B.E.(EE) Part-III 6th Semester Final Examination, 2012

ELECTRICAL MACHINES-IV (EE-601)

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) Using two reaction theory draw the phasor diagram of a salient-pole synchronous motor for under-excited condition. From the phasor diagram find the expression for 'tan δ' and 'E_0', where the symbols have their usual significance.
   b) A 1500 kW, 3-phase, star connected, 3.3 kV synchronous motor with negligible resistance has reactance of $X_d = 4.01\ \Omega$ per phase and $X_q = 2.88\ \Omega$ per phase. All losses may be neglected. Calculate the excitation emf when the motor is supplying rated load at unity pf. Calculate the maximum mechanical power that the motor can supply with excitation held fixed at this value. [5+6]

2. a) How a three-phase wound rotor induction motor can be run as synchronous motor?
   b) State the disadvantages of a well designed three-phase induction motor used as a synchronous induction motor and comment on the performance of a wound-rotor motor when running at synchronous speed. Suggest modifications to improve its performance as synchronous motor.
   c) Derive an expression for the synchronizing torque of a non-salient pole alternator connected to infinite bus. [2+6+3]

3. a) Develop the excitation circles for a cylindrical rotor synchronous machine considering motor mode of operation at over-excited condition. How are these circles helpful in studying the steady state behaviour of synchronous machines?
   b) Show that the locus of the tip of the armature current phasor for a synchronous generator at leading power factor is a circle when electromagnetic power is constant. Hence show that the zero power circle passes through origin. [5+6]

4. a) Describe methods of starting synchronous motors against light load torque. Explain, why at the time of starting synchronous motor with the help of damper winding, field winding terminals should be shorted through high resistance.
   b) Find the expression for power in terms of the load angle 'δ' for a 3-phase salient pole synchronous motor working at a leading power factor and hence, draw the power-angle characteristics for a salient pole synchronous machine. Armature resistance may be neglected. [6+5]

5. a) Describe the synchronizing procedure to be followed in connecting a three-phase alternator to infinite bus.
   b) What is capability curve or operating chart of synchronous generator? Describe its basis of development.
   c) Mention effects of loss of excitation of a synchronous generator. [4+4+3]

SECOND HALF

6. a) Why does a single-phase induction motor as compared to a three-phase induction motor of same rating have larger slip and less efficiency?

b) 'A single-phase induction motor connected to a single-phase supply can continue running in the initial direction of rotation' - Explain it using cross field theory.

c) A 220 V, single-phase induction motor has the following test results:

No load: 220 V, 6 A, 350 W

Blocked rotor: 125 V, 15 A, 580 W.

The stator winding resistance is 1.2 Ω measured with direct current. Estimate power output and efficiency at a slip of 0.06. [2+3+(3+3)]

7. a) What are the advantages of capacitor-run motors over capacitor-start single-phase induction motor? Mention the type of capacitors.

b) In which direction does a shaded pole motor rotate? Justify your answer with relevant diagrams. Name a few applications of this motor.

c) A 230 V, 380 W, 50 Hz, 4 pole single-phase induction motor has the following data at standstill:

Main winding impedance: $Z_M = (5.2 + j10.1)\ \Omega$

Auxiliary winding impedance: $Z_A = (12.7 + j\ 9.2)\ \Omega$

Find the value of external resistance that should be inserted in series with the auxiliary winding so that maximum torque at starting is obtained. [(2+1) + (1+2+1) +4]

8. a) For a single-phase ac commutator motor with brush axis displaced from neutral axis, show that the resultant voltage across brush pair (180^0 elec. apart) is independent of brush shift angle.

b) Draw the phasor diagram for an uncompensated ac series motor. From this diagram deduce that the speed of the motor is less for ac operation than dc operation for the same supply voltage and armature current.

c) Discuss in brief how compensating winding improves the ac series motor performance. [3+(3+3)+2]

9. a) Why does a Schrage motor run in a direction opposite to the rotating magnetic field?

b) Explain, with neat diagrams, how it is possible to obtain the speeds both below and above synchronous speed in a Schrage motor. Also comment on the power factor status of the motor.

c) Deduce an expression to show how no-load speed varies with brush separation in a Schrage motor. [3+(3+2)+3]

10. Write short notes on: (any two) [$5\frac{1}{2}$ x 2]

a) AC tachogenetator

b) Two phase servo motor

c) Cross field machines

d) Double revolving field theory

e) Commutation in AC motor
