B.E.(EE) Part-III 5th Semester Final Examination, 2011

Electrical Machines-III (EE-501)

Time: 3 hours | Full Marks: 70

Use separate answerscript for each half.
Answer SIX questions, taking THREE from each half.
Two marks are reserved for neatness in each half.

FIRST HALF

1. a) Why turbogenerator field conductors are made of silver bearing copper?
   b) A three-phase synchronous motor can run at synchronous speed only – Explain.
   c) What are the aims of an excitation system of large alternators? Discuss the advantages of a dc separately excited generator over a dc shunt generator as an exciter. [3+3+(2+3)]

2. a) Show analytically that the external characteristics of a three-phase alternator supplying lagging p.f load lie on an ellipse.
   b) A three-phase alternator is floating on an infinite bus. Explain with the help of phasor diagram that by increasing field excitation keeping prime mover torque unchanged, it is not possible to transfer any active power except i^2r loss.
   c) A synchronous motor operating at rated voltage draws rated current at unity power factor. The synchronous reactance of the motor is 1 p.u, armature resistance being negligible. Apart from supplying this rated power, the motor has to supply reactive power of 0.8 p.u.. How much percentage change in field current has to be made? [3+4+4]

3. a) Why voltage regulation of an alternator is larger than a distribution transformer?
   b) Discuss how the airgap length influences the steady state stability limit and parallel operation of alternators.
   c) An isolated alternator with 40% synchronous reactance and negligible resistance is supplying ¾ th full load current at 0.7 p.f lagging at rated terminal voltage. If the current rises to the full load value at 0.6 p.f lagging, determine the percentage change in the terminal voltage if the excitation system remains unchanged. [2+(2+2)+5]

4. a) A three-phase synchronous motor is operating steadily on full load at upf. Draw relevant curves to explain what will happen to its power factor when load is completely thrown off.
   b) Why for a synchronous machine OCC is a nonlinear curve while the SCC is a linear one?
   c) Armature leakage reactance of a synchronous machine is slightly less than potier reactance – Explain in brief.
   d) Citing an example, explain with the help of phasor diagram how the use of synchronous condenser improves the system performance. [2+3+3+3]

5. a) Draw the phasor diagram of a three-phase alternator under maximum power output condition and find whether the current is leading or lagging.
   b) Derive the condition for maximum reactive power at the terminals of a three-phase alternator.

c) A 415V, 3-phase star-connected cylindrical rotor synchronous motor has an armature resistance of 0.6 Ω per phase and a synchronous reactance of 7.6 Ω per phase. The largest possible value of open circuit emf is 1.3 times the terminal voltage. Find the maximum H.P that can be delivered and the corresponding input current and pf. [2+3+6]

SECOND HALF

6. a) Describe the reduced voltage starting of a squirrel-cage induction motor by means of an auto-transformer and a star-delta starter and mention their merits and demerits.
   b) Design the 5 sections of a 6 stud starter for a 3-phase slip-ring induction motor. The full load slip is 2% and the maximum starting current is limited to twice the full load current. Rotor resistance per phase is 0.03 Ω. Deduce the formula used for calculating the resistance sections and state the assumptions made. [5+(3+3)]

7. a) Explain the phenomena of crawling and cogging in induction motors.
   b) Mention the disadvantages of rotor resistance method of speed control of a three-phase wound rotor induction motor.
   c) A 20 kW, 3-phase, 400V, 4-pole, 50Hz squirrel-cage induction motor, when working at rated voltage and frequency develops a full-load torque at 1470 rpm. If the motor is fed from 40Hz source, with its voltage adjusted to give the same airgap flux as at 50Hz, then calculate
      (i) the magnitude of the 40Hz voltage source and
      (ii) the speed at which the motor would now run so that the same full load torque, as at 50Hz, is developed. [4.5+1.5+(2+3)]

8. a) Name the different methods of controlling speed of a polyphase induction motor applicable separately for wound rotor and squirrel cage induction motors.
   b) Discuss the principles of consequent-pole technique and pole amplitude modulation method of speed control of a squirrel-cage induction motor.
   c) Six d.c. generators are running in parallel in a substation, each having an armature of 0.15 Ω, running at the same speed and excited to give equal induced emfs. Each generator supplies an equal share of load of 360 kW at a terminal voltage of 500V into a load of fixed resistance. If the field current of one generator is raised by 5 percent, the others remaining unchanged, assuming that the flux is proportional to field current and the speeds remain constant, calculate
      i) New terminal voltage
      ii) Output of each machine. [2.5+4.5+4]

9. a) Explain the method to bring a second d.c. shunt generator into parallel operation with one already delivering power. How should their characteristics be related in order that they should satisfactorily share a common load according to their respective ratings?
   b) What is meant by armature reaction in d.c. machine?
   c) A single turn armature coil has in the commutating zone an inductance of 0.025 mH. Find what commutating field is required for straight line commutation of 25A. [6+1+4]

10. a) What are interpoles? What should be the polarity of the interpoles with respect to the main poles in a d.c. machine?
    b) Explain the commutation process in a d.c. machine and describe the following terms in reference to commutation of d.c. machine:
       i) Accelerated commutation
       ii) Linear commutation
       iii) Retarded commutation.
    c) A 4-pole, lap wound armature running at 1400 rpm delivers a current of 100 A and has 64 commutator segments. The brush is equal to 1.4 commutator segments and inductance of each armature coil is 0.05 mH. Calculate the value of reactance voltage assuming linear commutation. [3+5+3]