B.E.(EE) Part-III 5th Semester Final Examination, 2012

Electrical Machines-III (EE-501)

Time: 3 hours **Full marks: 70**

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

FIRST HALF

1. a) For a 13.8 kV, 210 MW turbogenerator answer the following :
   (i) What type of prime mover is used and why?
   (ii) Where the field winding is placed and why?
   b) Why for alternators driven by IC engine damper winding is a must while for large turbogenerator it may be omitted.
   c) The rated operating power factor of an alternator is decided by its field current limit ---Justify. [(2+4)+3+2]

2. a) State the assumptions to be made to determine the airgap flux of a cylindrical rotor synchronous machine.
   b) Compare the performance of an isolated alternator supplying its own load with that of an alternator connected to infinite bus when (i) prime mover torque is increased (ii) field excitation is increased.
   c) Draw time phasor diagram to show that a three-phase synchronous motor initially floating on an infinite bus becomes more and more lagging as its load is gradually increased at constant field current. Explain whether the motor will deliver to or receive reactive power from the bus under this condition. If it receives then how it can be made to deliver reactive power to the bus? [3+(2+2)+(2+1+1)]

3. a) Why is ZPF test carried out at constant armature current?
   b) Derive an expression to show how short circuit current will vary with the speed of the alternator. Draw the curve.
   c) Illustrate with an example the advantages of using a synchronous condenser in an energy system network.
   d) A three-phase synchronous motor is supplying a certain load. In order to stop the motor it is essential to switch off first the ac supply and then field current. Explain the reason. [3+(3+1)+3+1]

4. a) Define SCR of a synchronous machine. How does it help in improving steady state stability limit of the machine and its ability to remain in synchronism with the bus?

b) The following table gives data for obtaining OCC, SCC and ZPFC on a 3 phase, 6 pole, 440V, 50 HZ star connected alternator. The effective ohmic resistance between any two terminals of the armature is 0.3 Ω.

Field current (A)	2	4	6	7	8	10	12	14	16	18
O.C tml voltage (V) (L-L)	156	288	396	440	474	530	568	592	-	-
S.C line current (A)	11	22	34	40	46	57	69	80	-	-
ZPF tml voltage(V) (L-L)	-	-	-	0	80	206	314	398	460	504

Find the regulation at full load current of 40A at 0.8 pf lagging using ZPF method.

[(1+3)+7]

5. a) Deduce the condition under which a synchronous machine can deliver reactive power to the bus to which it is connected.

b) A cylindrical rotor alternator has a armature resistance of 6% and a synchronous reactance which may be assumed constant at 50% with the excitation at maximum value, the open circuit emf is 1.4 times the terminal voltage and the full load output is developed at a load angle of 15^0 electrical. At what load angle will the same output be obtained if the excitation is changed such that the open circuit emf is reduced by 30%.What is the ratio of the full load output to the maximum possible output? The terminal voltage is constant at rated value. [5 + 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 its merits and demerits.

b) A 40 kW, 400V, 50 Hz, 3-phase slip-ring induction motor has the following data:

Rotor resistance/phase= 0.2Ω
Full-load copper loss= 1500W
Friction and windage loss= 500W

Assuming that starting current is not to exceed 1.25 times full-load current, work out the steps of a four section starter. Deduce the formula used for calculating the resistance sections and state the assumptions made. [5+ (3+3)]

7. a) Name the different methods of controlling speed of a polyphase induction motor applicable separately for both wound rotor and squirrel cage induction motors.

b) Discuss the principle and pole amplitude modulation method of speed control of a squirrel cage induction motor.

c) A 50 Hz, 3-phase induction motor has a rated voltage V_1. The motor's breakdown torque at rated voltage and frequency occurs at slip of 0.2. The motor is instead run from a 60Hz supply of voltage V_2. The stator impedance can be neglected.

(i) If $V_2 = V_1$, find the ratio of currents and torques at starting. Also find the ratio of maximum torques.

(ii) Find the ratio V_2/V_1 such that the motor has the same values of starting current and torque at 50 and 60 Hz. [3+3+5]

8. a) Explain the phenomena of crawling and cogging in induction motors.
   b) State the advantages of low frequency starting of an induction motor.
   c) A 4-pole, lap wound armature running at 1400 rpm delivers a current of 100A and has 64 commutator segments. The brush width is equal to 1.4 commutator segments and inductance of each armature coil is 0.05mH.Calculate the value of reactance voltage assuming linear commutation. [5.5+1.5+4]

9. a) Explain how the trouble of flashover in the commutator of a d.c. machine can be overcome by compensating windings.
   b) What is meant by commutation in d.c. machine. If coil resistance is neglected as compared to the copper carbon resistance, linear commutation is obtained; if coil resistance is not neglected, resistance commutation is obtained. Explain.
   c) Calculate the ampere turns for each interpole of an 8-pole generator with 107 slots, each containing 900 ampere-conductors. The interpole air-gap is 1.0 cm. The flux density in the gap is to be 0.3 wb/m^2. Neglect the iron parts of the circuit and leakage. [3+4+4]

10. 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) Two compound generators G_1 and G_2 (fitted with an equalizing bar) operating in parallel supply a load of 475 A. The data of these generators are as follows:

	G_1	G_2
Generated e.m.fs (V)	250	254
Series field resistance (Ω)	0.004	0.006
Armature resistance (Ω)	0.02	0.04

Determine:
(i) Current in each armature
(ii) Current in each series winding
(iii) The current flowing in the equalizing bar
(iv) The bus bar voltage.
Neglect the shunt field current. [6+5]