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Courses » Electrical Machines - I

Announcements **Course** Forum Progress Mentor

Unit 8 - Week 7

Week 7: Assignment

1) In Lap winding the number of parallel paths is equal to ___________________________. *10 points*

- The number of conductors
- The number of poles
- The number of pole pairs
- The number of coils

Accepted Answers:
The number of poles

2) Lap winding is suitable for __________________________________. *10 points*

- Low voltage high current machines
- High voltage machines
- Low current machines
- None of these

Accepted Answers:
Low voltage high current machines

3) The number of parallel paths in wave winding is equal to _____________________. *10 points*

- 2
- 4
- The number of poles
- The number of pole pairs

Accepted Answers:
2

4) The wave winding is suitable for_______________________ *10 points*

- Low voltage machines
- High voltage low current machines
- Low voltage high current machines
- None of these

Accepted Answers:
High voltage low current machines

5) A 24 slot, 2-pole dc machine has 10 turns per coil. The average flux density per pole is 1T. ***10 points***
The effective length of the machine is 25cm and radius of the armature is 10cm. The magnetic poles are designed to cover 80% of the armature periphery. If the angular velocity is 183.2 rad/s, determine the induced emf in the armature winding?

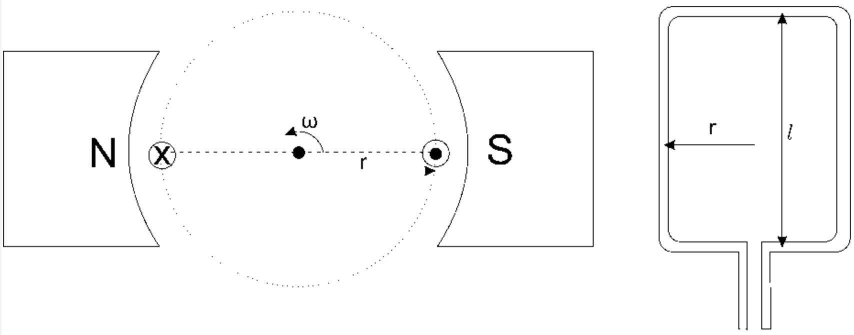
- 683V
- 879V
- 821V
- 913V

Accepted Answers:
879V

6) The following informations are given about a simple rotating loop given in Figure. ***10 points***

Flux density, B	:	0.4T
Length of conductor	:	0.6m
r	:	0.4m
ω	:	500rad/s

What is the induced voltage in the rotating loop?



loop dimensions

- 9.6V
- 19.2V
- 192V
- 96V

Accepted Answers:
96V

7) A 4-pole dc motor is lap-wound with 480 conductors. The pole shoe is 20 cm ***10 points***
long and the average flux density over one-pole-pitch is 0.4 T, the armature diameter being 40 cm. Find the torque developed when the motor is drawing 30A and running at 1500 rpm.

- 6Nm
- 68Nm
- 29Nm
- 57Nm

Accepted Answers:
57Nm

8) A four-pole dc machine has an armature of radius 14 cm and an effective length of 28 cm. ***10 points***
The poles cover 75% of the armature periphery. The armature winding consists of 30 coils, each coil having 6 turns. The coils are accommodated in 36 slots. The average flux density under each pole is 0.6T. If the armature is lap-wound, find the armature constant K_a?

Hint- If generated EMF is E_a, then $E_a = K_a \varphi N$, where 'φ' is Flux per pole and 'N' is speed in rmp.

- 4
- 5
- 6
- 7

Accepted Answers:
6

9) For the dc machine described in Problem 8, determine the induced armature voltage in volts when the armature rotates at 1000 rpm.

Note-Please enter only the numeric value while entering your answer. For example if the answer is '25.25%', please enter only the numeric value i.e. 25.25. Please do not enter the '%' or any units. Approximation can be done on your answer. For example if your answer is 0.5356, then 0.54, 0.536 or 0.5356 are all acceptable answers.

Accepted Answers:
(Type: Range) 160-170

10 points

10) For the dc machine described in Problem 8, find the electromagnetic torque developed in Newton-metres when the armature current is 400A.

