D 30898 (Pages : 3) Name.....

Reg. No.....

THIRD SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION OCTOBER 2012

Mechanical Engineering

AN/ME/AM 305/PTME 09 304—ELECTRICAL TECHNOLOGY

(2009 admissions)

Time : Three Hours Maximum : 70 Marks

Part A

Answer all *questions.*

1. Write the speed equation of a d.c. machine.
2. Explain Sumpner's test for testing two single phase transformer. Also explain why is it beneficial for finding efficiency of transformers.
3. Why PMMC ammeters are the most widely used instrument ?
4. Draw an appropriate equivalent circuit of an induction motor.
5. Mention the basic types of electrical drives.

(5 × 2 = 10 marks)

Part B

Answer any four *questions.*

6. Derive the E.M.F. equation of a d.c. generator.
7. A D.C. series motor rated 250 V, 20 A runs at 750 r.p.m. at full load. It has 4 poles and 500 conductors. The flux per pole is given by equation $\phi = 0.05\sqrt{I}$. Where I is the field current in amperes and ϕ is in webers. If the motor current is reduced to 15 A. Find the new speed and the reduction in torque developed. Assume a total resistance of 1.0 ohm.
8. A single phase transformer rated 570 watts has an efficiency of 95% when working at full load and half full load, both at unity power factor. Calculate its efficiency at 75% of full load.
9. Explain the various starting methods of squirrel-cage induction motor.
10. A three-phase 250 kVA, 3300 V, star-connected alternator has a stator resistance of 0.05 ohm per phase and a synchronous reactance of 10 ohms per phase. Find the regulation at full load at 0.8 p.f. lagging.
11. Explain the methods of breaking used in induction motor.

(4 × 5 = 20 marks)

Turn over

Part C

Answer **all** *questions.*

12. (A) (i) Explain clearly the effect of the back e.m.f. of a shunt motor. What precautions must be taken when starting a shunt motor ?

(4 marks)

(ii) A four-pole d.c. motor is connected to a 500 V d.c. supply and takes an armature current of 80 A. The resistance of the armature circuit is 0.4 Ω. The armature is wave-wound with 522 conductors and the useful flux per pole is 0.025 Wb. Calculate (a) the back e.m.f. of the motor ; (b) the speed of the motor ; (c) the torque in N-m developed by the armature.

(6 marks)

Or

(B) (i) Draw a labelled diagram of the cross-section of a four-pole d.c. shunt-connected generator. What are the essential functions of the field coils, armature, commutator and brushes ?

(5 marks)

(ii) The e.m.f. generated by a four-pole d.c. generator is 400 V. When the armature is driven at 1000 r.p.m. Calculate the flux per pole, if the wave-wound armature has 39 slots with 16 conductors per slot.

(5 marks)

13. (A) (i) Derive the expression of condition for maximum efficiency of a transformer.

(5 marks)

(ii) The working coil of a (0 – 400 V) moving-iron voltmeter requires 300 ampere turns to give full scale deflection. The added resistance is to be three times the coil resistance. Find the diameter of the wire for the coil if the wire be of copper having a resistivity of $1.7 \times 10^{-6}\ \Omega$ cm ; the mean length of 1 turn = 13.5 cm.

Or

(B) (i) Explain the principle of operation of single phase transformer. (6 marks)

(ii) A 15 V moving-iron voltmeter has a resistance of 300 Ω and an inductance of 0.12 H. Assume that the voltmeter reads correctly on d.c. What will be the percentage error when the instrument is placed on 15 V a.c. supply at 100 Hz ?

(4 marks)

14. (A) (i) Explain why an induction motor cannot develop torque when running at synchronous speed. Define the slip speed of an induction motor and deduce how the frequency of rotor currents and the magnitude of the rotor e.m.f. are related to slip.

An induction motor has four poles and is energized from a 50 Hz supply. If the machine runs on full load at 2% slip, determine the running speed and the frequency of the rotor currents.

(5 marks)

(ii) Give a clear explanation of the following effects in a three-phase induction motor : (a) the production of the rotating field ; (b) the presence of an induced rotor current ; (c) the development of the torque.

(5 marks)

Or

(B) (i) A 3-phase delta-connected alternator is excited to give 6600 V between line on no load. Its resistance is 0.5 ohm and synchronous reactance 5 ohms per phase. Determine the terminal voltage and regulation when it is delivering a line current of 200 A at (a) 0.8 p.f. lag ; (b) 0.6 p.f. lead.

(5 marks)

(ii) A 4-pole, 3-phase 60 Hz connected alternator has a total number of conductors equal to 1080. The winding is full pitched and the flux per pole is 0.44 Wb. Find the synchronous speed and the induced e.m.f. Assume a distribution factor of 0.959.

(5 marks)

15. (A) (i) List out the advantage of V/f control as applied to a synchronous motor. (3 marks)

(ii) A three-phase 400 V, 1480 r.p.m., 50 Hz four-pole, star-connected induction motor has the following data : $R_s = 0.4\ \Omega$, $R_r = 0.20\ \Omega$, $X_s = 0.85\ \Omega$, $X_r = 0.95\ \Omega$ and $X_m = 29\ \Omega$ all parameters being referred to the stator. Using frequency control the frequency is increased to 55 Hz. Determine the (a) speed at breakdown torque (b) value of break down torque ; and (c) stator and rotor copper losses for a slip of 0.02.

(7 marks)

Or

(B) (i) Describe a scheme that provides four-quadrant operation of a separately excited d.c. motor using d.c. choppers.

(4 marks)

(ii) Derive expressions for I_{max}, I_{min} and p_{reg} for the regenerative mode of operation of separately excited d.c. motor supplied by a chopper circuit.

(6 marks)

[4 × 10 = 40 marks]