53 (IE 401) ELMC

2017

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)* Why is the transformer core laminated ? Explain with proper justification. 5

   (b) Derive an expression for the e.m.f. induced in a transformer winding. Show that e.m.f. per turn in primary is equal to e.m.f. per turn in the secondary. 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 $i = 3\sin(314t - 60^\circ)$. Determine the core loss and r.m.s value of the exciting current. 10

2. *(a)* Describe the constructional details of commutator of a dc machine. 5

(b) Develop the circuit model of a dc machine. 5

(c) A dc shunt generator gives an open-circuit voltage of $240V$. When loaded, the terminal voltage falls to $220V$. Determine the load current in case armature-circuit and field-winding resistance are $0{\cdot}1\Omega$ and 50Ω respectively. Neglect the effect of armature reaction. 10

3. *(a)* Write the analogy between transformer and induction motor. 5

(b) Derive the expression of frequency of rotor winding in case of an induction motor. 5

(c) A 3-phase, $50Hz$ induction motor has full-load speed of $960rpm$. Calculate *(i)* number of poles *(ii)* slip frequency *(iii)* speed of rotor field with respect to rotor structure ; with respect to stator structure ; and with respect to stator. 10

4. *(a)* Draw the combined space and time-phasor diagram for a cylindrical-rotor alternator with armature current lagging the excitation e.m.f. Discuss about the various parameters involved in it. 5

(b) Explain how open-circuit test is conducted on a synchronous machine. 5

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

5. *(a)* What is yoke, pole core, pole shoe in a dc machine ? What purpose do they serve ? Explain with a suitable diagram. 10

(b) What should be the value of chording angle for eliminating *(i)* third harmonics *(ii)* fifth harmonics ? 10

6. *(a)* Explain why a single-phase motor has no starting torque ? 5

(b) What is a resistance split-phase induction motor ? 5

(c) Describe the basic operating principle of the stepper motor. 10

7. (a) A single-phase, 230*V*, 50*Hz*, 4 pole, capacitor-start induction motor has the following standstill impedances : 10

Main winding $Z_m = (6 + 4j)\Omega$

Auxiliary winding $Z_a = (8 + 6j)\Omega$

Calculate the value of starting capacitor required to produce 90° phase difference between the currents in the main and auxiliary winding.

(b) A 5*kVA*, 1000/200*V*, 50*Hz* single phase transformer gave the following test results : 10

Open-circuit test (*l.v.* side) : 200*V*, 1·2*A*, 90*W*

Short-circuit test (*h.v.* side) : 50*V*, 5*A*, 110*W*

Compute the parameters of the approximate equivalent circuit referred to *l.v.* side.