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TEE – 401

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

PAPER ID : 2051

Roll No.

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B.Tech.

FOURTH SEMESTER EXAMINATION, 2005-2006

ELECTROMECHANICAL CONVERSION I

Time : 3 Hours

Total Marks : 100

Note : (i) Attempt **ALL** questions.

(ii) All questions carry equal marks.

(iii) In case of numerical problems assume data wherever not provided.

(iv) Be precise in your answer.

1. Attempt *any four* parts of the following : (5×4=20)

(a) Describe the principle energy conversion. Draw general block diagram representation of an electro-mechanical energy conversion device.

(b) A 10kW, 1440 rpm d.c. shunt generator has a time constant $\frac{L_f}{r_f}$ of 0.2 sec for its field winding. Undernormal operating conditions, the $I_f^2 r_f$ loss in the field winding is 400 Watts. Compute the energy stored in the magnetic field produced by the field winding, under normal operating conditions.

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(c) Show that the torque developed in a doubly excited magnetic system is equal to the rate of increase of field energy with respect to displacement at constant currents.

(d) A doubly excited rotating machine has following self and mutual inductances :

$$r_s = 40 \text{ V}, r_r = 2 \text{ V}, M_{sr} = 0.08 \cos \theta_r, L_s = 0.16 \text{ H}, \\ L_r = 0.04 + 0.02 \cos 2\theta_r$$

θ_r is the space angle between coil axes. The rotor is revolving at a speed of 100 rad/sec. For $i_s = 10$ A d.c and $i_r = 2$ A d.c. Derive expressions for the instantaneous voltages applied to the stator and rotor windings.

(e) Prove that energy and co-energy in a linear magnetic system are given by same expressions. Give the significance of co-energy.

(f) An electric machine has cylindrical stator and salient pole rotor. Justify the correctness of the following statements :

(i) Reluctance torque is produced when exciting winding is on rotor.

(ii) When stator and rotor both carry exciting windings, electro-magnetic as well as reluctance torques are produced.

2. Attempt *any three* parts of the following : (20)

- (a) With a suitable diagram, give the constructional features of d.c. machines. Explain working of commutator.
- (b) Derive the expression for the torque developed in a d.c. machine.
- (c) A dc shunt generator driven by a belt from an engine runs at 750 rpm while feeding 100 kW of electric power into 230 V mains. When the belt breaks it continues to run as a motor drawing 9 kW from the mains. At what speed would it run ? Armature resistance 0.08Ω and field resistance 115Ω .
- (d) Describe the effect of armature reaction in a d.c. machine. How it is minimized ?
- (e) Explain process of commutation in a d.c. machine. How it is improved ?

3. Attempt *any two* parts of the following : (10x2=20)

- (a) Draw the speed torque characteristics of d.c. shunt, series and compound motors. A 200 V shunt motor has $R_a = 0.1 \Omega$, $R_f = 240 \Omega$ and rotational loss 236 W. On full-load, the line current is 9.8 A with the motor running at 1450 rpm.

Determine

- (i) the mechanical power developed
- (ii) the power output
- (iii) the load torque
- (iv) the full-load efficiency

- (b) What are the advantages of field-flux control method over the armature - circuit - resistance control method employed for speed control of d.c. motors.

A 15 kW, 250 V, 1200 rpm shunt motor has 4 poles, 4 parallel armature paths, and 900 armature conductors ; $R_a = 0.2 \Omega$. At rated speed and rated out put the armature current is 75 A and $I_f = 1.5$ A. Calculate (i) Flux/pole (ii) the torque developed (iii) rotational losses (iv) η (v) the shaft load (vi) the shaft load found remains fixed, but the field flux is reduced to 7% of its value by field control, determine new operating speed.

- (c) Explain what would happen if the d.c. motor is directly switched on to the supply, without any starter. A 240 V, 50 A, 1500 rpm dc shunt motor has an armature resistance of 0.2Ω . Calculate the values of various steps of starter with armature current not exceeding 1.4 P.U. Neglect shunt field current Derive Formula used.

4. Attempt *any two* parts of the following : (10x2=20)

- (a) What is an open-delta system ? Give the application of this system. Two transformers each rated 250 - kVA, 11/2 - kV and 50-Hz are connected in open delta on both the primary and secondary.
- (i) Find the load kVA that can be supplied from this transformer connection.
- (ii) A delta connected three-phase load of 250 kVA, 0.8 pf, 2 kV is connected to the low-voltage terminals of this open-voltage transformer. Determine the transformer currents on the 11 kV side of this connection.

- (b) State the conditions for the parallel operation of two transformers on load. A 20 kVA, 440/220 V transformer with an equivalent impedance of 0.01Ω is to operate in parallel with a 15 kVA, 440/220 V transformer with an equivalent impedance of 0.015Ω . The two transformers are connected in parallel and made to carry a load of 25 kVA. Assume both the impedances to have the same angle.
- Find the individual load currents
 - What percent of the rated capacity is used in each transformer ?
- (c) Explain three phase to two phase scott connection and its performance on load. Mention its applications.
5. Attempt *any four* parts of the following : (5x4=20)
- Explain principle of working and application of three winding transformers.
 - Describe Sumpner's test for determination of efficiency of transformers.
 - Explain excitation phenomenon in transformers.
 - What is all day efficiency and what is its importance ? For what type of transformer it is used.
 - Explain working of single phase auto-transformer and mention its applications.
 - Show that there will be saving of copper in auto-transformer in comparison to same rating of two winding transformer.

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