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No. of Printed Pages—4 **EE-402**

B. TECH.

FOURTH SEMESTER EXAMINATION, 2002-2003

ELECTRICAL MACHINES

Time : 3 Hours *Total Marks : 100*

Note : Answer **ALL** the Five questions.

1. Answer any FOUR of the following :— **(5×4=20)**

(*a*) Explain the process of voltage build-up in a d.c. shunt generator. What is the field circuit critical resistance ?

(*b*) Draw external characteristics of d.c. separately excited and shunt-excited generators and explain more drooping nature in one over other with proper reasoning.

(*c*) A 10-hp, 230 V shunt motor has an armature resistance of $0{\cdot}5\ \Omega$ and field circuit resistance of $115\ \Omega$. At no-load and rated (full) voltage the speed is 1200 r.p.m. and armature current is 2 A. If load is applied, the speed drops to 1100 r.p.m. Determine the armature current and the line current.

(*d*) Explain, with suitable diagram, the armature reaction in d.c. machines. Give methods of compensating the armature reaction.

(*e*) Which of the following three motors has the poorest speed regulation : shunt motor, series motor, or cumulative compound motor ? Explain.

(*f*) Why is the electric braking of electric motors superior to mechanical braking ? How is dynamic braking of d.c. shunt motor done ? Explain.

2. Answer any TWO parts of the following :— (10×2=20)

(a) What are the different methods of speed control of a d.c. motor ? Give advantages and disadvantages of each in brief. Why is it dangerous to uncouple the mechanical load of a d.c. series motor ?

(b) With the help of Speed-Torque characteristics, describe the operation of an electric motor in all the four-quadrants. Which of the quadrants are reserved for motoring and which are for braking ? Explain.

(c) Define voltage regulation of a transformer. The following test data were taken on 25 KVA, 2400/240 V, 50 Hz transformer with low voltage winding shorted and measurement made on h.v. side :—

$$V = 41{\cdot}5 \text{ V}, \quad I = 21{\cdot}7 \text{ A}, \quad P = 350 \text{ W}.$$

Calculate the voltage regulation of this transformer when it supplies full load at 0·8 p.f. lagging. Neglect the magnetising current.

3. Answer any FOUR parts of the following :— (5×4=20)

(a) Describe various losses in a transformer. Explain how each loss varies with load current, supply voltage and frequency.

(b) Discuss relative advantages and disadvantages of employing three, 1-phase transformers for use in 3-phase operation over employing a single unit 3-phase transformer.

(c) Show that the magnetic field produced in the air gap of a three-phase Induction motor is of rotating nature. Give the expression of this speed in terms of poles and frequency of supply.

(d) The power input to the rotor of a 400 V, 50 Hz, 6-pole, 3-phase. Induction motor is 80 KW. The rotor e.m.f. is observed to make 100 complete alternations per minute. Calculate slip, mechanical power developed and rotor copper loss.

(e) (i) Explain, why a 3-phase induction motor is self-starting motor.

(ii) The magnetising current in a transformer is 2 to 5% whereas in 3-phase induction motor, it is about 25-40% of rated current. Mention the reason.

(f) A voltage $v = 200 \sin 314\, t$ is applied to the transformer winding in a no-load test. The resulting current is found to be

$$i = 3 \sin (314\, t - 60^\circ)\,.$$

Determine the core loss and the parameters of no-load approximate equivalent circuit.

4. Answer any TWO of the following :— **(10×2=20)**

(a) By means of a power-flow diagram, show the flow of power in a 3-ph induction motor from the elecrical source to the mechanical load at the motor shaft. Based on above, show that

$$P_g : P_{cu} : P_m = 1 : s : (1 - s)$$

where P_g, P_{cu}, P_m are air gap power, rotor copper loss and mechanical power developed respectively and s is the per unit slip.

(b) Draw and explain the torque-slip characteristic of a typical 3-phase induction motor. Mark the starting torque and maximum torque and explain how the starting torque and maximum torque vary with rotor circuit resistance.

(*c*) A 3-phase squirrel cage type induction motor, when started by means of a star-delta starter, takes 200% of full-load current (line) and develops 44% of full-load torque at starting. Calculate the starting torque and current if an autotransformer with 75 per cent tapping was employed.

5. Attempt any TWO of the following :— **(10×2=20)**

(*a*) Derive the e.m.f. equation of an alternator incorporating distribution and pitch factors in it. Discuss the effects of these factors on output and performance.

(*b*) Determine the voltage regulation of a 2000 V, 1-phase alternator giving current of 100 A at 0·8 p.f. lagging. Use the test data given below :

Full-load current of 100 A is produced on short circuit by field excitation of 2·5 A; an e.m.f. of 500 V is generated on open circuit by same excitation. The armature resistance is $0{\cdot}8\,\Omega$.

(*c*) Explain effects of varying excitation on the armature current and power factor in a 3-phase synchronous motor. Draw the curves for armature current and power factor variation with excitation for two loads P_1 and P_2 with $P_1 < P_2$.