QUIZ – ANSWER KEY

QUIZ NO: 104

TOPIC: ELECTRICAL ENGINEERING

DATE: 31/08/2022

1. The starting torque of a 3-phase induction motor is _____ supply voltage ?

   [A] Independent of

   [B] Directly proportional

   [C] Directly proportional to square

   [D] Inversely proportional

   Answer: C

   Explanation:-

$$T_s = \frac{KE_2^2 R_2}{R_2^2 + X_2^2}$$

E_2 = Rotor induced E. M.F per phase on standstill condition Which is directly proportional to applied volta

$$E_2 \propto V$$

$$T_s = \frac{KV_2^2 R_2}{R_2^2 + X_2^2}$$

$$Hence\ T_s \propto V^2$$

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2. The starting torque of an induction motor is maximum when rotor resistance per phase is _____ rotor reactance/phase ?

[A] Equal to

[B] Less than

[C] More than

[D] None of the above

Answer: A

Explanation:-

$$T_s = \frac{K{E_2}^2 R_2}{{R_2}^2 + {X_2}^2}$$

On diffrentiating the above equation

$$\frac{dt}{dR_2} = K\left(\frac{1}{{R_2}^2 + {X_2}^2} + \frac{R_2\,(2R_2)}{\left({R_2}^2 + {X_2}^2\right)^2}\right)$$

OnSolving

$${R_2}^2 + {X_2}^2 = 2R_2$$

or

$$R_2 = X_2$$

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Maximum starting torque is obtained when the slip is equal to the **ratio** between the **rotor resistance (R_2)** and the **rotor inductive reactance (X_2). This slip is also known as slip at maximum torque, labeled as S_m.**

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3. The maximum torque of a 3-phase induction motor under running conditions is ?

[A] **Inversely proportional to the Rotor reactance at standstill**

[B] Inversely proportional to the supply voltage

[C] Directly proportional to the Resistance

[D] None of the above

Answer: A

Explanation:-

The torque of rotor under running condition is

$$T = \frac{KsE_2{}^2R_2}{R_2{}^2 + (sX_2)^2}$$

Slip Corresponding to Max torque

$$s = \frac{R_2}{X_2}$$

Putting the value of slip in above equation we get

$$T = \frac{KR_2/X_2E_2{}^2}{R_2{}^2 + (R_2{}^2/X_2{}^2).X_2{}^2} = K\frac{E_2{}^2}{2X_2}$$

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Hence it can be concluded that the maximum torque 3 phase induction motor is inversely proportional to the rotor reactance.

The maximum torque is not dependent on the rotor resistance R_2. But the slip at which it occurs i.e. the speed at which it occurs depends on the value of rotor resistance R_2.

4. A 3 phase induction motor has the facility for pole changing from 4 to 6. When it is operating as a 4 pole machine on 440V, 50Hz balanced 3 Phase supply, the frequency of rotor current is 3Hz. Then the speed of the motor is ?

   [A] 1500 RPM

   [B] 1200 RPM

   [C] 1360 RPM

   [D] 1410 RPM

   Answer: D

   Explanation:-

   Synchronous machine of 4 pole machine is
   Ns = 120f/p = 120×50/4 = 1500 RPM

   Since Rotor frequency is slip times the stator frequency

   fr = sfs

   or s = fr/fs

   = 3/50 = 0.06

   Rotor Speed Nr = (1 – s) Ns

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Nr = (1 – 0.06)1500

Nr = 1410 RPM

5. If the motor were to run at 65% speed as in 'the given above question, but operate as a 6 pole machine, what will be the slip and frequency of the rotor currents ?

[A] 4.175 Hz

[B] 3.286 Hz

[C] 2.458 Hz

[D] 1.432 Hz

Answer: A

Explanation:-

Synchronous speed of the 6 pole machine

Ns = 120f/p = 120×50/6 = 1000 Hz

N_{r2} = Rotor speed of 6 pole machine

= 0.65 × 1410 = 916.5 RPM

Slip s = $(N_{s2} – N_{r2})/N_{s2}$

s = (1000 – 916.5)/1000

= 0.0835

Rotor frequency fr = sfs

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= 0.0835 x 50 = 4.175 Hz

6. For a slip of 0.05, find the ratio of rotor speeds with the motor operating with 4 and 6 poles respectively ?

[A] 2.8

[B] 1.5

[C] 3.2

[D] 4.5

Answer: B

Explanation:-

Rotor speed with 4 poles with slip 0.05

= (1 – 0.05)×1500
= **1425 RPM**

Rotor speed with 6 poles with slip 0.05

= (1 – 0.05)1000
= **950 RPM**

The Ratio of rotor speeds with the motor operating with 4 and 6 poles

N_{r4}/N_{r6} = 1425/950 = **1.5**

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7. Semi-closed slots or totally closed slots are used in induction motors to improve ?

[A] Starting current

[B] Starting Torque

[C] Power Factor

[D] Pull-out Torque

Answer: C

Explanation:-

Semi-closed slot in an Induction motor

Advantages

- Semi-closed slots have narrow slots, therefore, flux distribution is uniform hence harmonics are less so smooth operation is possible.
- In the Semi-closed slot, the average length of the air gap is less compared to the open type hence magnetic circuit reluctance is the less magnetizing current means better power factors.

Disadvantages

- It is not possible to insert large former coils.
- Access to the slot is difficult compared to an open type.
- They offer high leakage reactance to the windings.

Closed slots have almost same advantages and disadvantages.

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8. The rotor slots are slightly skewed in squirrel cage induction motor in order to ?

   [A] Increasing Rotor bar strength

   [B] Prevent cogging effect

   [C] Both 1 & 2

   [D] None of the above

   Answer: B

   Explanation:-

- Rotor bars are skewed to prevent the cogging effect.
- When an induction motor refuses to start even if the full voltage is applied to it, this is called cogging.
- Starting torque of an induction motor depends on the product of the magnitude of stator and rotor current and sine of the angle between both.
- If the conductors remain linear, the angle between stator and rotor current will be 180 degrees. As sin(180)=0, the starting resultant torque will be zero and thus motor will fail to start. This phenomenon is called cogging.
- Skewing makes the rotor conductor longer with the reduced cross area. This increases the rotor conductor resistance hence starting performance and the torque of an induction motor are improved.

9. A 3-phase induction motor is running at 2% slip. If the input to rotor is 1000 W, then mechanical power developed by the motor is ?

   [A] 500 W

   [B] 200 W

   [C] 20 W

   [D] 980 W

   Answer: D

   Explanation:-

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Mechanical power developed in 3-phase motor = (1 − s) × power input to rotor

= (1 – 0.02) x 1000 = 980 W

10. The approximate efficiency of a 3-phase, 50 Hz, 4-pole induction motor running at 1350 r.p.m. is ?

[A] 90%
[B] 60%
[C] 45%
[D] 100%

Answer: A

Explanation:-

Given
P = 4
f = 50 Hz
N = 1350 RPM

Ns = 120f/P = 120 × 50/4 = 1500 RPM

Slip s = (Ns – N)/Ns

= (1500 – 1350)/1500 = 0.1

Approximate efficiency of Induction motor = (1 – s)

1 – 0.1 = 0.9 = 90%