(ii) Determine voltage regulation of transformer whose ohmic drop is 1.5% and leakage reactance drop is 5% at 0.8 pf. lagging.

(b) A 100 kVA, 1000/220 V, 1-phase transformer gave the following test results :

OC Test (hv) : 1 kV, 0.8 kW, 2 A

SC Test (*lv*) : 15 V, 1.5 kW, 455 A

Determine parameters of equivalent circuit referred to hv side ad efficiency at full load 0.8 pf lagging.

(c) (i) What is an auto-transformer ? Discuss its merits and demerits.

(ii) A 5 kVA, 2300/230 V two-winding transformer is connected as an auto-transformer and supplied by a 2530 V source. The transformer is loaded so that the rated currents of the windings are not exceeded. Calculate : currents in different sections of the auto-transformer, kVA output and kVA transferred inductively and conductively.

5. Answer any ***two*** of the following :

(a) (i) Discuss three-phase Transformer Phasor groups. How the displacement is expressed as the clock hour number ?

(ii) Show the terminal connections of a 3-phase Transformer with corresponding phasor diagram having the vector groups : D_{y1} and Y_{d11}.

(b) Explain with suitable diagrams how harmonics are produced in transformers even when the supply voltage be purely sinusoidal. Which order of harmonics are usually prominent ? What is done to neutralize the effect of third harmonic voltages in high voltage star-star connected transformers ?

(c) Explain Scott-connection.

Two electric furnaces are supplied with two 1-phase Scott-connected transformers with similar secondary windings. When the load on one transformer is 400 kW and on the other 600 kW, what currents will flow in each of the three-phase lines when the furnaces work at :

(i) Unity pf

(ii) 0.714 pf. lagging ?

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(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 0207 **Roll No.**

B. Tech.

(SEM. IV) THEORY EXAMINATION 2011-12

ELECTRO-MECHANICAL ENERGY CONVERSION—I

Time : 3 Hours *Total Marks : 100*

Note : (1) Attempt ***all*** questions.

(2) All questions carry equal marks.

(3) In case of numerical problems, assume data wherever required.

1. Answer any ***four*** of the following :

(a) Explain flow of energy in electro-mechanical devices with a suitable model and write energy balance equation.

(b) For the simple magnetic relay of Fig. 1, the variation of flux linkages ψ in terms of current i and displacement x is given by the relation :

$\psi = i\, x^{1/2}$.

Develop expression for the magnetic force.

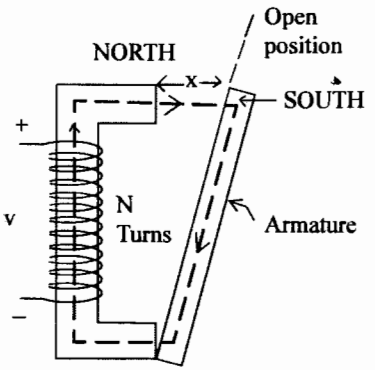

Fig. 1

(c) For a singly excited magnetic system, establish relationship between magnetic field energy and co-energy. Develop also the relation for the magnetic stored energy and co-energy in terms of reluctance and permeance.

(d) For doubly excited magnetic field system, various inductances are :

$L_{11} = (4 + \cos 2\theta) \times 10^{-3}$ H

$L_{12} = 0.15 \cos \theta$ H

$L_{22} = (20 + 5 \cos 2\theta)$ H.

Determine torque developed if $i_1 = 5$ A and $i_2 = 0.10$ A.

(e) Describe the principle of virtual work and hence show that the magnetic force F is given by :

$$F = \frac{-\partial W_{fld}}{\partial x}(\phi, x) = \frac{-\partial w_{fld}}{\partial x}(\lambda, x)$$

Above terms have usual meanings.

(f) Develop torque equation in an electric machine with cylindrical air-gap.

2. Answer any *two* of the following :

(a) (i) Give constructional features of a d.c. machine. Describe its working principle explaining how the commutator converts alternating voltage of the armature into direct voltage.

(ii) Find the back-pitch, front-pitch, resultant pitch and the average pitch for a 6-pole, 34 coil side wave wound d.c. machine. Give also the scheme of connecting the conductors.

(b) (i) Develop from first principle the torque equation for a d.c. machine.

(ii) A 6-pole lap wound d.c. machine has 40 slots and 8 conductors/slot and each conductor carries a current of 30 A. The machine core diameter is 0.4 m, length is 0.3 m and average value of flux density is 0.3 T. The machine is driven at 1500 rpm. Determine emf, armature current and power developed.

(c) A 4-pole dc generator has a lap wound armature having 720 conductors. If the generator delivers a current of 40 A on full load, calculate AT_d, AT_c per pole for a brush lead of 8° mech. Determine also the number of series turns of the compensating winding on main poles to balance AT_d and number of series turns on interpoles to neutralize AT_c, if the leakage coefficient is 1·1.

3. Answer any *two* of the following :

(a) Explain why a starter is required for starting a d.c. motor. Describe a 3-point starter, having no-volt and over-load protections for a d.c. shunt motor. What modification is made in a 4-point starter ? Give relative merits of these two types of starters.

(b) (i) Draw the speed-torque characteristics of d.c. shunt, series and compound motors in same diagram and compare them. Which of the characteristic is more suitable for traction purpose and why ?

(ii) The armature resistance of a 200 V shunt motor is 0.4 Ω and no load current is 2 A, when loaded taking armature current of 50 A, the speed is 1200 rpm. Determine no-load speed ignoring shunt field current.

(c) The Hopkinson test on two identical shunt machines gave the following results :

Input voltage = 250 V

Input current = 10 A

Output current of generator = 60 A

Field current of generator = 4 A

Field current of motor = 3A

Armature resistance of each machine is 0.1 Ω. Determine efficiency of motor and generator.

4. Answer any *two* of the following :

(a) (i) Develop equivalent circuit of a single phase transformer and draw the phasor diagram and do power flow analysis.