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Unit 9 - Week 8

Week 8: Assignment

1) An 8-pole dc machine has 800 lap wound conductors. The flux per pole of the machine is 36mWb. If a no-load induced voltage of 280V is required. What should be the speed of rotation of the machine? ***10 points***

- 843
- 2332 rpm
- 292 rpm
- 583 rpm

Accepted Answers:
583 rpm

2) If the dc machine described in problem-1 was wave connected, what should be the speed of rotation for a no-load induced voltage of 280V ? ***10 points***

- 291 rpm
- 146 rpm
- 462 rpm
- 283 rpm

Accepted Answers:
146 rpm

3) A 4 pole generator delivers 143 A of current. It is lap connected and has 492 armature conductors. The shunt field takes around 10A current. If the brushes are given a mechanical lead of 10 degrees, then what is the demagnetizing ampere turns per pole? ***10 points***

- 1260AT
- 1040AT
- 980AT
- 1500AT

Accepted Answers:
1040AT

4) A 100kW shunt generator driven by a belt is running at 300prm and is connected to a 220V bus bar. The armature resistance and field resistance are 0.025ohm and 60ohm respectively and a brush drop of 1V per brush is present. Under these conditions, the belt suddenly brakes and the machine continues to run as a motor drawing 10kW. What will be its speed as a motor now? ***10 points***

- 300 rpm
- 315 rpm
- 279 rpm
- 263 rpm

Accepted Answers:
279 rpm

5) The open circuit voltage of a DC shunt generator is 127 V. When the machine is loaded the terminal voltage becomes 120 V. What is the load current? The field winding resistance is 15 ohms and the armature winding resistance is 0.02 ohms. Ignore effects of armature reaction. ***10 points***

- 342A
- 54A
- 77A
- 180A

Accepted Answers:
342A

6) What is the percentage reduction in speed of a generator working with constant excitation on 500V bus-bars to decrease its load from 500 to 250kW. The armature resistance is 0.015 ohm. Effect of armature reaction can be neglected. ***10 points***

- 3%
- 2.4%
- 1.45%
- 0.8%

Accepted Answers:
1.45%

7) A 4 pole shunt generator has field and armature resistances of 50ohm and 0.1 ohm respectively. Sixty 100V,40W bulbs are being lit by the generator. What is the current per armature path in the generator? ***10 points***

- 6.5A
- 5A
- 4.5A
- 6A

Accepted Answers:

6.5A

Previous Page End

Assignment - 8 : Solution

Q1.Solution

No. of poles, $P = 8$

No. of conductors, $Z = 800$

Flux per pole, $\phi_p = 36\ mWb$

No-load voltage required, $E = 280V$

No of parallel path, $a = P = 8$ (lap connected windings)

$$E = \frac{\phi_p Z N P}{60a}$$

$$N = \frac{60aE}{\phi_p Z P}$$

$$N = \frac{60 \times 8 \times 280}{36 \times 10^{-3} \times 800 \times 8} = \textbf{583.3rpm}$$

Q2.Solution

$$E = \frac{\phi_p Z N P}{60a}$$

$$N = \frac{60aE}{\phi_p Z P}$$

No. of parallel paths, $a = 2$

$$N = \frac{60 \times 2 \times 280}{36 \times 10^{-3} \times 800 \times 8} = \textbf{145.83rpm}$$

Q3.Solution

No. of poles, $P = 4$

No. of conductors, $Z = 484$

No. of parallel paths, $a = 2$

Phase lead of brushes, $\beta = 12^o$

Armature current, $I_a = 120A$

$$AT_{peak} = \frac{I_a}{a}\frac{Z}{2P} = \frac{120 \times 484}{2 \times 2 \times 4} = 3630$$

Total De-magnetizing ampere turns per pole $De\_mag\_AT = AT_{peak} \times \frac{2\beta P}{2\pi} = 3630 \times \frac{2 \times 12 \times 6}{360} = \textbf{1452}$

