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Paper Code : EE-401

ELECTRIC MACHINES-I

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) The armature reaction m.m.f. in a d.c. machine is

   a) sinusoidal b) trapezoidal

   c) rectangular d) triangular.

   ii) For a *P*-pole machine, the relation between electrical degree (θ_e) and mechanical degree (θ_m) is given by

   a) $\theta_e = \frac{2}{P}\theta_m$ b) $\theta_e = \frac{4}{P}\theta_m$

   c) $\theta_e = P\,\theta_m$ d) $\theta_e = \frac{P}{2}\theta_m$.

iii) A lap wound *dc* machine has 400 conductors and 8 poles. The voltage induced per conductor is 2V. The machine generates a voltage of

a) 100V b) 200V

c) 400V d) 800V.

iv) The armature resistance of a 6-pole lap wound d.c. machine is 0·05 ohm. If the armature is rewound using a wave winding, then the armature resistance will be

a) 0·45 ohm b) 0·30 ohm

c) 0·15 ohm d) 0·10 ohm.

v) The supply voltage to an induction motor is reduced by 10%. By what percentage, approximately, will the maximum torgue decrease ?

a) 5% b) 10%

c) 20% d) 40%.

vi) The phenomenon of crawling in a three phase induction motor may be due to

a) unbalanced supply voltage

b) 7th space harmonic of air gap field

c) 7th time harmonic of voltage wave

d) 5th space harmonic.

vii) The rotor power output of a 3-phase induction motor is 15 kW and the corresponding slip is 4%. The rotor copper loss will be

a) 600 W b) 625 W

c) 650 W d) 700 W.

viii) In a 3-phase induction motor if stator impedance is neglected, then the slip at maximum torque is equal to

a) $\frac{x_2}{r_2}$ b) $\frac{r_2}{x_2}$

c) $\sqrt{\frac{r_2}{x_2}}$ d) $\sqrt{\frac{x_2}{r_2}}$.

ix) The stator referred resistance in the equivalent circuit of an induction motor, representing mechanical output is

a) $\frac{r_2^1}{s}$ b) $r_2^1\left(\frac{1}{s}-1\right)$

c) $\frac{r_2}{s}$ d) $r_2^2\left(\frac{1}{s}-1\right)$.

x) A shell type transformer has

a) high eddy current loss

b) reduced magnetic leakage

c) negligible hysteresis loss

d) none of these.

xi) In which transformer, the teritary winding is used ?

a) Star - delta b) Delta - delta

c) Star - star d) Delta - star.

xii) Three single phase transformers, each of 100 kVA rating, are connected in closed delta arrangement. If one of them is taken out, it would be possible to load the bank in such a manner that each one is loaded to the extent of

a) 86·6 kVA b) 66·7 kVA

c) 57·7 kVA d) 33·33 kVA.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Explain how voltage builds up in a *dc* shunt generator. Explain the terms critical field resistance and critical speed. 3 + 2

3. What are the advantages of distributed winding in rotating electrical machine ? Show that $K_d = \frac{\sin\left(\frac{m\alpha}{2}\right)}{m\sin\left(\frac{\alpha}{2}\right)}$

where K_d = distribution factor, m = number of slots per pole per phase and α = angular slot pitch. 2 + 3

4. Induction motor cannot run at synchronous speed. Explain. If the motor is made to run above synchronous speed, how will it behave ? 3 + 2

5. Explain the basic principle of vector grouping of 3-phase transformers. How many vector groupings have been developed ? Explain the meaning of each vector grouping. 1 + 2 + 2

6. a) How the rotation of induction motor can be reversed ?

   b) A 3-phase induction motor is running at a very low load. If one supply phase is open circuited, whether the motor will continue to run to drive the load ? If not, why not ? If runs, what will be the line current ? *p.f.* in both the cases may be assumed to be same. 2 + 3

GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) Explain the star-delta starting of induction motor.

   b) A 12 kW, 3-phase, 6-pole, 50 Hz delta connected induction motor runs at 960 r.p.m. on full load. If it takes 85 A on direct standing, find the ratio of the starting torque to full-load torque with a star-delta starter. Full load efficiency and power factor are 88% and 0·85 respoectively. 7 + 8

8. a) What do you understand by armature reaction ? Explain the concept of demagnetizing and cross-magnetizing armature ampere turns.

   b) An 8-pole, 120 kW, 600V, wave connected *d.c.* generator has 540 conductors and is delivering full-load current. If brushes are shifted by 4° mechanical, calculate

      i) demagnetizing

      ii) cross-magnetizing

      ampere-turns per pole. 9 + 6

9. a) What is auto-transformer ? Why are such transformers used ? Explain its working principle.

   b) A 11500/2300 V transformer is rated at 100 kVA as two-winding transformer. If two windings are connected in series to form an auto-transformer, what will be the voltage ratio and output ? 9 + 6

10. a) One of the windings of 3-phase transformer shall be delta connected. Explain why.

    b) Why zig-zag connection of transformer is used ?

    c) How group-3 and group-4 transformers can be run in parallel ? 5 + 5 + 5

11. Write short notes on any *three* of the following : $3 \times 5 = 15$

a) Scott-connected transformer and its use

b) Regeneration braking

c) Current transformer

d) Conditions of parallel operation of 3-phase transformers

e) Commutation in *dc* machine.