Roll No. _____ Total Pages : 4

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BT-3/D08

Electromechanical Energy Conversions

PAPER - ELE-201E

Time : 3 Hrs. Maximum Marks : 100

Note : Attempt any five questions, selecting at least one question from each unit.

UNIT- I

1. a. Explain the principle of Single phse ideal transformer. Derive an expression for induced emf in a transformer and also draw its no-load phasor diagram. 10

   b. A 230/460 V transformer has a primary winding resistance of 0.2 Ω and a reactance of 0.5 Ω and the corresponding value for the secondary winding are 0.75 Ω and 1.8 Ω respectively. Find the secondary terminal voltage when supplying

   (i) 10A at 0.8 p.f. lagging

   (ii) 10A at 0.8 p.f. leading 10

2. a. The following test resuls were obtained on a 20 kVA, 2200/220 V, 50 Hz single phase transformer :

   O.C. test (L.V. side) : 220V, 1.1 A, 125W

   S.C. test (H.V. side) : 52.7 V,8.4 A, 287 W

   The transformer is loaded at unity power factor an secondary side with a voltage of 220V. Determine the maximum efficiency and the load at which it occurs. 10

   b. Explain the working principle and construction of an auto-transformer. Draw and explain the phasor diagram under loaded condition. 10

UNIT-II

3. a. Describe the principle of Energy conversion. For a singly excited magnetic field system, derive the relation for the magnetic energy stored in terms of reluctance. 10

   b. Develop the circuit model fo a d.c. mahcine and explain the generating mode. 5

   c. A 6-pole, lap wound d.c. motor takes 340 A when the speed is 400 rpm. The flux per pole is 0.05 Wb and the armature has 864 turns. Neglecting mechanical losses, calculate the brake horse power of the motor. 5

4. a. In a 50kW, 230 V on no-load and 250v onfull-load over compound d.c. generator (long shunt), the flux per pole required to prodce 230V on no-load at 1050 rpm is 0.06 Wb. The resistance of the armature and series field are 0.04 Ω and 0.01Ω respectively and the shunt field resistance is 100Ω. Calcualte the value of the flux per pole at full load speed 1000 r.p.m. Neglect brush drop. 10

   b. A d.c. series motor runs at 500 r.p.m. drawing 40A from 600 V supply. Determine the value of the external resistance to be added in series with the armature for the motor to run at 450 r.p.m. The load torque varies as the square of the speed. Assume linear magnetization and take armature resistance as 0.3Ω and series field resistance 0.2Ω. 10

UNIT- III

5. a. Draw the equivalent circuit and phasor diagram of a three-phase induction motor. Derive the expression for developed torque and find the condition for maximum torque. 10

   b. A 25 H.P., 400V, 50Hz, 4-pole, star-connected induction motor has the following impedances per phase in ohms referred to the stator side :

   $R_s = 0.641\ \Omega$, $R_r = 0.332\ \Omega$, $X_s = 1.106\Omega$,

   $X_r = 0.464\Omega$ and $X_m = 26.3\Omega$.

   The rotational losses are 1.1 kW (constant) and core losses and assumed negligible. If the slip is 2.2% at rated voltage and frequency, find speed, stator current, power factor, output and input power and efficiency of the motor. 10

6. a. Explain the two-field revolving theory for a single phase induction motor. Draw its equivalent circuit diagram.10

   b. A 230 V, 380 W, 50Hz, 4-pole, single phase induction motor gave the following test results :

   No-load test : 230V, 84W, 2.8A

   Blocked rotor test : 110V, 460W, 6.2A

   The stator winding resistance is 4.6Ω and during blocked rotor test, the auxiliary winding is open. Determine the equivalent circuit parameters. 10

UNIT-IV

7. a. Calculate the r.m.s value of the induced e.m.f. per phase of a 10-pole, 3-phase, 50 Hz alternatore with 2 slot per pole phase and 4 conductors per slot in two layers. The

coil span is 150. The flux per pole has a fundamental component of 0.12 Wb and a 20% third harmonic component. 10

   b. Draw and explain the phasor diagram of salient pole unsaturated alternator supplying full load lagging power current. Show that the power output per phase is given by

$$P = \frac{EV}{X_d} \sin\delta + \frac{V^2}{2}\left[\frac{1}{X_q} - \frac{1}{X_d}\right] \sin 2\delta$$

10

8. a. Draw the equivalent circuit of a synchronous motor and derive the commonly used expression for the power developed by a synchronous motor. 10

   b. A 2000V, three phase, 4 pole, star connected synchronous motor runs at 1500 r.p.m. The excitation is constant and corresponds to an open circuit voltage of 2000V. The resistance is negligible as compared to synchronous reactance of 3Ω per phase. Determine the power input, power factor and torque developed for a armature current of 200A. 10