Roll No.:.....

National Institute of Technology, Delhi

Name of the Examination: B. Tech.

Branch	: Electrical & Electronics Engg.	Semester	: IV
Title of the Course	: Electrical Machines-I	Course Code	: EEB251

Time: 3 Hours | Maximum Marks: 50

SECTION-A (10 Marks)

Note: All parts of this question are compulsory and carry two marks each.

Q1. It is compulsory to attempt all parts of this question at one place.

i. Explain the phenomenon of torque production in a dc motor through concept of interaction of magnetic fields. Also show that no electromagnetic torque is produced if stator has two poles and rotor has four poles.

ii. Show that the emf generated in a short pitched coil is reduced by a factor $cos(\varepsilon/2)$ where 'ε' is the chording angle.

iii. Explain Armature Reaction with suitable phasor diagram. Elaborate its effect on the performance of dc machine and on the commutation process. Also list the methods used for limiting the effects of armature reaction.

iv. Explain the possible reasons for the failure of voltage build up in a self excited dc generator. How each reason can be trouble-shooted?

v. Why parallel operation of transformer is desired? Which necessary conditions need to be satisfied for proper parallel operation of transformers?

SECTION-B (20 Marks)

Note: Attempt any four questions, each question carries 5 marks.

Q2. When a 20 kVA, 3300/220 V, 50 Hz transformer is operated on rated voltage at no load, its power input is 160 watts at a power factor of 0.15. Under rated load conditions, the voltage drop in the total resistance and total leakage reactance are 1and 3 percentage of rated load respectively. Determine input power and power factor when the transformer delivers 14.96 kW at 220 V at 0.8 pf lagging to a load on the LV side.

Q3. What are the different possible methods for speed control of dc motors? Derive the expression of speed in terms of other parameters controlling it and draw characteristics for each case. Also explain Ward-Leonard method for speed control of a dc motor with neat diagram.

Q4. A dc shunt motor is running at 1500 rpm at rated load torque. Discuss what would happen to the motor operation, if the following changes are made:

(a) Field terminals are reversed.
(b) Supply wires are reversed.
(c) Brushes are shifted against the direction of rotation.
(d) Brushes are shifted in the direction of rotation.
(e) Some of the field turns are short circuited.

Q5. A 220 V unsaturated shunt motor has an armature resistance (including brushes and interpoles) of 0.04 W and a field resistance of 100 W. (a) Find the value of resistance to be added to the field circuit to increase the speed from 1,200 to 1,600 rpm, when the supply current is 200 A; (b) with the field resistance as in (a), find the speed when the supply current is 120 A. If the machine is run as a generator to give 200 A at 220 V, find (c) the field current at 1,300 rpm, and (d) the speed when the field current is 2 A.

Q6. A 25 KW, 125 V separately excited dc machine is operated at a constant speed of 3000 revolutions/min with a constant field current such that open circuit armature voltage is 125 V and armature resistance is 0.02 ohms.

(a) Compute the armature current, terminal power, electromagnetic power and electromagnetic torque when the terminal voltage is (i) 128 V and (ii) 124 V.

(b) If the machine is operating as a motor with terminal voltage of 123 V and with terminal power of 21.9 kW, calculate the speed of the motor.

SECTION-C (20 Marks)

Note: Attempt any two questions, each question carries 10 marks.

Q7. A 250 V, 1500 rpm dc machine has an armature resistance (including brushes) of 0.2 ohms and a brush drop under load of 2 V. The rotational losses for a speed of 1500 rpm and for an armature generated voltage of 250 V are 600 watts. Neglect field circuit losses.

(a) For an armature current of 30 Amps and an armature generated voltage of 250 V, find the electromagnetic torque of the motor at rated speed.

(b) If the machine in part (a) is working as a generator, determine the shaft power input and the electric power output.

(c) If the machine in part (a) is working as a motor, determine electric power input and shaft power output.

(d) The motor of part (c) drives a load requiring constant torque at all motor speeds. Calculate the motor speed if the armature terminal voltage is halved and the field flux is kept constant.

Q8. (a) Two single phase transformers having identical voltage ratings but unequal kVA ratings are to be operated in parallel. Under what condition can the two transformers supply a total kVA equal to the sum of their individual kVA ratings without any transformer getting over-heated? Derive the condition mentioned. (5 Marks)

(b) Two single-phase, 11000/440 volts transformers have kVA ratings of 200 kVA and 100 kVA respectively. The equivalent resistance and reactance of the 200 kVA transformer are respectively 1.0 ohms and 5.0 ohms when referred to 11000 V side. The equivalent resistance of the 100 kVA transformer referred to 11000 V side is 9.0 ohms. (i) what should be the equivalent resistance of 100 kVA transformer if each transformer is to supply load in proportion to its kVA rating when operated in paralle. (ii) What is the maximum combined kVA can be supplied by the transformer in parallel without overloading any one of them. (5 marks)

Q9. A 50 kW, 250 V, 1200 rpm dc motor when tested on no-load at 250V draws an armature current of 13.24 A, while its speed is 1215 rpm. With field winding un-energized, armature of the motor draws a current of 16.67 amps when a voltage of 1V is applied to it. Upon conducting other tests it is found that R_f =50 ohms while V_b (brush voltage drop) = 2 V. Calculate the motor efficiency at a shaft load of 50 kW at rated voltage with a speed of 1196 rpm. Assume that the stray load loss is 1% of the output. What would be the load for the motor to have maximum efficiency and what would be its value.

****