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

PAPER ID : 2051 Roll No. 07029210042

B. Tech.

(SEM. IV) EXAMINATION, 2008-09

ELECTROMECHANICAL ENERGY CONVERSION - I

Time : 3 Hours] *[Total Marks : 100*

Note : (i) Attempt **all** questions.
(ii) Each question carries **equal** marks.

1 Attempt any **two** parts of the following :

(a) (i) Describe the principle of energy coversion. From a consideration of the various energies involved, develop the model of an electromechanical energy-conversion device. **2×5**

(ii) For a linear magnetic circuit, derive the following relations for the stored magnetic energy W_{fld} and co-energy W'_{fld}

$$W_{fld} = W'_{fld} = \frac{1}{2} F\phi = \frac{1}{2} \psi_i = \frac{1}{2} \phi^2 Rl = \frac{F^2}{Rl} = \frac{1}{2} Li^2 \text{ Joules}$$

where

F = Instantaneous mmf

ψ = Magnetic flux linkage

ϕ = Instantaneous flux

Rl = Reluctance

i = Instantaneous current

L = Self-inductance.

(b) For the simple magnetic relay of **Fig. 1. (b),** the variation of flux linkage ψ in terms of current i and displacement x from the open position is given by the relation $\psi = ix^{1/2}$; obtain an expression for the magnetic force. **1×10**

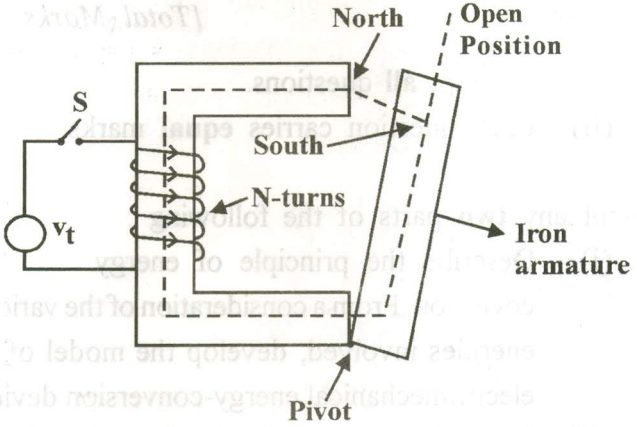

Fig. 1. (b)

(c) (i) What are the advantages of analysing energy conversion devices by field-energy concept? **2×5**

(ii) Describe the principle of virtual work and hence show that the magnetic force f_e is given by

$$f_e = \frac{-\partial W_{fld}}{\partial x}(\phi, x) = -\frac{\partial W_{fld}}{\partial x}(\phi, x)$$

Above terms have usual meanings.

2 Answer any **two** of the following :

(a) (I) Give the materials and functions of the following parts of a DC machine : **2×5**

(i) Field poles

(ii) Yoke

(iii) Commutator

(iv) Commutating Poles

(v) Armature.

(II) Explain lapwinding with suitable example.

(b) A 2-pole dc shunt generation charges a 100-V battery of negligible internal resistance. The armature of the machine is made up of 1000 conductors, each of 2 milli-ohm resistance. The charging currents are found to be 10A and 20A for generator speeds of 1055 and 1105 rpm respectively. Find the field circuit resistance and flux per pole of the generator. Neglect armature reaction effects. **1×10**

(c) (i) The effect of armature reaction is to decrease the flux under one pole tip and to increase it under the other pole tip. Explain this with respect to a dc generator by using the developed view of armature current sheet and poles. **2×5**

(ii) What are interpoles? Why are the interpoles designed to provide mmf more than the armature mmf in the commutating zone?

3 Attempt any **two** parts of the following :

(a) (i) Draw the speed-torque characteristics of d.c. shunt, series and compound motors in one figure and compare them. Which characteristic is more suitable for traction purposes and why ? **2×5**

(ii) A 6-pole , 230 V d.c. series motor has a flux per pole of 4 mWb / Amp over the working range of the magnetization curve which is assured to be linear. The load torque is proportional to speed squared and its value is 20 Nm at 800 rpm. There are 432 wave-connected conductors and the total resistance of the motor is 1.0 Ω. Determine the motor speed and current when this motor is connected to rated supply voltage. **2×5**

(b) (i) A 250 V, 15 kW, shunt motor has a maximum efficiency of 88% and a speed of 700 rpm, when delivering 80% of its rated output. The resistance of its shunt field is 100 Ω. Determine the efficiency and speed when the motor draws a current of 78 A from mains. **2×5**

(ii) Explain in brief how efficiency is obtained from HOPKINSON'S Test.

(c) A d.c. shunt motor is connected to a 3-point starter. Explain what would happen if : **5×2**

(i) The starter handle is moved rapidly from OFF to the ON position

(ii) The field circuit is open and an attempt is made to start the motor.

(iii) The field circuit becomes open circuit with the motor running at no-load, with the assumption that the starter is not provided with the no-volt release and the spring.

(iv) The starter handle is pulled back to stop the motor.

(v) There is a sudden overload of 100%.

4 Answer any two of the following :

(a) (i) Explain how the 3-phase core type transformer was evolved from three single-phase core type transformers having both their windings on one leg. **2×5**

(ii) In 3-phase shell type transformers, a considerable economy is achieved in the core material if the middle phase winding is wound in the reversed direction as compared with the outer two phase windings. - Explain.

3500 V and the other of 180 kVA at 1000 V, are to be energised from this auto-transformer output. Draw a suitable diagram of connections and find the currents in various parts of the circuit. Assume the loads to have the same power factor.
