B.E.(EE) Part-II 3rd Semester Examintion, December 2012

Electrical Machines-I
(EE303)

Time: 3 hours Full Marks: 70

Answer any SIX questions taking THREE from each half.
TWO marks are reserved for neatness in each half.

FIRST HALF

1. Justify the following with proper reasoning:
   (a) For stable no-load operation, OCC of a d.c machine should be non-linear.
   (b) Air gap is longer at pole tips than at the centre of a pole in d.c. machines.
   (c) Mica is ideally suitable as separator between the commutator segments of a d.c. machine. (3+4+4)

2. (a) A self excited d.c. shunt generator fails to build-up in a trial run. State and explain the probable reasons.
   (b) A short shunt type d.c. compound generator delivers 100A to a load at a voltage of 250 volt. The armature, series field and shunt field resistances of the machine are: 0.1 Ω, 0.1 Ω and 130 Ω respectively. Calculate the generated EMF considering brush contact resistance drop of 1 Volt per brush. Neglect armature reaction. (5+6)

3. (a) Draw the load characteristic of a d.c. shunt generator and explain why the characteristic becomes un-stable when the loading limit is exceeded?
   (b) A belt driven d.c. shunt generator was running at 1500 rpm delivering 10 kW to a 220 V bus bar. The belt snaps, following which, the machine starts running as a motor, drawing 2 kW from the bus bar. What will be the speed of rotation as motor? The armature and series field resistances of the machine are 0.25Ω and 55Ω respectively. (5+6)

4. (a) Derive the torque vs. speed relationship for a d.c. series motor and plot the same. Explain how this characteristic will be modified due to saturation of the field and armature reaction.
   (b) A 440 volt d.c. series motor has a speed regulating rheostat "R" placed in series with the armature circuit. The combined armature and series field resistance is 0.3Ω. At a certain load, the motor draws a current of 20 A when running at 1200 rpm with $R = 0\Omega$. In another loading condition the motor draws 15 A when R is 3Ω. Determine the ratio of the power outputs of the motor in the two cases. Assume that the flux at 15 A is 80% of the flux at 20 A. (5+6)

5. (a) Describe the Ward-Leonard method of speed control for d.c motors and discuss its advantages and disadvantages.
   (b) Draw the internal circuit diagram of a 3-point starter and highlight its main features. (5+6)

SECOND HALF

6. Justify the validity of the following statements with reasons:
   - (a) In an open-delta bank of two transformers, one transformer will handle the entire load if the power factor of the load is 0.5.
   - (b) The equivalent circuit parameters of transformer in per unit system are same on both sides when they are expressed in terms of their own base.
   - (c) Distribution transformers are judged by energy-efficiency and not by power efficiency.
   - (d) In Sumpner's test, the frequency of voltage injected in the secondary circuit may not be equal to the rated frequency.
   - (e) Five limb core construction has an advantage over the three limb core construction. (2+2+2+2+3)

7. (a) How is magnetic leakage reduced to a minimum in transformers?
   - (b) Draw the phasor diagram of a single-phase transformer supplying a leading power factor load.
   - (c) Open-circuit and short-circuit tests on a 5 kVA, 220/400 V, 50 Hz, single-phase transformer gave the following results:
     O.C. test: 220V, 2A, 100W (l.v. side)
     S.C. test: 40V, 11.4 A, 200W (h.v. side)
     Compute the equivalent circuit parameters referred to h.v. and l.v. sides of the transformer. Also determine the efficiency and approximate regulation of the transformer at full load 0.9 power factor lagging. (3+2+(3+3))

8. (a) Define voltage regulation of a transformer. How does it depend on power factor of the load? Derive an expression for computing the per-unit voltage regulation of a transformer for lagging power factor load.
   - (b) Why is the direction of winding in the central limb of three phase shell type transformer reversed?
   - (c) The maximum efficiency of a three-phase 11000/400V, 500 kVA transformer is 98.8% and occurs at 80% full load, unity power factor. Its percentage impedance is 4.5%. Load power factor is now varied while the load current and the supply voltage are held constant at their rated values. Determine the load power factor at which the secondary terminal voltage is minimum and find the value of the latter. (5+2+4)

9. (a) Why is the short-circuit test usually performed on the h.v. side of a transformer? Why is the core loss almost negligible in this test?
   - (b) Two single-phase furnaces A and B are supplied at 100 V by means of Scott-connected transformers from a three-phase, 6 kV system. Furnace A is supplied from the teaser transformer. Calculate the line currents on the three phase side when furnace A takes 500 kW at unity power factor and furnace B 600 kW at 0.8 pf (lag).
   - (c) Draw the connection diagrams and phasor diagrams of the following transformer connections: Yz11 and Dz6
   - (d) Two single-phase transformers A and B of identical voltage and turn ratio operate in parallel. If the impedances of the two transformers are equal while resistance / reactance ratio of A is higher than that of B, what would be the magnitudes of IA and IB and their phase positions? (3+3+3+2)

10. (a) What are the conditions for satisfactory parallel operation of single-phase transformers?
    - (b) A 5 kV, 25 Hz single-phase transformer has copper, eddy current and hysteresis losses of 1.5, 0.5 and 0.6 percent of output on full load. What will be the percentage losses if the transformer is used on a 10 kV, 50 Hz system keeping the full load current constant? Compare the full-load efficiencies for the two cases.
    - (c) With reference to transformer and rotating electrical machines indicate the different ways by which a voltage can be induced.
    - (d) A 500 kVA transformer with 0.01 pu resistance and 0.05 pu reactance is connected in parallel with a 250 kVA transformer with 0.015 pu resistance and 0.04 pu reactance. The secondary voltage of each transformer is 400V on no load. Find how they share a load of 750 kVA at power factor 0.8 lagging. (2+3+3+3)