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

1. *(a)* Derive the *emf.* equation of a DC generator. 5

   (b) Draw the neat circuit diagrams of shunt and series generators and also write their voltage equations. 5

(c) A shunt generator delivers 195A at a terminal p.d. of 250V. The armature resistance and shunt field resistance are 0·02Ω and 50Ω respectively. The iron and friction losses equal 950W. Find — 10

(i) *emf.* generated

(ii) *Cu*-loss

(iii) output of the prime mover

(iv) mechanical, electrical and commercial efficiencies.

2. (a) What do you mean by back-*emf.* of a DC motor and why starter is required to start a DC motor? 5

(b) With a neat diagram, show the power stages of a DC motor and find the overall, electrical and mechanical efficiencies. 5

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

(i) copper losses

(ii) armature torque

(iii) shaft torque

(iv) efficiency.

3. (a) What is an ideal transformer and how does it differ from practical transformer? 5

(b) A transformer takes a current of 0·6A and absorbs 64 W when primary is connected to its normal supply of 200 V, 50 Hz; the secondary is open. Find the magnetising and iron loss currents. 5

(c) A 4 kVA, 200/400V, 50 Hz, 1-ϕ transformer gave the following test results — 10

No-load test : 200V, 0·7A, 60W (LV Side)

Short circuit test : 9V, 6A, 21·6W (HV Side)

Calculate —

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

(ii) the efficiency on full-load at unity p.f.

(iii) the secondary terminal voltage on full-load at p.f. 0·8 leading.

4. (a) How the speed of a three phase induction motor can be controlled? Write briefly. 5

(b) Briefly write about the star-delta starting of three phase induction motor. 5

(c) An 8-pole, $3-\phi$, 50 *Hz* induction motor running with a slip of 4% is taking 20 *kW*. Stator losses amount to 0·5 *kW*. If the mechanical torque lost in friction is 16·25 *N-m*, find *(i)* BHP, *(ii)* efficiency. 10

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

(b) Draw the equivalent circuit of a loaded alternator with a phasor diagram. 5

(c) A 1500 *kVA*, 6·6 *kV*, $3-\phi$ star-connected alternator has effective armature resistance of $0{\cdot}5\Omega/ph.$ and a synchronous reactance of $5\Omega/ph.$ Find the percentage change in terminal voltage when the rated output of 1500 *kVA* at — 10

(i) Unity power factor

(ii) 0·8 power factor lagging is switched off.

The speed and excitation current remain unchange.

6. (a) Write the operating characteristics and some important applications of universal motors. 5

(b) With a neat circuit and a phasor diagram, briefly explain the operation of split-phase induction motor. 5

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

7. (a) Explain the torque-slip characteristics of a $3-\phi$ induction motor. 5

(b) Draw the exact equivalent circuit of a loaded transformer and write the voltage equations for primary and secondary sides. 5

(c) A 40 *kVA* transformer has iron loss of 450 *W* and full-load copper loss of 850 *W*. If the power factor of the load is 0·8 lagging, calculate — 10

(i) full-load efficiency

(ii) the *kVA* load at which maximum efficiency occurs and

(iii) the maximum efficiency.
