QUIZ – ANSWER KEY

QUIZ NO: 99

TOPIC: ELECTRICAL ENGINEERING

DATE: 16/08/2022

1. A three-point starter is suitable for ?

   [A] Shunt Motor

   [B] Series Motor

   [C] Shunt & Compound Motor

   [D] Shunt, Series, and compound motor

   Answer: C

   Explanation:-

   3 point starters in DC Shunt and Compound machines serve for the following purposes.

   - It limits the high starting current into the armature by having the resistance high at the time of starting and reducing it during the running conditions.
   - It also protects the motor from overload and under-voltage conditions.

2. In the DC machine, the fractional pitch winding is used ?

   [A] To reduce the Harmonic in generated EMF

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[B] Improve Cooling

[C] Increase EMF

[D] To reduce the copper losses

Answer: A

Explanation:-

- In full pitched coils, as one conductor of a turn in a coil cuts N pole, the other conductor of the same turn cuts S pole resulting in the production of induced emf(E), i.e phase angle is 180 degree
- In short-pitched coils, both conductors of the same turn in a coil don't cut the respective poles simultaneously. so phase angle is slightly less than 180 degree As a result, the magnitude of induced emf gets reduced to $E \times \cos(n\alpha/2)$
  Where;

  $E \times \cos(n\alpha/2)$ is called a pitch factor

  For eliminating 3rd harmonic from Generated EMF,
  $\cos(3\alpha/2) = 0$
  $3\alpha/2 = \pi/2$
  $\alpha = \pi/3 = 60°$

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3. In which of the following applications DC series motor is used ?

[A] Centrifugal Pump

[B] Motor Operation in DC and AC

[C] Water pump drive

[D] Starter for car

Answer: D

Explanation:-

- In DC series motor Torque (Ta) increases as the Square of armature current (Ia) $T_a \propto I_a^2$.
- So DC motor provides high starting torque which is required to start a car.

4. The number of the pole in Small Dc Motor Up to 5 H.P are ?

[A] 2 poles

[B] 4 poles

[C] 8 poles

[D] 10 poles

Answer: A

Explanation:-

- Small H.P motors require only 2 poles because as the number of poles is inversely proportional to the speed therefore 2 pole motor runs at high speed than 4 pole motor.
- Two pole motor has better efficiency.
- Two pole motor has better rpm and noise performance.

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5. The ratio of starting torque to full load torque is least in ?

   [A] Differential Compound Motor

   [B] Shunt motor

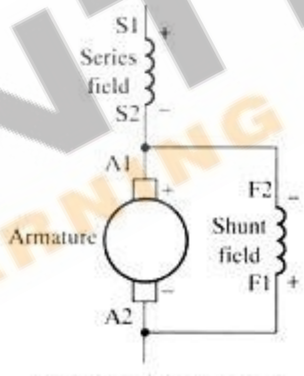
   [C] Series Motor

   [D] Cumulative compound motor

   Answer: A

   Explanation:-

- In the differential compound, motor two field windings i.e shunt and series windings oppose each other.
- This causes a reduction in flux and consequences a decrease in torque.



(b) Differential compound dc motor (short shunt)

6. A 220 V, 15 kW, 1000 RPM Shunt Motor with an armature resistance of 0.25Ω, has a rated line current of 68 A and a rated field current of 2.2 A. The change in field flux required to obtain a speed of 1600 RPM while drawing a line current of 52.8 A and a field current of 1.8 A is ?

   [A] 18.18% Increase

   [B] 18. 18% decrease

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[C] 36.36 % increase

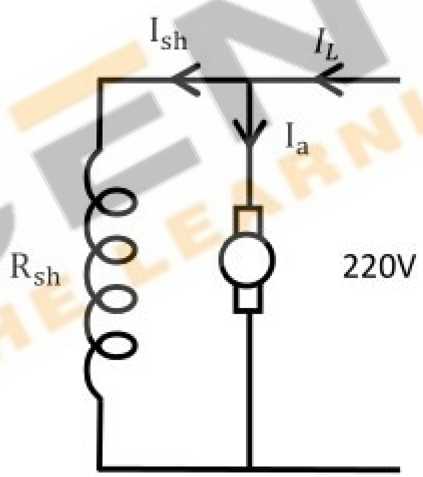
[D] 36. 36 % decrease

Answer: D

Explanation:-

Given Data;

Supply Voltage **V** = 220 V
Speed N_1 = 1000 RPM
Armature Resistance R_a = 0.25 Ω
Line Current I_L = 68A & 52.8A
Field current I_F = 2.2 A & 1.8 A
Speed N_2 = 1600 RPM



The Line current of DC shunt motor is the sum of Armature current and Shunt field current

$$I_L = I_a + I_{sh}$$

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∴ $I_a = I_L - I_{sh}$

$I_{a1} = 68 - 2.2 = 65.8$ A

From the voltage equation, the Back EMF will be

$E_{b1} = V - I_{a1}R_a$

$= 220 \times 65.8 \times 0.25$

$E_{b1} = 203.55$

Similarly for the line current of 52.8 A and a field current of 1.8 A the armature current will be

