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Ex/BESUS/ EE-401/06

B.E. (EE) Part-II 4th Semester Examination, 2006

Electrical Machines-I

(EE-401)

Time : 3 hours Full Marks : 100

Use separate answerscript for each half.
Answer SIX questions, taking THREE from each half.
Two marks are reserved for neatness in each half.

FIRST HALF

Justify the validity of the following statements with reasons :

a) In d.c. machines, air-gap length at pole centre is short as compared to air-gap lengths at pole tips.

b) Under saturated conditions, the effect of armature m.m.f. is to demagnetize the main field.

c) The field winding of a d.c. series machine is wound with fewer turns of thick wire whereas that of d.c. shunt machine is wound with a large number of turns of fine wire.

d) A differential compound d.c. motor may start up in the direction opposite to that for which it is designed.

e) D.C. shunt generators often fail to build up after they have been shunt down through a severe type of short circuit. [3+3+4+3+3]

2. a) A 220 V, 500 A, 600 r.p.m. separately excited motor has armature and field resistance of 0.02 Q and 10 Q respectively. The load torque is given by the expression $T_L = 2000 - 2\,n$, N-m, where n is the speed in r.p.m. Speeds below the rated are obtained by armature voltage control and speeds above the rated are obtained by field control, i) Calculate the motor terminal voltage and the armature current when the speed is 450 r.p.m. ii) Calculate the field winding voltage and the armature current when the speed is 750 r.p.m.

b) Draw the external characteristics of various types of d.c. generators in one figure on the assumption of same rated terminal voltage and the same rated load current. Why does the external characteristic of a d.c. shunt generator turn back as the generator is overloaded?

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c) With the help of sketches discuss the advantages of four-point starter over the three-point starter for a d.c. shunt motor. [(3+3)+(3+2)+5|

3. a) Explain the nature of speed-torque and torque-current characteristics of a d.c. shunt and a d.c. series motor considering the effect of saturation and armature reaction.

b) "In a d.c. machine, the area of pole shoe is kept more than that of pole core" - Justify.

c) A lOkW, 6 pole d.c. generator develops an e.m.f of 200 V at 1500r.p.m. The armature has a lap connected winding. The average flux density over a pole pitch is 0.9 Tesla. The length and diameter of the armature are 0.25 m and 0.2 m respectively. Calculate (i) the flux per pole; (ii) the total number of active conductors in the armature and (iii) the torque developed by the machine when the armature supplies a current of 50 A.

d) State the advantages of using short-pitched and distributed winding in alternator. What is the value of distribution factor for a uniformly distributed three-phase winding? [4+2+6+(3+l)|

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4. a) A d.c. shunt motor is connected to a three-point starter. Explain what would happen if (i) the starter handle is moved rapidly from "OFF" to "ON" position; (ii) the field excitation is minimum at the time of starting.

b) Explain the various possible causes of failure of voltage build-up process in a d.c. shunt generator.

c) A d.c. shunt machine connected to 230 V supply has resistance of armature as 0.115 *Q* and of field winding as 115 Q. Find the ratio of the speed as a generator to the speed as a motor with the line current in each case being 100 A.

d) A three-phase, 50Hz, 2-pole, star-connected alternator has 54 slots with 4 conductors per slot. The pitch of the coils is 2 slots less than the pole pitch. If the machine gives 3300V between lines on open circuit with sinusoidal flux distribution, determine the useful flux per pole. |(2+2)+3+4+5]

5. a) For a certain relay, the magnetisation curves for open and closed positions of the armature are linear. If the armature of the relay moves from open to closed position at constant current very slowly, show that the mechanical work done is equal to the field energy stored and is half of the electrical energy input.

b) Prove that energy and co-energy in a linear magnetic system are given by identical expressions.

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c) For a doubly-excited magnetic field system, various inductances are :

$L_n = (4 + \cos 2e)$ mH

$L_{12} = 0.15 \cos 9$ H and

$L_{22} = (20 + 5 \cos 26)$ H.

Find the torque developed if ij = 1A and $i_2 = 0.02$A. Also explain the significance of each term in torque.

d) "Ward-Leonard method of speed control can be used for wide-range and smooth speed control of a d.c. motor" - Explain with the help of relevant diagram. [5+2+4+51

SECOND HALF

6. a) Why transformers require a magnetic core? Why is it laminated?

b) Explain how core loss in a transformer is represented in electrical equivalent circuit.

c) Why is it necessary to refer electrical quantities of secondary winding in terms of primary or viceversa? What is the significance of the exercise.

d) In a single phase transformer zero voltage regulation occurs at pf of 0.94 leading whereas its maximum possible voltage regulation is 4%. Find its voltage regulation at 0.8 pf lagging. If its ohmic losses are 136.5 W, find kVA of the transformer. [(2+l)+3+(2+l)+(5+2)|

7. a) Draw relevant curves to show how iron loss and ohmic loss in a transformer varies with load when it is operated from a constant voltage, constant frequency supply. Indicate on it where maximum efficiency takes place.

b) Name the test to determine the iron loss of a transformer at rated voltage, rated freq. condition. Describe how will you separate the ironloss components experimentally.

c) Without the help of equivalent circuit explain why a small voltage is required to drive rated current through transformer windings under short circuit condition.

d) Three 25 kVA, 34500/277 V distribution transformers connected in delta-star gave the following test results

OC test (LV side)	480 V	4.11 A	945 W
SC test (HV side)	2010V	1.26A	912W

Find the pu equivalent circuit of this transformer bank. |(l+l)+(l+3)+3+7]

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8. a) Can third harmonic voltage exist across the lines of a delta connected winding of transformer?

   b) In a Yy_0, 11000/433 V, 3ph transformer the polarities of phase B winding gets reversed. Find the magnitude of the output voltage with appropriate phasor diagram. Assume RYB to be the phase sequence of the supply.

   c) Explain how three phase, three wire star-star connected transformer with independent magnetic circuit will behave when a single phase load is applied.

   d) A three phase step down transformer is energised from 11 kV, 50Hz source. If it takes a line current of 20 A from the supply mains, then calculate the output voltage, output current and output kVA if the transformer connection is (i) star/delta, (ii) delta/delta. I2+4+4+(3+3))

9. a) State the conditions for successful parallel operation of two three phase transformers.

   b) How a Dyl 1 transformer can be operated in parallel with a Ydl transformer. Give connection diagram.

   c) Two 11/3.3kV, 3 phase 500kVa and 750kVA transformers have their respective leakage impedances of (1.2+j4.6)% and (1.4+j4.5)%

      i) If no transformer is to be overloaded, calculate the maximum kVA load that can be supplied by these two transformers in parallel.

      ii) If the total load on the transformers is 1200kVA at 0.8 pf lagging, then calculate the load voltage with primary voltage at 11 kV. [4+5+(4+3)]

10. a) What are the information that can be discerned from the equation of a field distribution given by b = B_{max} Sin cot Cos 6, the symbols having usual significance. Sketch this field.

    b) Show that a balanced three phase transformer excited by balanced three phase supply can not produce a rotating field.

    c) A 2 pole, non-salient pole synchronous machine has full pitched winding with 3 slots/pole. If each coil has 50 turns and 10 amp d.c. is the conductor current, then sketch the mmf waveform and indicate on it the peak values. Also draw the approximate mmf waveform. |4+4+(4+2+2)]

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