53 (IE 401) ELMC

2018

ELECTRICAL MACHINES

Paper : IE 401

Full Marks : 100

Time : Three hours

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

Answer Question No. ***1*** *and* ***any four*** *from the rest.*

1. *(a)* Explain why — 4×3=12

   (i) DC Series motors are used to start heavy loads.

   (ii) In open-circuit test of a single phase transformer, high voltage side should be kept open and in short-circuit test, the low voltage side should be short-circuited.

   (iii) A 3-ϕ induction motor can't run at synchronous speed.

(b) A 6-pole, 3-ϕ induction motor is connected to a 25*Hz* supply and at full load the rotor *emf* makes 105 complete cycles in 2 minutes. Find the full-load percentage slip. 4

(c) Mechanical energy is supplied to a DC generator at the rate of 4200*J/s*. The generator delivers 32·2*A* at 120*volt*. Calculate the energy lost per minute of operation. 4

2. (a) Write about the different types of losses in a DC generator. Also derive a condition for maximum efficiency. 10

(b) A long-shunt compound generator running at 1000*r.p.m.* Supplies 22*kW* at a terminal voltage of 220*V*. The resistances of the armature, shunt-field and the series field are 0·05Ω, 110Ω and 0·06Ω respectively. The overall efficiency at the above load is 88%. Find *(i) Cu*-losses *(ii)* iron and frictional losses *(iii)* torque exerted by the prime mover. 10

3. *(a)* Describe about the following methods of speed control of DC shunt motors with a neat diagrams.

(i) Field Control *(ii)* Armature Control. 5+5=10

(b) A 230*V* shunt motor takes 5*A* at no-load. The resistances of the armature and field circuits are 0·25Ω and 115Ω respectively. If the motor is loaded to carry 40*A*, determine —

(i) iron losses and frictional losses

(ii) efficiency. 10

4. *(a)* A 10*kVA*, 200/400*V*, 50*Hz*, single-phase transformer gave the following test results — 10

O.C. test : 200*V*, 1·3*A*, 120*W* ..... on LV Side

S.C. test : 22*V*, 30*A*, 200*W* ..... on HV Side.

Calculate :

(i) the magnetising current and the component corresponding to core loss at normal frequency and voltage.

(ii) the magnetising branch impedances and

(iii) Percentage voltage regulation when supplying full-load at 0·8 *p.f.* leading.

(b) A 600*kVA*, single phase transformer when working at unity power factor has an efficiency of 92% at full load and also at half-full load. Determine the efficiency when it operates at unity *p.f.* and 60% of full-load. 10

5. (a) Derive an expression for torque of an 3-ϕ induction motor under running condition. Also find the condition to obtain maximum running torque. 10

(b) A 3-ϕ, 500*V*, 50*Hz* induction motor with 6-poles develops 20 B.H.P. at 950 *r.p.m.* with a power factor of 0·86 (*lag*). The mechanical losses are total of 1 *H.P.* Calculate for this load *(i)* the slip, *(ii)* the rotor copper loss, *(iii)* the input if the stator losses total 1500*W*, *(iv)* the line current. 10

6. (a) A 3-ϕ, star-connected alternator is delivering 20*MW* and 8*MVAR* to an infinite bus at 11*kV*. The alternator has synchronous impedance of $(0+j3)\Omega$. Determine the load angle and the excitation *emf.* of the alternator. 10

(b) Draw the equivalent circuit of an loaded alternator per phase with the phasor diagram. Also briefly discuss about the terms —

Armature resistance, armature leakage reactance, synchronous reactance and armature reaction. 10

7. (a) Mathematically show, how rotating magnetic field can be produced from two phase supply. 10

(b) Write about the construction and operation of AC series motor. 10