ELEMENTS OF ELECTRICAL ENGINEERING
Course Code : UE25EE141A/B

PES UNIVERSITY

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ELEMENTS OF ELECTRICAL ENGINEERING

NUMERICAL EXAMPLES OF SEPARATELY EXCITED DC MACHINE

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ELEMENTS OF ELECTRICAL ENGINEERING

Numerical on DC Generator

Q1.A 6-pole armature is wound with 498 conductors. The flux and the speed is such that the average EMF generated in each conductor is 2V. The current in each conductor is 120A. Find the total current and the generated EMF of the armature winding if the winding is connected a) wave b) lap. Also find the total power generated in each case.

Soln : $P = 6$; $Z = 498$; $e_c = 2V$; $I_c = 120A$

(i) Lap wound

No. of parallel paths, $A = P = 6$

Generated EMF = e_c * (conductors per parallel path)

$$= 2V * \left(\frac{498}{6}\right) = 166V$$

Armature current, $I_a = I_c * A = 720A$

Electrical Power developed $= E_g I_a = \underline{119.52\,KW}$

ii) Wave wound

$A = 2 \Rightarrow E_g = e_c * \frac{Z}{A} = 2V * \frac{498}{2} = \underline{498V}$

$I_a = I_c * A = 240V$

Electrical Power developed $= E_g I_a = \underline{119.52\,KW}$

Numerical on DC Generator

Question 2:

A 4-pole lap-connected armature of a DC generator is required to supply the following loads connected in parallel:
1) 5 kW Geyser at 250V
2) 2.5 kW Lighting load also at 250V

The generator has an armature resistance of 0.2Ω. The armature has 120 conductors in the slots and runs at 1000 rpm. Allowing 1V per brush drop for contact drop, find

i) **Flux per pole**
ii) **Armature current per parallel path**

Numerical on DC Shunt Generator

Solution:

i) Current drawn by Geyser = $\frac{5000W}{250V}$ = 20A

Current drawn by Lighting load = $\frac{2500W}{250V}$ = 10A

Hence, total load current, I_L = 30A

Hence, Armature current, $I_a = I_L$ = 30A

Generated EMF, $E_g = V + I_a * R_a$ + Total Brush contact drop = 250V + (30*0.2)V + 2V = 258V

$$E_g = \frac{\Phi ZN}{60} * \frac{P}{A} \quad V$$; Substituting Z, N, 60, A,

Flux per pole, Φ = 129 mWb

ii) Armature current per parallel path = I_a/A = 7.5A

Numerical on DC Motor

A 4 pole DC motor is connected to 500V DC supply and takes an armature current of 80A. The resistance of the armature circuit is 0.4Ω. The armature is wave wound with 522 conductors and a useful flux per pole is 0.025Wb. Calculate i) back EMF of the motor ii) speed of the motor iii) the torque in Nm developed by the armature.

$P = 4$; $V = 500V$; $I_a = 80A$; $R_a = 0.4\Omega$; $Z = 522$; $\phi = 0.025\,Wb$

i) $V = E_b + I_a R_a + V_b$ $\quad V_b \simeq 0$ [brush drop]

$\therefore E_b = V - I_a R_a$

$= 500 - 80 \times 0.4$

$E_b = 468\,V$

ii) $E_b = \frac{\phi P N Z}{60A} \Rightarrow N = 1075\,RPM$

iii) $T_a = 0.159\,\phi Z I_a \frac{P}{A}$

$T_a = 331.99\,Nm$

Numerical on DC Motor

A DC motor draws 10A from a 200V DC supply. If its armature resistance is 0.5Ω and runs at 1000 rpm, determine the torque developed by the motor.

Soln :

Given, $V = 200V$; $I_L = 10A$; $R_a = 0.5\Omega$;

$N = 1000$ rpm

Since it is a separately Excited Motor,

$$I_a = I_L = 10A$$

We know, $E_b I_a = T_e * \frac{2\pi N}{60}$

$E_b = V - I_a R_a = 195V \Rightarrow T_e = 18.62$ Nm

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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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