MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

Paper Code : EE-501

ELECTRICAL MACHINE-II

Time Allotted: 3 Hours | *Full Marks*: 70

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

Group – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for *any ten* of the following: http://www.makaut.com 1×10=10

(i) In double revolving field theory, the slip of the forward motor is S, then the slip of the backward motor is

(a) 2S
(b) S
(c) 2—S
(d) S—2

(ii) In a synchronous motor

(a) E is always less than V
(b) E=V
(c) E is more than V
(d) E may be more or less than V

(iii) In a salient pole synchronous machine, where X_d = d-axis synchronous reactance and X_q = q-axis synchronous reactance, http://www.makaut.com

(a) $X_q = X_d$
(b) $X_q > X_d$
(c) $X_q < X_d$
(d) $X_q = 0$

(iv) Negative voltage regulation is observed in an alternator which is

(a) over excited
(b) under excited
(c) normally excited
(d) All of these

(v) In a synchronous generator operating at zero power factor lagging, the effect of armature reaction is

(a) magnetizing
(b) demagnetizing
(c) cross-magnetizing
(d) both magnetizing and cross- magnetizing

(vi) Short pitch winding results in

(a) higher terminal voltage
(b) higher efficiency
(c) higher power factor
(d) better voltage waveform

(vii) During hunting of synchronous motor

(a) negative phase sequence currents are generated.
(b) harmonies are developed in the armature circuit.
(c) field excitation increases.
(d) damper bar develops torque.

(viii) The maximum possible speeds in rpm at which an alternator can be driven to generate voltages at 60 Hz and 50 Hz are respectively

(a) 2000, 2400
(b) 3000, 3600
(c) 2400, 2000
(d) 3600, 3000

(ix) A capacitor start and capacitor run induction motor is supplied from

(a) single-phase supply
(b) 2-phase supply
(c) 3- phase supply
(d) None of these

(x) For the same no. of poles which stepper motor produces largest stepping angles?

(a) Variable reluctance type
(b) Hybrid type
(c) Permanent magnet type
(d) All of these

(xi) A single phase hysteresis motor can run at

(a) synchronous speed
(b) sub synchronous speed
(c) synchronous and super synchronous speed
(d) synchronous and sub synchronous speed

(xii) The stepping angle for a 3-phase, 24 pole permanent stepper motor is

(a) 15 degree
(b) 8 degree
(c) 5 degree
(d) 4 degree

Group – B

(Short Answer Type Questions)

Answer *any three* of the following: 5×3=15

2. A purely single phase induction motor does not have starting torque but has running torque. Why? 5

3. Explain the principle of operation of capacitor-start capacitor-run type single-phase induction motor with necessary diagrams and phasor. 2+3=5

4. The number of poles or teeth in the stator and rotor of a stepper motor are different. Why? 5

5. Write down the working principle of hysteresis motor with necessary diagram. 5

6. Describe the slip test to determine the d-axis synchronous reactance (X_d) and q-axis synchronous reactance (X_q) of a salient pole synchronous machine. 5

Group – C

(Long Answer Type Questions)

Answer *any three* of the following: 15×3=45

7. (a) Explain how the equivalent circuit parameters of a single phase induction motor can be determined experimentally. State the assumptions you have made.

   (b) A 6-pole, 50Hz, single phase induction motor, when running at normal speed, has forward field and backward field resistances of 60ohms and 1.4ohms respectively. The stator current at a full-load slip of 5% is 3A. Determine the full-load torque in Nm. Assume rotational losses to be 4% of internal power developed. 8+7=15

8. (a) Explain double revolving field theory of 1-phase I/M.

   (b) A 50 Hz, four pole split-phase induction motor has auxiliary resistance of 5Ω and reactance of 20Ω, both in main and winding. Find the value of resistance and capacitance to be added to the auxiliary winding circuit so that the two winding carry same current and the currents are 90° to each other. 7+8=15

9. (a) Explain EMF method of calculation voltage regulation of synchronous generator and state why it leads to pessimistic value at lagging power factor load.

   (b) The effective resistance of a 3-phase, star connected, 50 Hz, 2200 V, synchronous generator is 0.5 ohms per phase. On short circuit, a field current of 40 A gives full load current of 200 A. An emf (Line to Line) of 1100V is produced on open circuit with the same excitation. Determine synchronous impedance. Hence compute power angle and regulation at full load 0.8 pf lagging. 7+8=15

10. (a) A 3-phase, 6-pole, 2.3 kV, 200 kVA, star-connected synchronous motor has synchronous reactance of 12 ohm per phase and negligible resistance. The motor is initially operating at a load of 120kW with field current adjusted such that the armature current is minimum. The field current is now increased such that the armature current is increased by 50%. With this field current, the load is reduced to 60 kW. Calculate new values of armature current and power factor.

(b) A 4-pole, star connected, 50 Hz, 11kV, 40 MVA turbo-generator, with synchronous reactance of 0.8 pu is connected to a power network. This power network can be represented by 11kV infinite bus with a series reactance of j0.5 ohms. A voltage regulator adjusts the field current such that alternator terminal voltage remains constant at 11kV.

The generator delivers an output of 40 MVA.

(i) Draw phasor diagram under condition specified.

(ii) Find armature current and alternator P.F.

Find magnitude of excitation emf. 8+7=15

11. (a) Show with the help of phasor diagrams that a compensated series motor possesses better speed torque characteristics, better power factor and improved commutation as compared to an uncompensated series motor.

(b) A 2-pole, 50 Hz, 300 V, single phase series motor has 800 armature turns and 350 field turns. The total effective resistance is 6Ω and total leakage reactance is 14Ω. For a power input of 350 watts, the motor draws 2A and the speed is 3600 rpm.

(i) Compute the peak value of field flux per pole.

(ii) If the motor is conductively compensated and draws the same amount of current, find the p.f. and speed. The motor has full compensation and the leakage impedance of compensating winding is 1+j2Ω 7+8=15

12. Write short notes *any three* of the following: 5×3=15

(a) Servomotor

(b) Induction regulator

(c) Tacho-Generator

(d) Induction generator

(e) Synchronous condenser