Printed Pages : 7

TEE – 401

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

PAPER ID : 2051 Roll No. ☐☐☐☐☐☐☐☐☐☐

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 2×5 coversion. From a consideration of the various energies involved, develop the model of an electromechanical energy-conversion device.

(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

$\psi =$ Magnetic flux linkage

ϕ = Instantaneous flux

Rl = Reluctance

i = Instantaneous current

L = Self-inductance.

(b) For the simple magnetic relay of **Fig. 1. (b)**, 1×10 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.
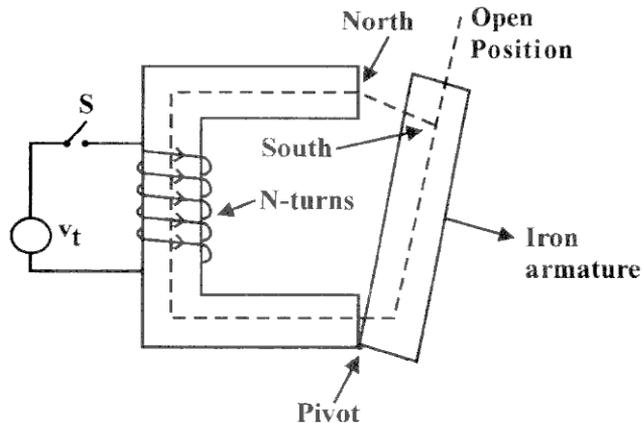

Fig. 1. (b)

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

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

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

Above terms have usual meanings.

2

Answer any **two** of the following :

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

  (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 **1×10**
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.

(c) (i) The effect of armature reaction is to **2×5**
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.

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

2051] 3 [Contd..

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

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

       (ii) A 6-pole , 230 V d.c. series motor **2×5**
              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 $1.0\,\Omega$.
              Determine the motor speed and current
              when this motor is connected to rated
              supply voltage.

   (b) (i) A 250 V, 15 kW, shunt motor has **2×5**
              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.

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

2051]   ‖‖‖‖‖ ‖‖‖‖‖‖‖ ‖‖   4   **[Contd..**

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

   (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   2×5
            transformer was evolved from three single-phase core type transformers having both their windings on one leg.

       (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.

(b) Describe in detail the four phasor groups pertaining to 3-phase transformers. Draw the phasor diagrams and connection schemes for each of these four groups. **1×10**

(c) (i) Scott-connected transfomers supply two single-phase loads at 100 V. The load across the teases secondary is 300 kW at unity power factor and that across the main secondary is 200 kW at 0.8 power factor lagging. For a 3-phase input voltage of 11000 V, calculate the primary line currents and the leakage impedance drops are ignored. **2×5**

(ii) In open-delta transformers, show that the secondary line voltages form a balanced 3-phase system of voltages, in case the suppy voltages are balanced.

5 Answer any two of the following :

(a) (i) In Sumpner's test, the reading of the wattmeter recording the core losses, remains unaffected when low-voltage is injected in the secodanry series circuit. - Explain. **2×5**

(ii) Explain why the exciting current of a single-phase transformers contains harmonics even when the supply voltage is a Sine wave.

(b) (i) Discuss the conditions necessary for the **2×5** successful parallel operation of single-phase transformers. How can you check these conditions?

(ii) Two single-phase transformers rated 1000 kVA and 500 kVA have per unit leakage impedanace of $(0.02+j0.06)$ and $(0.025+0.08)$ respectively. What is the largest kVA load that can be delivered by the parallel combination of these two transformers without overloading any one.

(c) (i) Discuss the relative merits and **2×5** demerits of an auto-transformer.

(ii) A 2000/1000/500 V, single-phase three winding transformer is to be used as an auto-transformer, with supply voltage of 3000 V. Two loads, one of 1050 kVA at

2051]　　　‖‖‖‖‖‖‖‖‖‖‖‖‖‖‖‖　7　　　　[Contd..

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.