B. Tech.
(SEM. IV) EXAMINATION, 2006-07
ELECTROMECHANICAL ENERGY CONVERSION - I

Time: 3 Hours] [Total Marks: 100

Note: Attempt all questions.

1. Attempt any two parts of the following: 10×2=20

(a) Define energy and co-energy. What is the significance of co-energy?
   Show that the field energy in a linear magnetic system is given by
   \[ W_F = \frac{1}{2} L i^2 = \frac{1}{2} \psi i = \frac{1}{2L} \psi^2 \]

(b) Derive an expression for the torque in a doubly excited system having salient pole type of stator as well as rotor. State the assumption made.

(c) For the electro mechanical system shown in figure 1, the air gap flux density under steady operating condition is
   \[ B(t) = Bm \sin \omega t \]
   Find
   (i) The induced coil voltage
   (ii) The force of field origin as a function of time, and

V-2051] 1 [Contd...
(iii) the motion of armature as a function of time.

![Diagram of armature and commutator](image)

**Fig. 1**

2 Attempt any two parts of following: \[10 \times 2 = 20\]

(a) Design the winding for a 4-pole armature with 2540 conductors, 127 commutator segments and 32 slots.

(b) Explain commutation process in d.c. machines. What are the causes of poor commutation? Describe the role of interpoles and compensating winding in d.c. machines.

(c) Draw the external load characteristics of various D.C. generators.

A dc shunt generator delivers a current of 50A at 200V to a load of constant resistance while running at 1000 rpm. Its armature circuit resistance is 0.5 \( \Omega \) and that of field winding is 50 \( \Omega \). Find the load current in case speed of dc generator falls to 800 rpm, field current remaining constant. Neglect effect of armature reaction.
3 Attempt only four parts of the following: 5x4=20

(a) Explain Ward Leonard method of speed control with neat diagram.

(b) A dc series motor is driving a fan load where the load torque is proportional to cube of speed. The resistance of the armature and field in series is 1 $\Omega$ and the motor takes 10A and runs at 1000 rpm when operating from 200V supply. Calculate the value of resistance to be inserted in series with the armature to reduce the operating speed to 800 rpm.

(c) The following is the OCC of a dc shunt generator at 300 rpm

<table>
<thead>
<tr>
<th>If (A)</th>
<th>0</th>
<th>0.2</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
<th>0.6</th>
<th>0.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOC (V)</td>
<td>7.5</td>
<td>93</td>
<td>135</td>
<td>165</td>
<td>186</td>
<td>202</td>
<td>215</td>
</tr>
</tbody>
</table>

The field resistance of the machine is adjusted to 354.5 $\Omega$. Determine
(i) no load voltage
(ii) Critical field resistance
(iii) Critical speed for given field resistance.

(d) Explain the working of 3 point starter of d.c. machines.

(e) A 480V, 20 KW shunt motor took 2.5A, when running with light load. Taking the armature resistance to be 0.6 $\Omega$, field resistance to be 800 $\Omega$ and brush drop is 2V, find the full load efficiency.

(f) Describe Hopkinson’s test for testing the d.c. shunt machines.
4 Attempt any four parts of the following: \(5 \times 4 = 20\)

(a) Define ‘All day efficiency’. A transformer has its maximum efficiency of 0.98 at 15 KVA unity power factor load. Find the all day efficiency for the following loading cycle: 2kW at 0.5 p.f. for 12 hours, 12 kW at 0.8 p.f. for 6 hours and 18 kW at 0.9 p.f. for 6 hours.

(b) What are the possible connections for a 3 phase transformer bank? Explain \(Y-4\) connection.

(c) Explain the division of load between transformers in parallel.

(d) A 100/400V, 2KVA single phase transformer has 5\% impedance. If it is connected as a 500/400 V auto-transformer, deduce from fundamentals its KVA rating and percentage impedance as an auto transformer.

(e) What is the inrush phenomena in transformer? Derive an approximate expression for the magnitude of the maximum instantaneous current.

(f) Explain open delta connection of a 3-phase transformer. What are the applications of this system? Discuss.

5 Attempt any four parts of the followings: \(5 \times 4 = 20\)

(a) Describe voltage build up process in d.c. shunt generator.

(b) Derive emf and torque equation in a d.c. machine.

(c) How polarity test is conducted in three phase transformer? Explain.

(d) Explain scott connection and give its application.

(e) What are the disadvantages of current and voltage harmonics in transformers? How these harmonics can be eliminated?

(f) Describe sumpner’s test and give its limitations.