53 (IE 401) ELMC

2019

ELECTRICAL MACHINES

Paper : IE 401

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

Answer ***any five*** *questions.*

1. *(a)* Draw neat diagrams of the following machines and show their various current directions : 10

   (i) Shunt generator

   (ii) Shunt motor

   (iii) Long-shunt compound generator

   (iv) Short-shunt compound generator

   (v) Separately excited DC generator

Contd.

(b) A 4-pole lap-connected armature of a DC shunt generator is required to supply the following loads connected in parallel.

5*kW* geyser at 250*V* and 2·5*kW* lightning load also at 250*V*.

The generator has an armature resistance of 0·2Ω and a field resistance of 250Ω. The armature has 120 conductors in the slots and run at 1000*rpm*. Allowing 1*V* per brush for contact drops, find —

(i) Flux per pole

(ii) armature current per parallel path. 10

2. (a) Why a DC series motor have high starting torque? 5

(b) Sketch a DC machine with 4-poles and indicate the flux path for the four poles. 5

(c) A 220*V* shunt motor takes a total current of 80*A* and runs at 800*rpm*. Shunt field resistance and armature resistance are 50Ω and 0·1Ω respectively. If iron and friction losses amount to 1600*W*, find — 10

(i) copper losses

(ii) armature torque

(iii) shaft torque

(iv) efficiency

3. (a) Draw the phasor diagram of a loaded transformer for inductive load. 5

(b) In a 50*kVA* transformer, the number of turns on the primary and secondary windings are 834 and 58 respectively. If primary is connected to a 3300*V* supply, find —

(i) secondary voltage

(ii) the primary and secondary currents when the transformer is fully loaded. Neglect the losses. 5

(c) A 20*kVA*, single phase, 50*Hz*, 2200/200*V* transformer gave the following test results :

OC test : 2200*V* applied to primary, power taken 220*W*.

SC test : Power required to circulate F.L. current in short-circuited secondary is 240*W*.

Calculate the efficiency at full-load and half full-load at p.f. 0·8 lagging. 10

4. (a) Derive the condition for maximum efficiency of a transformer. 5

(b) Draw the exact equivalent circuit of a loaded transformer clearly showing the voltages at different sections. 5

(c) A voltage $v = 200 \sin 314t$ is applied to the transformer winding in a no-load test. The resulting current is found to be $i = 3 \sin(314t - 60°)$. Determine the core loss and r.m.s. value of the exciting current. Draw the circuit diagram as well as phasor diagram. 10

5. (a) Draw and explain the important points of the torque-slip characteristics of a 3-ϕ induction motor. 5

(b) With a neat diagram, show the power stages of an induction motor. 5

(c) An 18·65*kW*, 4-pole, 50*Hz*, 3-phase induction motor has friction and windage losses of 2·5% of the output. The full-load slip is 4%. Find for full-load,

(i) the rotor *Cu*-loss
(ii) the rotor *i/p*
(iii) the shaft-torque
(iv) the gross torque. 10

6. (a) Draw the circuit diagram of a capacitor start motor clearly showing the starting and running winding with the connection of capacitor.

Also draw the phasor diagram of the above motor. 5

(b) What is the function of the centrifugal starting switch in a single phase induction motor? 5

(c) Briefly explain the Double-field revolving theory. 10

7. (a) Derive the emf equation of an alternator. 5

(b) What do you mean by Distribution factor and Pitch factor related to an alternator winding? 5

(c) A 3-phase, 17·32*kVA*, 400*V*, star-connected alternator is delivering rated load at 400*V* and at p.f. 0·8 lag. Its synchronous impedance is $(0{\cdot}2 + j2)\Omega$ per phase. Find the load angle at which it is operating. 10