$I_{a2} = 52.8 - 1.8 = 51$ A

Hence **$E_{b2} = V - I_{a2}R_a$**

$= 220 \times 51 \times 0.25$

$E_{b2} = 207.25$

Let the on load speed be **N.** As we know that back EMF of DC motor is directly proportional to the flux and speed.

$$E_b \propto N\phi$$

$E_{b1}/E_{b2} = (N_1/N_2) \times (\Phi_1/\Phi_2)$

$203.55/207.25 = (1000/1600) \times (\Phi_1/\Phi_2)$

$\Phi_2/\Phi_1 = 0.6364$

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∴% Decrease = $[(\Phi1–\Phi2)/\Phi1]\times100$

$=1–(\Phi2/\Phi1) =1–0.6364 =0.3636\times100 =36.36$

7. A separately excited DC motor has an armature resistance of 0.5 W. It runs from a 200 V DC supply drawing an armature current of 20 A at 1500 rpm. For the same field current, the torque developed for an armature current of 10 A will be ?

   [A] 23.59 N-m

   [B] 34.76 N-m

   [C] 15.28 N-m

   [D] 19.99 N-m

   Answer: C

   Explanation:-

   Given parameters;

   Ra = 0.5 ohm

   Supply Voltage V = 250 V
   Armature current I_a = 20 A
   Speed N = 1500 rpm
   Armature current I_a = 20 A
   Torque T =?

   From the voltage equation, the back EMF of DC motor is;

   $\mathbf{E_b = V – I_aR_a}$

   = 250 − 20 × 0.5

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$E_b = 240$

The torque of DC motor is

$T = P / \omega$

Where;
P = Output power of separately excited motor and it is given as **$P = E_b I_a$**
ω = Angular speed in rad/sec. and it is given as $\omega = 2\pi N / 60$

Hence for the armature current of 10 A the torque developed is;

$T = E_b I_a \times 60 / 2\pi N$

$= 240 \times 10 \times 60 / 2\pi \times 1500$

= 15.28 N-m

8. A separately excited 300 V DC shunt motor under no-load runs at 900 rpm drawing an armature current of 2 A. The armature resistance is 0.5 Ω and the leakage inductance is 0.01 H. When loaded, the armature current is 15 A. Then the speed in rpm is ?
   [A] 881 RPM
   [B] 780 RPM
   [C] 1000 RPM
   [D] 1200 RPM

Answer: A

Explanation:-

Given Data;

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Supply Voltage **V** = 300 V
No-Load Speed $\mathbf{N_o}$ = 900 RPM
Armature current at no-load $\mathbf{I_a}$ = 2 A
Armature Resistance $\mathbf{R_a}$ = 0.5 Ω
Leakage Inductance = 0.01 H
Armature current at full load $\mathbf{I_o}$ = 15A

⇒ From the voltage equation, the back EMF of DC motor at no-load

$\mathbf{E_{bo} = V - I_aR_a}$

$= 300 \times 2 \times 0.5$

$\mathbf{E_{bo} = 299\ V}$

⇒ The back EMF of DC motor on Loaded

$\mathbf{E_b = V - I_aR_a}$

$= 300 \times 15 \times 0.5$

$\mathbf{E_b = 292.5\ V}$

Let the on load speed be **N.** As we know that back EMF of DC motor is directly proportional to the flux and speed.

$$\mathbf{E_b \propto N\phi}$$

$$E_b \propto N \ (\phi \text{ is constant})$$

The ratio of emf and speed can be equated at on load and no-load condition.

N/No=Eb/Ebo

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$N = (E_b / E_{bo}) \times N_o$

$N = (292.5/299) \times 900$

$N = 881$ RPM

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9. A 240 V DC series motor takes 40 A when giving its rated output at 1500 rpm. Its resistance is 0.3 Ω. The value of resistance that must be added to obtain rated torque at 1000 rpm is ?

   [A] 6Ω

   [B] 5.7Ω

   [C] 2.2Ω

   [D] 1.9Ω

   Answer: D

   Explanation:-

   Supply Voltage **V** = 300 V
   Rated Speed N_1 = 1500 RPM
   Armature current at no-load I_a = 40 A
   Armature Resistance R_a = 0.3 Ω
   N_2 = 1000RPM

   As it is known the torque is constant, thus armature current and flux will also remain constant. The voltage equation can be given as;

   $E_b = V - I_aR_a$

   $= 250 - 40 \times 0.3$

   $E_b = 228$ V

   At constant flux;

   N/No=Eb/Ebo

   Eb2=(N2/N1)×Eb1=(1000/1500)×228

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Eb2=152V

Now the Back EMF of DC series Motor is given by;

$E_b = V - I_a(R_a + R_{se})$

$152 = 240 - 40\ (0.3 + R_{se})$
$40R_{se} = 76$

$R_{se} = 1.9\Omega$

10. The direction of rotation of a DC shunt motor can be reversed by interchanging ?

[A] The armature terminal only
[B] Either field or armature terminals
[C] The supply terminals
[D] The field terminals only

Answer: B

Explanation:-

The direction of rotation of a DC shunt motor can be reversed by interchanging the leads of either the field winding or the Armature Winding.

Generally changing the direction of the field is easier, because it carries a lesser current as compared to armature current. However, the reversal should not be done while the armature is excited.