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10EE54

Fifth Semester B.E. Degree Examination, June/July 2015
D.C. Machines and Synchronous Machines

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. With neat diagrams, explain the O.C.C. and load characteristics of a d.c. shunt generator. **(06 Marks)**

b. Indicate the main applications of d.c. shunt generator, d.c. series generator and dc compound generators. **(06 Marks)**

c. The O.C.C. of a separately excited d.c. generator is as follows:

I_{field}, amps	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6
Emf gen. volts	30	55	75	90	100	110	115	120

If the machine is run as a shunt generator with a field resistance of 100Ω, find the open circuit voltage, field current and critical resistance. What should be the field resistance to have an open circuit emf of 120 volts? **(08 Marks)**

2 a. With a suitable diagram, explain the characteristics of d.c. series motor (performance curves). **(06 Marks)**

b. With a neat diagram, explain the construction and working of a 3-point starter for a d.c. shunt motor. **(06 Marks)**

c. A 4-pole d.c. series motor has 944 wave connected armature conductors. When it is developing 4kW of power, flux per pole is 34.6 mwb. Calculate the current taken by the motor and its speed. The supply voltage is 600 volts and the total motor resistance is 3.8 ohms. **(08 Marks)**

3 a. List the various losses in a d.c. machine. Also indicate the ways in which these losses can be reduced. **(06 Marks)**

b. For the simple d.c. separately excited power shown in Fig.Q.3(b), prove that torque (T) produced is proportional to the product of flux per pole (ϕ) and armature current (I_a). **(06 Marks)**

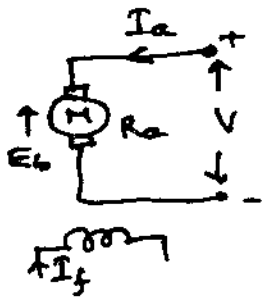

Fig.Q.3(b)

c. A 600V, 6-pole, wave connected dc shunt motor has 1200 armature conductors with 20 mwb flux per pole. The armature and field resistances are 0.5Ω and 250Ω respectively. Calculate its speed and torque while drawing 15A from the supply. **(08 Marks)**

4 a. Explain with a suitable diagram Swinburne's test for a d.c. shunt machine. Give the expressions a d.c. shunt machine. Give the expression for the efficiency i) When the machine runs as a motor; ii) When the machine runs as a generator. What are the limitations of this test? **(10 Marks)**

b. Two identical dc shunt machines gave the following results on a Hopkinson's test.
Line voltage – 230 volts.
Line current (excluding both field currents) – 30A.
Motor armature current – 230A.
Field current (motor) – 4A.
Field current (generator) – 5A.
If the armature resistance of each machine is 0.025Ω, calculate the efficiency of the motor. **(10 Marks)**

PART – B

5 a. Derive the emf equation of a synchronous generator. **(06 Marks)**

b. Explain clearly the armature reaction in synchronous generator. Indicate how it is different from the armature reaction in case of a d.c. generator. **(08 Marks)**

c. Draw the phasor diagram of a non-salient synchronous generator for a leading, lagging and unity power factors. Indicate clearly the various quantities in the diagrams. **(06 Marks)**

6 a. Explain mmf method of finding the voltage regulation of a synchronous generator. **(06 Marks)**

b. Explain how slip test is conducted to find out the X_d and X_q of a salient pole alternator. **(06 Marks)**

c. A 3.5MVA, 3ϕ, 4160 volts, 50Hz, Y-connected synchronous generator has negligible armature resistance and 5.64Ω of synchronous impedance at a particular operating point. A field current of 200A is found necessary to circulate rated current on short circuit. A filed current of 150A is needed to induce rated voltage on open circuit.
For the above machine calculate the regulation by i) emf method and ii) by mmf method at unity power factor. The OC test data is given below.

I_f, amps	50	100	150	200	250	300	350	400	450
EMF_i volts	1620	3150	4160	4750	5130	5370	5550	5650	5750

(08 Marks)

7 a. What are the necessary conditions for two alternators to run in parallel? Briefly explain. **(04 Marks)**

b. Explain the process of synchronizing the given alternator to infinite bus by a suitable method. **(08 Marks)**

c. A 3MVA, 6600V, 8-pole, 50Hz alternator has a synchronous reactance of 2.9Ω. It is running in parallel with infinite bus. Calculate synchronizing power and synchronizing torque per mechanical degree of phase displacement when running at no load. **(08 Marks)**

8 a. Explain briefly the principle of operation of a 3-phase synchronous motor. **(04 Marks)**

b. What are V-curves and inverted V-curves? Explain their significance briefly. **(08 Marks)**

c. A 2200V, 50Hz, 3ϕ, 8-pole, star connected synchronous motor has $Z_s = (0.3 + j5)\Omega$. While running at noload, its excitation is adjusted such that the induced emf becomes equal to the supply voltage. Calculate the armature current, power factor and power input when the motor is loaded to have load angle of 12° (electrical). **(08 Marks)**

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