(Set-Q_1)

B.Tech-3rd (ME/PE)

Elements of Electrical Machines

Full Marks : 70

Time : 3 hours

Answer **six** questions including **Q. No. 1**

The figures in the right-hand margin indicate marks

1. Answer the following questions : 2 × 10

(*i*) What is the function of commutator in dc generator ?

(*ii*) Which type of dc motor would be suitable for drives requiring high starting torque but only fairly constant speed ?

(*iii*) A 200 kVA transformer has iron loss of 1 kW and full load Cu-loss of 2 kW. What is its load kVA corresponding to maximum efficiency ?

(*iv*) An autotransformer with a transformation ratio of 0·8 supplies a load of 3 kW. What is the power transferred conductively from primary to secondary ?

(*v*) What is the voltage regulation of an alternator supplying 0·75 leading p.f. load at rated terminal voltage of 3000 V and having no load induced emf of 2400 V ?

(*vi*) If the field of a synchronous motor is underexcited, what will be its power factor ?

(*vii*) A 3-phase, 4-pole 50 Hz induction motor runs at a speed of 1440 r.p.m. What is the frequency of rotor current ?

(*viii*) When applied voltage per phase is reduced by one-half in an induction motor, to what factor the starting torque would be reduced ?

(*ix*) If rotor input of an induction motor running with a slip of 10% is 100 kW, what is the gross power developed by the rotor ?

(x) How the direction of rotation of a single phase induction motor can be reversed ?

2. (*a*) Explain the various operating characteristics of separately excited dc generator. 5

(*b*) Describe the voltage build-up of a dc stunt generator. 5

3. (*a*) A dc series motor drives a load, the torque of which varies as the square of the speed. The motor takes a current of 15 A when the speed is 600 r.p.m. Calculate the speed and the current when the motor field winding is shunted by a divertor of the same resistance as that of the field winding. Neglect the armature winding and series winding voltage drops. 5

(*b*) A 7·46 kW, 200 V dc shunt motor has full load efficiency of 85%. The armature resistance is 0·25 Ω. Calculate the value of

the starting resistance necessary to limit the starting current to 1·5 times the full load current at the moment of first switching on. The shunt current may be neglected. Find also the back emf of the motor, when the current falls to its full load value, assuming that the whole of the starting resistance is still in circuit. 5

4. (*a*) A 20 kVA, 50 Hz, 2000/200 V distribution transformer has leakage imedance of (0·42 + *j* 0·52) Ω in the HV winding and (0·004 + *j* 0·05) Ω in the LV winding. The shunt branch admittance referred to the LV side is (0·002 – *j* 0.015) Ω. Draw the equivalent circuit referred to (*i*) LV side, (*ii*) HV side indicating all impedances. 5

(*b*) The following data were obtained on a 20 kVA, 50 Hz, 2000/200 V transformer :

	Voltage	Current	Power
OC test with HV open circuited :	200 V	4 A	120 W
SC test with LV short circuited :	60 V	10 A	300 W

Draw the approximate equivalent circuit of the transformer referred to the HV side. 5

5. (*a*) Explain various types of 3-phase transformer connections using three single phase units with winding connections and phasor diagrams. 5

(*b*) A 2000/200 V, 20 kVA transformer is connected as a step-up auto-transformer (2000/2200 V). Calculate its kVA rating, kVA transferred inductively and conductively, its efficiency at full load 0·8 p.f. 5

6. (*a*) Derive the expression for induced emf in a 3-phase alternator. Explain the pitch factor, the distribution factor and their effects. 5

(*b*) Following test results are obtained from a 3-phase alternator. Full load current of 100 A is produced on short-circuit by a field current of 2·5 A. An e.m.f. of 500 V/phase is produced on open-circuit by the same field current. The stator resistance is 0·8 per phase.

At rated voltage of 2000 V, and rated current of 100 A, determine the voltage regulation if the load p.f. is (*i*) unity, (*ii*) 0·8 leading (*iii*) 0·7 lagging. 5

7. (*a*) Describe the principle of operation of a synchronous motor. 5

(*b*) Explain the V-curves of synchronous motor. 5

8. (*a*) A 3-phase, 4 pole, 50 Hz induction motor has rotor resistance and reactance of 0·025 Ω/phase and 0·12 Ω/phase, respectively. Make simplifying assumptions, state them and :

(*i*) Calculate the speed at maximum torque.

(*ii*) Calculate value of additional rotor resistance per phase required to give three-fourth of maximum torque at starting. 5

(*b*) A 3-phase, 400 V, 50 Hz, 6 pole induction motor while rotating has frequency of

rotor emf 2 Hz and power input to rotor is 100 kW. Calculate : 5

(*i*) the slip

(*ii*) the rotor speed

(*iii*) mechanical power developed

(*iv*) the rotor copper loss

(*v*) speed of stator field with respect to rotor.