Note-Please enter only the numeric value while entering your answer. For example if the answer is '25.25%', please enter only the numeric value i.e. 25.25. Please do not enter the '%' or any units. Approximation can be done on your answer. For example if your answer is 0.5356, then 0.54, 0.536 or 0.5356 are all acceptable answers.

Accepted Answers:
(Type: Range) 620-650

10 points

Assignment - 7 : Solution

Q1.Solution

In lap winding the number of parallel paths is equal to the **number of poles**.

Q2.Solution

Because of many parallel paths, lap winding is suitable for **low voltage high current** dc machines.

Q3.Solution

The number of parallel paths in wave winding is equal to **2**.

Q4.Solution

Wave winding is suitable for **high voltage low current** dc machines.

Q5.Solution

The number of coils : 24

The number of turns per coil : 10

$$\text{Total number of armature conductors : } 2 \times 24 \times 10 = 480$$

$$\text{For a two pole machine number of parallel pathes : } \quad 2$$

$$\text{The actual pole area : } \quad A_p = \frac{2\pi rl}{P} = \frac{2 \times \pi \times 0.1 \times 0.25}{2} = 0.0785m^2$$

$$\text{The effective pole area : } A_e \quad = 0.0785 \times 0.8 = 0.0628$$

$$\text{The effective flux per pole: } \phi_p = BA_e = 1 \times 0.0628 = 0.0628Wb$$

$$\text{The induced emf armature winding : } \quad E_a = \frac{Z}{2\pi}\frac{P}{a}\phi_p\,\omega_m = \frac{480}{2\pi} \times \frac{2}{2} \times 0.0628 \times 183.2 = \mathbf{878.92}V$$

Q6.Solution

$$\text{Voltage induced in the rotating loop: } \quad e_{ind} = 2rlB\omega$$

$$= 2 \times 0.4 \times 0.6 \times 0.4 \times 500 = \mathbf{96V}$$

Q7.Solution

$$Flux/pole = \frac{\pi \times 40 \times 10^{-2}}{4} \times 20 \times 10^{-2} \times 0.4 = 0.025$$

$$\text{Induced emf:} \quad E_a = \frac{\phi n Z}{60}(\frac{P}{a}) = \frac{0.025 \times 1500 \times 480}{60} \times \frac{4}{4} = 300V$$

$$\text{Gross mechanical power developed} = E_a I_a$$

$$= \frac{300 \times 30}{1000} = 9kW$$

$$\text{Torque developed} = \frac{9 \times 1000}{\frac{2\pi \times 1500}{60}} = \textbf{57.3 Nm}$$

Q8.Solution

$$\text{Armature constant}(K_a) = \frac{Z \times P}{60a}$$

Where Z- is number of conductors

P-Number of poles

a- Number of parallel paths

Number of conductors Z $= 2 \times 30 \times 6 = 360$

$a =$ Number of poles for a lap winding $= 4$

$$K_a = \frac{360 \times 4}{4 \times 60} \textbf{ = 6}$$

Q9.Solution

$$\text{Area of pole } (A_p) = \frac{\text{Circumference of Armature} \times \text{Percentage area covered by poles}}{\text{Number of poles}}$$

$$= \frac{2\pi \times 0.14 \times 0.28 \times 0.75}{4} = 46.18 \times 10^{-3} m^2$$

Flux density (B) $= 0.6Wb$

Flux per pole $(\phi) = A_p \times B = 46.18 \times 10^{-3} \times 0.6 = 0.0277$

$\therefore$ Generated EMF $(E_a) = K_a \times \phi \times N$

$= 6 \times 0.0277 \times 1000$

= 166.2 V

Q10.Solution

$$\text{Torque } (T) = \frac{E_a \times I_a}{\omega}$$

$$I_a = 400A$$

$$\omega = \frac{2\pi N}{60} = \frac{2\pi \times 1000}{60}$$

$$= 104.72 rad/s$$

$$\therefore T = \frac{166.2 \times 400}{104.72}$$

= 634.83 Nm