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No. of Printed Pages—5 **EE–402**

B. TECH.

FOURTH SEMESTER EXAMINATION, 2003-2004

ELECTRICAL MACHINES

Time : 3 Hours *Total Marks : 100*

Note : Attempt all the **FIVE** questions.

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

(a) Discuss the constructional features and explain various parts of a D.C. generator.

(b) A short-shunt compound generator delivers a load current of 30 A at 220 V, and has armature, series-field and shunt-field resistances of 0·05 Ω, 0·30Ω and 200 Ω respectively. Calculate the induced e.m.f. and the armature current. Allow 1·0 V per brush for contact drop.

(c) Describe external characteristics of D.C. generators.

(d) A 25-kW, 250 V, D.C. shunt generator has armature and field resistances of 0·06 Ω and 100 Ω respectively. Determine the total armature power developed when working :

(i) as a generator delivering 25 kW output, and

(ii) as a motor taking 25 kW input.

(e) A 230 V series motor is taking 50 A. Resistance of armature and series-field winding is 0·2 Ω and 0·1 Ω respectively. Calculate :

(i) brush voltage,

(ii) back e.m.f.,

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(iii) power wasted in armature, and

(iv) mechanical power developed.

(f) Describe methods to control the speed of D.C. motors.

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

(a) Describe the factors for the selection of D.C. motor for specific application.

(b) Describe the Hopkinson's test for obtaining the efficiency of two similar shunt motors.

(c) Derive the EMF equation of single-phase transformer.

The no-load current of a transformer is 4·0 A at 0·25 p.f. when supplied at 250 V, 50 Hz. The number of turns on the primary winding is 200. Calculate —

(i) flux in the core,

(ii) the core loss, and

(iii) magnetising current.

(d) Draw the equivalent circuit of single-phase transformer. Explain the tests performed to obtain the parameters of the equivalent circuit.

(e) Define voltage regulation of a transformer.

A transformer has copper loss of 1·5% and reactance-drop of 3·5% when tested at full-load. Calculate its full-load regulation at :

(i) 0·8 p.f. lagging,

(ii) 0·8 p.f. leading.

(f) A 600-kVA, single-phase transformer when working at unity power factor, has an efficiency of 92% at full-load and also at half-

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load. Determine its efficiency when it operates at unity p.f. and 60% of full-load.

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

(a) Describe Sumpner test (Back-to-Back test) and explain how losses and efficiency are determined.

A 10 kVA, 1-phase, 500/250 V transformer gave following test results :—

O.C test 250 V, 3·0 A, 200 W
S.C test 15 V, 30 A, 300 W

Calculate efficiency and regulation at full-load, 0·8 p.f. lagging.

(b) *(i)* Describe, with a neat diagram, the working principle of instrument transformer.

(ii) A 3-phase, delta/star connected 11 kV/400 V, 50 Hz transformer takes a line current of 5 amp, when secondary load of 0·8 lagging p.f. is connected. Determine each coil current and output of transformer.

(c) Explain the working principle of 3-phase induction motor. The rotor of induction motor cannot run at synchronous speed. Explain, why.

A 3-ϕ induction motor is wound for 4 poles and is supplied from 50 Hz system. Calculate :

(i) synchronous speed,

(ii) rotor speed when slip is 4%, and

(iii) rotor frequency when rotor runs at 600 rpm.

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

(*a*) Derive torque, mechanical power and rotor output equations of a three-phase induction motor connected from A.C. mains.

A 400 V, 4-pole, 3-phase, 50 Hz induction motor has a rotor resistance and reactance per phase of 0·01 Ω and 0·1 Ω respectively. Determine :

(*i*) maximum torque in N-m and the corresponding slip,

(*ii*) the full-load slip and power output in watts, if maximum torque is twice the full-load torque and the ratio of stator to rotor turns is 4.

(*b*) Why are starters needed to start the induction motors ? Explain various starters used for cage and wound rotor type induction motors.

(*c*) Describe the methods to control the speed of induction motors.

The rotor of a 4-pole, 50 Hz, slip ring induction motor has a resistance of 0·25 Ω per phase and runs at 1440 rpm at full-load. Calculate the external resistance per phase, which must be added to lower the speed to 1200 rpm, the torque being same as before.

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

(*a*) Draw the neat diagram of synchronous alternator and derive the EMF equation.

The effective resistance of a 2200 V, 440 kVA, 1-phase, alternator is 0·5 ohm. On short-circuit, a field current of 40 A gives the full-

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load current of 200 A. The emf on open circuit with same field excitation is 1160 V. Calculate synchronous impedance and reactance.

(b) Explain Potier method to determine voltage regulation of an alternator.

A 20 kVA, 220 V, 50 Hz, star-connected, 3-phase salient pole synchronous generator supplies load at a lagging power factor angle 45°. The constants of generators are $X_d = 4{\cdot}0\ \Omega$ and $X_q = 2{\cdot}0\ \Omega$, $R_a = 0{\cdot}5\ \Omega$. Calculate power angle and voltage regulation under the given load conditions.

(c) Explain the following :—

(i) Synchronizing of alternators

(ii) V-curve of synchronous motor

(iii) Armature reaction in alternator