12526

3 Hours / 70 Marks   Seat No.

Instructions – (1) All Questions are *Compulsory*.

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1.   **Attempt any FIVE of the following :**   **10**

a) Define slip and synchronous speed of 3-phase induction motor.

b) Give any two advantages of slip ring rotor over squirrel cage rotor.

c) Give any two advantages of soft starters.

d) State any four types of single phase induction motor.

e) Define synchronous impedance and synchronous reactance.

f) Define chording factor and distribution factor for alternator.

g) List applications of stepper motor. (Any four)

2. **Attempt any <u>THREE</u> of the following :**   **12**

   a) Explain working of autotransformer starter for 3-phase Induction motor with neat diagram.

   b) Explain why the single-phase induction motors are not self starting.

   c) With the help of a neat labelled diagram, explain the construction and working of star-delta starter.

   d) Explain speed control of a three - phase Induction motor by the following methods –

      i) Frequency control

      ii) Stator voltage control

3. **Attempt any <u>THREE</u> of the following :**   **12**

   a) Describe with neat sketch, the principle of operation of single phase shaded pole Induction motor.

   b) Explain the construction and working of a capacitor - start capacitor-run single-phase Induction motor.

   c) Write any two applications of the following motors :

      i) Shaded - pole induction motor

      ii) Capacitor start induction-run motor

      iii) Resistance start induction run motor

      iv) Capacitor start capacitor run motor

   d) Prove that : $K_d = \dfrac{\sin(mB/2)}{m\sin(B/2)}$ in an alternator.

4. **Attempt any THREE of the following :** 12

    a) Draw and explain the block diagram showing power stages of a three-phase induction motor.

    b) Derive the condition for maximum torque under running condition of a three-phase induction motor.

    c) Explain construction of universal motor and draw it's torque-speed characteristics.

    d) Explain the construction and working of permanent-magnet stepper motor.

    e) Explain construction and working of synchronous reluctance motor.

5. **Attempt any TWO of the following :** 12

    a) Define armature reaction and explain armature reaction at various power factor of loads on the alternator. Draw suitable waveforms showing the effect.

    b) A 3-phase, 4 pole, 50 Hz, induction motor runs at 1440 r.p.m. while delivering the power output of 40 kW. The stator losses at this load are equal to rotor losses and mechanical losses amount to 3500 W. Calculate –

       i) Slip,

       ii) Total mechanical power developed by the rotor,

       iii) Rotor copper loss,

       iv) Rotor input

       v) Stator input,

       vi) Efficiency.

    c) Derive the e.m.f. equation of an alternator from first principle. State the meaning of each term therein.

Marks

6. **Attempt any TWO of the following :**   **12**

  a) A star connected rotor of a 3-phase, 4 pole 50 Hz induction motor has a resistance and standstill reactance of $0.35\,\Omega$ and $2\,\Omega$ per phase respectively. With stator connected to normal supply voltage, the emf induced between slip-zings at standstill is 160 V. Find –

    i) Rotor phase current and power factor at starting when the zings are

        (1) Short - circuited

        (2) Joined to a star - connected resistance of $3\,\Omega$ per phase

    ii) Rotor phase current and power factor at full load if the corresponding motor speed (with slip-rings shorted) is 1410 r.p.m.

  b) Draw and explain V and inverted V curves of synchronous motor.

  c) A 746 KW, 3-phase, 50 Hz, 16 pole induction motor has a rotor impedance of $(0.02 + j0.15)\,\Omega$ at standstill. Full load torque is obtained at 360 rpm.

    Calculate :

    i) Speed at which maximum torque occurs,

    ii) Ratio of maximum to full-load torque,

    iii) External resistance per phase to be inserted in the rotor circuit to get maximum torque at starting.

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