EE54

NEW SCHEME

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Fifth Semester B.E. Degree Examination, January/February 2005

Electrical & Electronics Engineering

D.C. Machines & Synchronous Machines

Time: 3 hrs.] [Max.Marks : 100

Note: ***Answer any FIVE full questions.***

1. (a) Explain what is meant by critical field resistance in a D.C. shunt generator and the method of determining it. **(5 Marks)**

   (b) Explain with sketches how armature reaction results into demagnetisation and cross magnetisation effects. Derive expressions for demagnetising and cross magnetising AT. **(10 Marks)**

   (c) A 4 pole, lap-wound armature running at 1500 RPM delivers a current of 150 A and has 64 commutator segments. The brush spans 1.2 segments and inductance of each armature coil is 0.05 mH. Calculate the value of reactance voltage assuming linear commutation. Neglect Mica thickness. **(5 Marks)**

2. (a) Explain the Ward-Leonard method of speed control with the help of a neat diagram. **(6 Marks)**

   (b) A 200 V shunt motor has $R_a = 0.1\Omega$, $R_b = 240\Omega$ and rotational loss 236 W. On full load the line current is 9.8 A with the motor running at 1450 rpm. Determine :

   i) the mechanical power developed

   ii) the power output

   iii) the load torque and

   iv) the full load efficiency. **(8 Marks)**

   (c) Sketch and explain the torque - Ia, speed - load and speed - torque characteristics of series motors. **(6 Marks)**

3. (a) With a neat circuit diagram explain the procedure to conduct Hopkinson's test. Show how efficiencies of motor and generator are calculated. What are the advantages of Hopkinson's test over Swinburne's test? **(10 Marks)**

   (b) A 230 V, D.C shunt motor runs at 800 RPM and takes armature current of 50 A. Find the resistance to be added to the field circuit to increase the speed from 800 rpm to 1000 rpm at an armature current of 80 A. Assume the flux to be proportional to field current. $R_a = 0.15\Omega$ and $R_f = 250\Omega$. **(6 Marks)**

   (c) What are the different losses in a D.C. shunt motor? How do they vary with load. **(4 Marks)**

4. (a) Derive an equation for the emf induced in an alternator. Also derive expressions for pitch factor and distribution factor. **(10 Marks)**

(b) A synchronous generator runs at 250 RPM and generates at 50 Hz. There are 216 slots each containing 5 conductors arranged is full pitched winding for 3 phase star connection. All conductors of each phase are in series and the flux per pole is 30 mWb sinusoidally distributed. Find the induced emf (line value). Find the kVA rating of the alternator when rated current is 100A. **(10 Marks)**

5. (a) Draw the vector diagram of an alternator supplying lagging load and hence derive an expression for the no load emf in terms of terminal voltage, load current, armature resistance and synchronous reactance. **(6 Marks)**

(b) A 3 phase 6000V alternator has the following OCC at normal speed

Field amperes	14	18	23	30	43
Terminal volts (line value)	4000	5000	6000	7000	8000

With armature short circuited and full load current flowing the field current is 17A and when the machine is supplying full load of 200 kVA at zero power factor, the field current is 42.5A and the terminal voltage is 6000 V. Determine the field current required when the machine is supplying full load 0.8 pf lag by ZPF method. **(10 Marks)**

(c) Write a short note on armature reaction in alternators. **(4 Marks)**

6. (a) An alternator is supplying constant load. With suitable vector diagrams explain the effect of variation of excitation on armature current and power factor. **(8 Marks)**

(b) A 1000 kW 3 phase star connected 3.3 kV, 24 pole 50 Hz synchronous motor has a synchronous reactance of 3.24Ω per phase and resistance is negligible. The motor is fed from infinite busbars. Its field excitation is adjusted to result in UPF at read load. Compute the maximum power and torque that the motor can deliver with its excitation remaining constant at this value. **(8 Marks)**

(c) Write short notes on synchronous condenser. **(4 Marks)**

7. (a) With a neat circuit diagram explain how an alternator is synchronised with busbars. **(8 Marks)**

(b) A 22 kV, 3 phase star connected turbo-alternator with a synchronous reactance of 1.2 Ω per phase is delivering 230 MW at UPF to 22 kV grid. With the turbine power remaining constant, the alternator excitation is increased by 30%. Determine the machine current and power factor. **(8 Marks)**

(c) Explain the phenomenon of hunting in synchronous motors. **(4 Marks)**

8. (a) With a neat circuit diagram explain the slip test on salient pole synchronous machines and indicate how X_d and X_q can be determined from the test. **(10 Marks)**

(b) A 3.5 MVA, slow speed, 3 phase synchronous generator rated at 6.6 kV has 32 poles. Its direct and quadrature axis synchronous reactances are 9.6 and 6Ω respectively. Neglecting armature resistance, determine the regulation and excitation emf needed to maintain 6.6 kV at the terminals when supplying a load of 2.5 MW at 0.8 pf lagging. What maximum power can generator supply at the rated terminal voltage if the field becomes open circuited? **(10 Marks)**

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