Fifth Semester B.E. Degree Examination, Dec 08 / Jan 09

D.C. Machines and Synchronous Machines

Time: 3 hrs.   Max. Marks:100

Note : *1. Answer any FIVE full questions.*
        2. Draw Phasor diagrams and figures neatly wherever required.

PART – A

1   a. What is armature reaction? With neat figures, explain armature reaction in D.C. machines under normal working conditions.   (08 Marks)
    b. With neat diagrams, explain the process of commutation in D.C. Machines.   (08 Marks)
    c. Calculate the reactance voltage for a D.C. Machine having following particulars : Speed = 900 rpm ; Number of commutator segments = 55. Brush Width in commutator segments = 1.74 ; Coefficient of self inductance = 153 μH. Assume linear commutation and neglect mica thickness. Current in each coil = 27 Amps.   (04 Marks)

2   a. "A series motor should never be started on no load". Justify the above statement with proper reasoning.   (04 Marks)
    b. "It is required to control the speed of a D.C. Shunt motor below and above normal rated speed". Suggest only one method of speed control and explain the same with suitable circuit diagram.   (06 Marks)
    c. A 4 pole d.c. series motor runs normally at 600 rpm on a 250volts d.c. supply taking 20 Amps. The field coils are all connected in series. Estimate the speed and current taken by the motor if the coils are reconnected in two parallel groups of two in series. The load torque increases as the square of the speed. Assume that the flux is directly proportional to the current and the drops in armature and series field can be neglected.   (10 Marks)

3   a. Derive the standard torque equation of a D.C. motor from first principle.   (05 Marks)
    b. Explain Swinburne's test to predetermine the efficiency of a d.c. machine by computing mechanical losses.   (07 Marks)
    c. The no load test on a 60HP, 220V d.c. shunt motor gave the following results on no load test. Input current = 13.25 Amps ; Field current = 2.55 Amps ; Resistance of the armature = 0.032Ω ; Brush drop = 2 volts. Find the full load current and full load efficiency.   (08 Marks)

4   a. Explain how the moment of inertia of a d.c. machine can be estimated.   (06 Marks)
    b. The Hopkinson's test on two d.c. shunt machines gave the following results on full load. Line voltage = 220 volts, Line current excluding field currents = 15Amps. Motor armature current 72 Amps. The field currents are 1.5Amps and 1.0 Amp for generator and motor respectively. The armature resistance of each machine is 0.2Ω. Calculate the efficiency of each machine.   (08 Marks)
    c. List the advantages of stationary armature in synchronous machines.   (06 Marks)

PART – B

5   a. Discuss the various measures adopted in practice to make the waveform of large alternators to be closely sinusoidal.   (10 Marks)

b. A 3 phase 10 pole 600 rpm star connected alternator has 12 slots per pole with 8 conductors per slot and the winding is short chorded by 2 slots. The flux per pole contains a fundamental of 0.09 wb, a third harmonic of 20% and fifth harmonic of 10% of the fundamental. Determine the rms values of phase and line voltages. **(10 Marks)**

6 a. Define "Regulation of an alternator". Explain the potier reactance method of finding regulation of an alternator. **(10 Marks)**

b. A 3.5 MVA star connected alternator rated at 4160 volts at 50Hz has open circuit characteristics as given by the following data :

I_f Amps :	50	100	150	200	250	300	350
V_{oc} Volts :	1620	3150	4160	4750	5130	5370	5550

A field current of 200 Amps is found necessary to circulate full load current on short circuit. Calculate by i) Synchronous impedance method. ii) Ampere – turn method, full load voltage regulation 0.8 p.f lagging. Neglect armature resistance. **(10 Marks)**

7 a. With a neat phasor diagram, derive an expression for the power output of a salient pole alternator. Draw the variation of power Vs load angle δ. **(10 Marks)**

b. Two identical 2000 KVA alternators operate in parallel. The governor of first machine is such that the frequency drops uniformly from 50 Hz on no load to 48 Hz on full load. The corresponding speed drop in second machine is 50 to 47.5Hz. i) How will the two machines share a load of 3000kW? ii) What is the maximum load at unity power factor that can be delivered without overloading either machine? **(10 Marks)**

8 a. Explain why a synchronous motor is not self starting. **(05 Marks)**

b. Write notes on $\vee$ and $\wedge$ curves of synchronous motors. **(05 Marks)**

c. A 400 volts, 6 pole, 3 phase, 50 Hz, star connected synchronous motor has a resistance and synchronous reactance of 0.5Ω and 4Ω per phase respectively. It takes a current of 15 Amps at unity power factor when operating at a certain field current. If the load torque is increased until the line current is 60 Amps, the field current remaining unchanged. Find the gross torque developed and the new power factor. **(10 Marks)**