Q4. Solution

$$\text{Load resistance,} \quad R_L = \frac{150}{180} = 0.83\Omega$$

$$E_1 = 150 + (180 \times 0.06) + 2 = 162.8V$$

$$\text{At 1200 rpm,} \quad E_2 = 162.8 \times \frac{1200}{1400} = 139V$$

$$\text{If } I_a \text{ is the new current,} \quad E_2 - 2 - (I_a \times 0.06) = R_L I_a$$

$$139 - 2 - (I_a \times 0.06) = 0.83 I_a$$

$$I_a = \textbf{153.9A}$$

Q5. Solution

$$I_a = 20A$$

$$\text{De-magnetizing ampere turns per pole} \quad = 1.2 \times 20 = 24$$

$$\text{No. of field turns,} \quad N_f = 200$$

$$\text{Equivalent field amperes for the de-magnetizing ampere turns} \quad i_{f\_eq} = \frac{24}{200} = 0.12A$$

$$\text{No. load terminal voltage} \ = 113.5V$$

$$\text{The corresponding field current,} I_f = 1.75A$$

$$\text{The effective field current taking into account the de-magnetizing effect,} \quad i_{f\_net} = 1.75 - 0.12 = 1.63A$$

$$\text{From the table, the corresponding E} \quad = 111.7V$$

$$\text{Hence, the terminal voltage,} \quad V_t = 111.7 - I_a R_a - E_{brush}$$

$$V_t = 111.7 - (20 \times 0.4) - 2 = \textbf{101.7V}$$

Q6. Solution

$$\text{Total armature current} = 143 + 10A$$

$$\therefore \text{Demagnetising ampere turns per pole} = \frac{ZI\beta}{a \times 360}$$

$$= \frac{492 \times 153 \times 10}{4 \times 360}$$

$$= \textbf{522.75 AT}$$

Q7. Solution

While running as generator, load current, $I_{lg} = \dfrac{100 \times 1000}{220} = 455A$

Field current $I_{sh} = 22/60 = 3.7A$

$\therefore$ Armature current $I_{a1} = I_{lg} + I_{sh} = 458.7A$

Generated voltage $E_g = 220 + I_{a1}R_a +$ brush drop

$= 220 + 458.7 \times 0.025 + 1 \times 2 = 233.5V$

While running as motor, load current, $I_{lm} = \dfrac{10 \times 1000}{220} = 45.5A$

$\therefore$ Armature current $I_{a2} = I_{lm} - I_{sh} = 41.8A$

Back EMF $E_b = 220 - I_{a2}R_a -$ brush Drop

$= 220 - 41.8 \times 0.025 - 2 = 217V$

For a shunt generator Speed 'N' $\propto E_b or E_g$

$\therefore$ The required speed is $= \dfrac{300 \times 217}{233.5} =$ **279 rpm**

Q8. Solution

Armature resistance drop $I_aR_a = E_g - V$

$= 127 - 120 = 7V$

$\implies I_a = 7/R_a = 7/0.02 = 350A$

The shunt field current $= 120/15 = 8A$

$\therefore$ Load current $I_l = 350 - 8 =$ **342 A**

Q9. Solution

$$\text{Load current } I_1 \text{while delivering 500kW} = \frac{500 \times 1000}{500} = 1000A$$

$$\text{Load current } I_2 \text{while delivering 250kW} = \frac{250 \times 1000}{500} = 500A$$

$$\text{Generated voltage while delivering 1000A} = E_g1 = 500 + 1000 \times 0.015 = 515V$$

$$\text{Generated voltage while delivering 500A} = E_g2 = 500 + 500 \times 0.015 = 507.5V$$

$$\text{Speed 'N'} \propto E_g/\phi$$

$$\text{But here the flux is constant and therefore, Speed } \propto E_g$$

$$\implies \frac{N_2}{N_1} = \frac{E_{g1}}{E_{g2}}$$

$$\therefore \text{Percentage reduction in speed } = \frac{N_1 - N_2}{N_1} \times 100 = \frac{E_{g2} - E_{g1}}{E_{g2}} \times 100$$

$$= \frac{515 - 507.5}{515} \times 100 = \textbf{1.45\%}$$

Q10. Solution

$$\text{Load current} = \frac{60 \times 40}{100} = 24A$$

$$\text{Shunt field current} = 100/50 = 2A$$

$$\text{Armature current} = 24 + 2 = 26A$$

$$\therefore \text{Current in each conductor} = \frac{26}{4} = \textbf{6.5A}$$