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

PAPER ID : 0207 Roll No.

B.Tech.

(SEM IV) EVEN SEMESTER THEORY EXAMINATION, 2009-2010

ELECTROMECHANICAL ENERGY CONVERSION-I

Time : 3 Hours *Total Marks : 100*

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

(ii) *All symbols have their usual meanings.*

1. Attempt **any four** parts of the following : **(4x5=20)**

(a) Derive the following relation for field energy.

$$W_f = \int_0^{\lambda} i \, d\lambda \qquad \text{where } \lambda = \text{flux linkage}$$

(b) Derive the following relation for mechanical force developed for voltage controlled system.

$$F_f = -\frac{\partial W_f(\lambda, x)}{\partial x} \quad \text{where } W_f = \text{field energy}$$

(c) For a certain relay, the magnetization curves for open and closed positions of the armature are linear. If the armature of the relay moves from open to closed position at constant current (i.e. infinitely slowly), show that the electrical energy input is shared equally between field energy stored and the mechanical work done.

(d) In an electromagnetic relay, functional relation between the current i in the exciting coil, the position of armature x and the flux linkages λ is given by

$$i = 2\lambda^3 + 3\lambda(1 - x + x^2), \; x > 0.5$$

Find the force on the armature as a function of λ.

(e) The simple magnetic relay have the following λ-i characteristics :

(i) Open position, $\lambda = 0.04i$ Wb-turn for all values of current i

(ii) Closed position $\lambda = 0.06i \quad 0 \leq i \leq 20$

$$= 1.2 + 0.03\ (i - 20) \qquad i > 20$$

For an armature movement from open to closed position, find the magnitude of average magnetic force. Air gap length is 2 cm and the current during armature movement is assumed to remain constant at 40 A.

(f) The magnetic flux density on the surface of an iron face is 1.6 T which is a typical saturation level value for ferromagnetic material. Find the force density on the iron face.

Attempt **any four** parts of the following : **(4x5=20)**

(a) Derive the emf equation of a d.c. generator.

(b) The terminal voltage of a 8 pole d.c. shunt generator with 780 wave connected armature conductors and running at 500 rpm at terminal voltage 240 V. The armature resistance is 0.24 Ω and the field resistance is 240 Ω. Find the armature current, the induced emf and the flux per pole if load resistance is 12 Ω.

(c) Explain why the terminal voltage Vs load current characteristic of a d.c. shunt generator is more drooping than that of separately excited generator.

(d) By drawing the relevant diagram of flux density waves show that there is the shift in the position of magnetic nutral axis (MNA) in the direction of rotation due to armature reaction in case of d.c. generator.

(e) What do you mean by poor commutation ? Discuss the reasons for poor commutation.

(f) A separately excited d.c. generator has terminal voltage 250 V with constant field excitation. If the load changes from 200 kW to 225 kW, find the percentage reduction in speed. The armature resistance is 0.015 Ω and total contact drop at brushes is 2V. Neglect armature reaction. The flux and total number of armature conductors remain constant.

Attempt **any two** parts of the following : **(2x10=20)**

(a) Explain Ward Leonard method to control the speed of d.c. motor.

The no load current and speed of a 4 pole, 250 V d.c. shunt motor are 6A and 500 rpm respectively. It has a shunt field current of 1 A. If its full load current be 80 A, find its full load speed. The value of armature resistance is 0.012 Ω. Neglect the brush drop. Armature reaction weakens the flux by 25%.

(b) With the help of circuit diagram, explain Hopkinson test on d.c. motor. Derive the expressions for efficiency of the d.c. machine as motor and generator. Write its advantages over Swinburn's test.

(c) Draw the speed Vs torque characteristic of d.c. series motor by deriving the relation of speed in terms of torque. Discuss its important features.

A 220V d.c. series motor takes 40A and runs at 500 rpm while driving a fan load. The load varies as the square of the speed. The resistance between terminal is 1.3Ω. It is required to raise the speed to 525 rpm by increasing the voltage. Find the voltage. Assume that the flux varies directly as the current.

4. Attempt **any two** of the following : **(2x10=20)**

(a) Define efficiency, voltage regulation and all day efficiency of the transformer. Derive the condition for maximum efficiency.

Find the all day efficiency of the transformer having maximum efficiency of 98.5% at 20 kVA, unity pf and loaded as follows :

11 Hours	:	5 kW, 0.7 pf lagging
6 Hours	:	8 kW, 0.8 pf lagging
7 Hours	:	No load

The maximum efficiency of the transformer occurs at 80% of full load.

(b) Draw the phasor diagram of a single phase step up transformer feeding a lagging pf load.

With the help of circuit diagram, explain short circuit test. Why the core loss is assumed negligible in this test ?

(c) Write merit, demerit and applications of autotransformer.

A 2200/220V transformer is rated as 15 kVA as a two winding transformer. It is connected as an autotransformer with low voltage winding connected additively in series with high voltage winding to feed a load at 2200V. The autotransformer is excited from a 2420V source. The autotransformer is loaded so that rated currents of the windings are not exceeded. Find :

(i) The current distribution in the winding,

(ii) kVA output.

(iii) kVA transferred conductively and inductively

(iv) Saving in conductor material as compared to a two winding transformer of the same VA rating

5. Attempt **any four** of the following : **(4x5=20)**

(a) Draw the connection and phasor diagram for star/zig zag star +30 connection.

(b) Discuss the basic cause for the generation of harmonics in the transformer.

(c) A three phase transformer bank consisting of three 1ϕ transformers is used to step down the voltage of a 3ϕ, 6600 V transmission line. If the primary line current is 10 A, calculate the secondary line voltage, line current and output kVA for Y/Δ connection. The turn ratio is 12. Neglect losses.

(d) Write all essential and desirable conditions to connect two 3ϕ transformer in parallel.

(e) Draw the connection diagram for open delta system and show that

$$\frac{S \text{ open } \Delta}{S \text{ closed } \Delta} = \frac{1}{\sqrt{3}}.$$

(f) Two single phase transformers share a load of 400 kVA at 0.8 pf lagging. Their equivalent impedances referred to secondary windings are $(1+j2.5)\ \Omega$ and $(1.5+j3)\ \Omega$ respectively. Calculate the load shared by each transformer.

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