This question paper contains 5 printed pages.

3335 *Your Roll No.* .....

B. Tech. (EEC) / I **J**

Paper V— POWER APPARATUS
(EEC–105)

Time : 3 hours *Maximum Marks* : 70

(Write your Roll No. on the top immediately on receipt of this question paper.)

Q. No. 1 is compulsory. Answer any four from the remaining.

All questions carry equal marks.

1. (*a*) Large rating transformers have higher efficiencies. Why?

   (*b*) In construction of transformers, why are low voltage windings placed near the magnetic core?

   (*c*) What transformer parameters are determined by the short circuit test? Sketch the approximate equivalent circuit under short circuit condition.

   (*d*) Explain, why the current in the primary of a transformer increases when a load is placed across the secondary winding.

   (*e*) State two reasons for skewing rotor slots in a squirrel cage induction motor.

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(*f*) A 50 Hz, 4 pole, 415 V, 3 phase induction motor operating at rated conditions has a speed of 1440 rpm. What is the frequency of rotor induced emf?

(*g*) Write two functions of damper winding in a synchronous motor. 2×7

2. (*a*) Draw approximate equivalent circuits of a transformer referred to primary and secondary windings and express the impedances, voltages and currents for the respective winding sides. 7

(*b*) Determine the parameters of the approximate equivalent circuit referred to the high voltage (HV) side of a 100 kVA, 4400/220 V, 50 Hz transformer whose O.C. and S.C. test results are given as:

O.C. Test : When 4400 V is supplied to the HV side with the low voltage winding kept open, the input power and current are 1010 W and 0·5 A respectively.

S.C. Test : When 353 V is supplied to the HV side with low voltage side short-circuited, the primary draws full load current and absorbs a power of 2100 W. 7

3. (*a*) Define efficiency of a transformer under any operating condition and derive condition for the maximum efficiency for constant values of the terminal voltage and load power factor angle. 7

(*b*) A 300 kVA transformer has a core-loss of 1·5 kW and a full load copper loss of 4·5 kW.

(*i*) Calculate its efficiency at half as well as full load at unity power factor.

(*ii*) Determine the load for which efficiency is maximum and calculate the corresponding efficiency at unity power factor. 7

4. (*a*) What are two different types of synchronous machines? Write necessary expressions and sketch power-angle characteristics for both types. 7

(*b*) The stator of a 3 phase alternator has nine slots per pole and carries a balanced three-phase double layer winding. The coils are short pitched and the coil pitch is 7/9, that is each coil spans seven slots. Determine the winding factor. 7

5. (*a*) Why is a synchronous motor not self starting? State how a synchronous motor is started. 7

(*b*) Draw an approximate equivalent circuit of a 3-phase induction motor and determine expressions for slip at which the maximum torque occurs and value of the maximum torque. Sketch the torque-speed curves for a wound-rotor induction motor and show the effect of increasing rotor resistance on the torque-speed characteristic of this motor. 7

6. (*a*) A 3 phase, 415 V, 50 Hz, four pole, Y-connected induction motor operating at full load runs at 1425 rpm. The rotor resistance and reactance per

phase are 0·4 Ω and 4 Ω, respectively, and the effective rotor-stator turns ratio is 0·8 : 1.

Calculate:

(*i*) the full load torque

(*ii*) the power output, if mechanical losses are 480 W

(*iii*) the maximum torque

(*iv*) the speed at which maximum torque occurs

(*v*) torque at starting. 7

(*b*) With help of neat torque-speed characteristics differentiate the operation/performance of single-phase, split phase, capacitor start and run, capacitor start motor, two capacitor motor and shaded pole motors. 7

7. (*a*) What is an universal motor? Discuss its torque-speed, efficiency and power factor characteristics for AC and DC operations. 7

(*b*) A 220 V, 50 Hz, 4-pole, single phase induction motor has the following equivalent circuit parameters at stand-still:

$R_1 = 2\ \Omega$, $R_2 = 4\ \Omega$, $X_1 = 2{\cdot}6\ \Omega$, $X_2 = 2{\cdot}0\ \Omega$, $X_m = 70\ \Omega$.

(*i*) Draw equivalent circuit of the motor when it is running at a speed of 1425 rpm.

(*ii*) What are the frequencies of the rotor currents induced by the forward field and the backward field? 7

8. Write short notes on any *two* of the following:

(*i*) Double revolving field theory

(*ii*) Two phase AC servomotor

(*iii*) Stepper motor

(*iv*) Static Kramer System. 2×7