Pearson India Education Services Pvt. Ltd., 2017
2. "Basic Electrical Engineering", D. C. Kulshreshta, 2nd Edition, McGraw-Hill. 2019
3. "Special Electrical Machines" E G Janardanan, PHI Learning Pvt. Ltd., 2014

Reference Books:

1. "Engineering Circuit Analysis" William Hayt, Jack Kemmerly, Jamie Phillips and Steven Durbin, 10th Edition McGraw Hill, 2023

2. "Electrical and Electronic Technology" E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 12th Edition, Pearson Education, 2016.

THANK YOU

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