LIB 13-1.16 AN

Reg. No. : [ ]

Question Paper Code : 21501

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Fourth Semester

Electrical and Electronics Engineering

EE 2251/EE 1251 A/080280003/EE 42/10133 EE 402 – ELECTRICAL MACHINES – I

(Regulations 2008/2010)

(Common to PTEE 2251/10133 EE 402 – Electrical Machines – I for B.E. (Part-Time) Third Semester – Electrical and Electronics Engineering – Regulations 2009/2010)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Name the main magnetic quantities with their symbols having the following units : Webers, Telsa, AT/Wb, H/m.

2. How will you minimize hysteresis and eddy current losses?

3. What are the no load losses in a two winding transformer and state the reasons for such losses.

4. Mention the conditions to be satisfied for parallel operation of two winding transformers.

5. What do you mean by coenergy?

6. What are the requirements of the excitation systems?

7. What is the difference between lap winding and wave winding of a DC machine armature?

8. Why does synchronous machine not produce torque at any other speed?

9. Draw the circuit model of dc shunt motor.

10. What is the function of no-volt release in a three-point starter?

PART B — (5 × 16 = 80 marks)

11. (a) Explain the statically and dynamically induced EMF. (16)

Or

(b) (i) Discuss AC operation of magnetic circuits (10)

(ii) A single phase, 50Hz, 100KVA transformer for 12000/240V ratio has a maximum flux density of 1.2 Wb/m^2 and an effective core section of 300 cm^2, the magnetising current (RMS) is 0.2A. Estimate the inductance of each wire on open circuit. (6)

12. (a) (i) Describe the construction and principle of operation of single phase transformer. (8)

(ii) Derive an expression for maximum efficiency of a transformer. (8)

Or

(b) A 500 kVA transformer has 95% efficiency at full load and also at 60% of full load both at upf.

(i) Separate out the transformer losses. (8)

(ii) Determine the transformer efficiency at 75% full load, upf. (8)

13. (a) (i) Show that the torque developed in doubly excited magnetic system is equal to the rate of increase of field energy with respect to displacement at constant current. (8)

(ii) The $\lambda - i$ characteristics of singly excited electromagnet is given by $i = 121\lambda^2 x^2$ for $0 < i < 4A$ and $0 < x < 10\,\text{cm}$. If the air gap is 5 cm and a current of 3A is flowing in the coil, calculate

(1) Field energy

(2) Co-energy

(3) Mechanical force on the moving part. (8)

Or

(b) Discuss in detail the production of mechanical force for an attracted armature relay excited by an electric source. (16)

14. (a) (i) Show the arrangement of a distributed stator winding with appropriate number of conductors in the slots designed to produce a sinusoidally varying air gap flux density. (6)

(ii) Prove that a three phase set of currents, each of equal magnitude and differing in space by 120° applied to a three phase winding spaced 120 electrical degrees apart around the surface of the machine will produce a rotating magnetic field of constant magnitude. (10)

Or

(b) (i) A D.C. machine has 'P' number of poles with curved pole faces having 'Z' number of conductors around the rotor armature of radius 'r' and the flux per pole is given as, φ . The rotor rotates at a speed of 'n' rpm. Obtain the induced e.m.f. of the D.C. machine assuming a number of parallel paths. (8)

(ii) A 12 pole D.C. generator has a simplex wave wound armature containing 144 coils of 10 turns each. The resistance of each turn is 0.011Ω. Its flux per pole is 0.05 Wb and it is running at a speed of 200 rpm. Obtain the induced armature voltage and the effective armature resistance. (8)

15. (a) (i) A 220 V dc generator supplies 4 kW at a terminal voltage of 220 V. The armature resistance being 0.4 Ω. If the machine is now operated as a motor at the same terminal voltage with the same armature current, calculate the ratio of generator speed to motor speed. Assume that the flux/pole is made to increase by 10% as the operation is changed over from generator to motor. (6)

(ii) A 220 V, 7.5 kW series motor is mechanically coupled to a fan. When running at 400 rpm the motor draws 30 A from the mains (220 V). The torque required by the fan is proportional to the square of speed. $R_a = 0.6\ \Omega$, $R_{se} = 0.4\ \Omega$. Neglect armature reaction and rotational loss. Also assume the magnetization characteristic of the motor to be linear.

(1) Determine the power delivered to the fan and torque developed by the motor. (5)

(2) Calculate the external resistance to be added in series to the armature circuit to reduce the fan speed to 200 rpm. (5)

Or

(b) A 250-V dc shunt motor has $R_f = 150\Omega$ and $R_a = 0.6\Omega$. The motor operates on no-load with a full field flux at its base speed of 1000 rpm with $I_a = 5$ A. If the machine drives a load requiring a torque of 100 Nm, calculate armature current and speed of motor. If the motor is required to develop 10 kW at 1200 rpm, what is the required value of the external series resistance in the field circuit? Assume linear magnetization. Neglect saturation and armature reaction. (16)