B.E.(EE) Part-II 3rd Semester Examintion, December 2011

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) Pole shoes in a d.c. machine must be laminated.
   (b) Brushes in a d.c. machine should be made of carbon.
   (c) Mica separators in the commutator of d.c. machine should have slight under-cut. (3+4+4)

2. (a) A self-excited d.c. shunt generator fails to build-up in its first trial run. Explain what could be the possible reasons for the failure.
   (b) A 4-pole d.c. generator has 1200 lap connected armature and generates 250 volt on open circuit when running at 500 rpm. The diameter of the pole-shoe circle is 0.35 meter, ratio of pole arc to pole pitch is 0.7 and axial length of the pole shoe is 0.2 meter. Find the average flux density in the air-gap. (5+6)

3. (a) Sketch and explain the external characteristic of a d.c. series generator and mention, which part of the characteristic is stable and why?
   (b) A separately excited d.c. generator, when running at 1200 rpm supplies 200 amp at 125 volt to a load having constant resistance. What will be the current supplied to the load, when the speed is dropped to 1000 rpm and the field excitation is reduced to 80%. Armature resistance is 0.04 and total brush drop is 2 volt. Assume un-saturated field. (5+6)

4. (a) Derive and sketch the speed-torque characteristic for a d.c. series motor and explain how this characteristic will be modified due to saturation of the field and due to armature reaction.
   (b) A 250 volt d.c. shunt motor runs at a speed of 1000 rpm at no-load drawing a line current of 5 amp. The armature and shunt field resistances are 0.2Ω and 250Ω respectively. Calculate the speed at which the motor will run, when loaded, drawing a current of 50 amp from the supply. Assume that armature reaction weakens the field by 3% at this load. (5+6)

5. (a) Describe the Ward-Leonard setup for speed control of d.c motors and explain how this method can be used for all the four quadrants of drives operation.
   (b) Explain with diagram, why a 4-point starter should be preferred to a 3-point starter for starting a variable speed d.c shunt motor drive that employs field control? (5+6)

SECOND HALF

6. Justify with reasons whether the following statements are correct or not:
   (a) Three-phase three-limb core type star-star connected transformer cannot supply unbalanced loads between line and neutral.
   (b) Eddy current loss of a transformer does not depend on the applied voltage.
   (c) In Sumpners test, the frequency of voltage injected in the secondary circuit may not be equal to the rated frequency.

(d) It is possible to operate a Dy1 transformer in parallel with Yd11 transformer.

(e) Distribution transformers are judged by energy-efficiency and not by power-efficiency. (3+2+2+2+2)

7. (a) Explain the purpose of using conservator and breather in a transformer.

(b) Why is the direction of winding in the central limb of three phase shell type transformer reversed?

(c) Why is an open-circuit test usually performed at rated voltage on the l.v. side of a transformer? Why is the copper loss almost negligible in this test?

(d) Two single-phase furnaces A and B are supplied at 220V by means of Scott-connected transformers from a 3-phase, 11 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 0.866 power factor lagging and furnace B 600 kW at 0.8 power factor lagging. Draw the phasor diagram. (3+2+3+3)

8. (a) Draw the connection diagrams and phasor diagrams of the following transformer connections: Dz6 and Yz1

(b) 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.

(c) Short circuit test is conducted on a 5 kVA, 400/100V, single phase transformer with 100 V winding shorted. The input voltage at full load current is 40 V. The wattmeter on the input side reads 250 W. Find the power factor for which regulation at full load is zero. (3+5+3)

9. (a) Is the efficiency of a transformer same at the same load at 0.8 pf lag and 0.8 pf lead? Explain.

(b) Why oil is used in transformer? Give a few desirable properties of transformer oil.

(c) Two transformers A and B are connected in parallel and supply 800 V. Both transformers have no-load voltage ratio of 800/400 V. Transformer A is rated at 100 kVA, its total resistance and reactance being 2% and 3% respectively. The rating of transformer B is 150 kVA, its total resistance and reactance being 1% and 4% respectively. Determine the load on each transformer and secondary voltage for a load of 250 kVA at 0.8 power factor lagging.

(d) Find the all-day efficiency of a transformer having maximum efficiency of 98.5% at 20 kVA at unity power factor and loaded as follows:
11 hrs : 5 kW at a p.f. of 0.7 lag,
6hrs : 8 kW at a p.f. of 0.8 lag,
7 hrs : no-load
The maximum efficiency of the transformer occurs at 80% of full-load. (2+3+3+3)

10. (a) 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?

(b) Show that a single pulsating field can be resolved into two rotating fields. Identify the features of the rotating fields.

(c) Show that a three-phase distributed winding excited by balanced three-phase currents will produce a sinusoidally distributed rotating field of constant amplitude when the phase windings are wound 120 electrical degrees apart in space.

(d) Two transformers connected in open-delta supply a balanced three-phase load of 240 kW at 400V and a p.f. of 0.866 (lag). Determine the power delivered by each transformer. Draw the phasor diagram. (2+3+3+3)