Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(EE)/SEM-5/EE-501/2011-12

2011

ELECTRICAL MACHINES - 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 : 10 × 1 = 10

i) A 230 V *dc* series motor is connected to a 230 V *ac* supply.

a) The motor will vibrate violently

b) The motor will run with less efficiency and more sparking

c) The motor will not run

d) The fuse will be blown.

ii) In a poly-phase A.C. machine "short-pitching" of coils leads to

a) high terminal voltage b) higher efficiency

c) higher power factor d) better induced *emf*.

iii) When the main winding of a 1-phase induction motor is connected to 220 V, 50 Hz source, it takes a current of 50 L – 60°A at standstill. Neglecting stator leakage impedance and magnetizing current, the rotor circuit parameters r_2 and x_2 in ohms are respectively

a) 2, 3·464 b) 3·464, 2

c) 4, 6·928 d) 6·928, 4.

iv) When a 3-phase synchronous mtor is running at synchronous speed, the damper winding produces

a) damping torque

b) eddy current torque

c) torque aiding the developed torque

d) no torque.

v) Number of slip-rings required in a conventional synchronous machine is

a) 0 b) 1

c) 2 d) 3.

vi) Induction generator runs at

a) supersynchronous speed

b) sub-synchronous speed

c) synchronous speed

d) none of these.

vii) In a salient pole synchronous machine, where X_d = d-axis synchronous reactance, X_q = quadrature axis synchronous reactance,

a) $X_q = X_d$ b) $X_q > X_d$

c) $X_q < X_d$ d) $X_q = 0$.

viii) The backward rotor slip in a single-phase induction motor is equal to

a) $1 - s$ b) s

c) $2 - s$ d) $s/2$.

ix) A synchronous motor is operating on no load at unity p.f. If the field current is increased, the p.f. will become

a) leading and current will decrease

b) lagging and current will increase

c) lagging and current will decrease

d) leading and current will increase.

x) It is desirable to eliminate 5th harmonic voltage from the phase voltage of an alternator. The coils should be short pitched by an electrical angle of

a) 30° b) 36°

c) 18° d) none of these.

xi) In brushless *dc* motor we have

a) no mechanical commutator

b) no brushes

c) no arcing

d) all of these.

xii) If the prime mover of the alternator supplying load to an infinite bus is suddenly shut down, then it will

a) stop

b) continue to run as an alternator

c) continue to run as a synchronous motor in the reverse direction

d) continue to run as a synchronous motor in the same direction.

GROUP – B

(Short Answer Type Questions)

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

2. With appropriate circuit and connection diagrams, explain the "2 bright and 1 dark" lamp method of synchronizing a 3-phase alternator to the grid or to another existing alternator. Is a '1 bright and 2 dark' lamp method possible ? Justify your answer in brief. 4 + 1

3. What is a synchronous condenser ? Explain its operation and utility with phasor diagram. 1 + 4

4. Describe the principle of operation of an induction generator. Can it be classified as a synchronous generator or as an asynchronous generator ? 4 + 1

5. Explain the operation of a variable-reluctance type stepper motor. Why does it fall out of step if the pulsing rate of logic controller is increased ? 3 + 2

6. With appropriate circuit diagram explain the operation of a brushless D.C. motor. Can it run without motor position feedback ? 4 + 1

GROUP – C

(Long Answer Type Questions)

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

7. a) A 2 kV, 50 Hz, 3-phase, *Y*-connected synchronous motor has an effective resistance and synchronous reactance of 0·2 Ω and 2·2 Ω per phase respectively. The input is 800 kW at rated voltage and the induced *e.m.f.* (line value) is 2500 V. Evaluate

   i) the line current

   ii) the power factor

   iii) the motor speed (if it is a 6-pole machine) and

   iv) the readings of the two wattmeters if the power is measured by 2-wattmeter method.

   Draw the par-phase phasor diagram at this condition. 2 + 2 + 1 + 3 + 2

   b) What is a damper winding and in which machine is it found ? Where is it placed within the machine ? Briefly explain its working. 2 + 1 + 2

8. a) What is a switched reluctance motor ? Describe its basic operating principle with regard to a 4-phase, 8-pole stator and 6-pole rotor radial flux (conventional) S.R. motor. 5

   b) What is the step-angle in the above case and what should be the interval (in mechanical degrees) after which the 4 phases of the above motor should be switched on sequentially, in case one phase is excited at a time ? 2

   c) What is the nature of the torque-speed characteristic ? What are the application areas of this motor ? 3

   d) Is it doubly excited ? Derive the voltage equation and justify the role of the term 'reluctance'. Write down the expression for torque developed. 1 + 3 + 1

9. Write short notes on any *three* of the following : 3 × 5

   a) A universal motor

   b) Linear induction motor

   c) Salient pole synchronous machine and its particular applicability in synchronous motors.

   d) A.C. servo motor.

10. a) Starting from the expression of sinusoidal supply current, mathematically derive the two revolving field theory model and the equivalent circuit of a single phase induction motor. 6

    b) What are the different methods of starting a single phase induction motor ? With the help of appropriate circuit diagram and phasor diagram, explain the principle of capacitor start–capactitor run 1-phase induction motor. Briefly indicate how to design the value of capacitor to be used. 2 + 3 + 2

    c) What may happen if one of the 3-lines of a 3-phase cage rotor induction motor suddenly gets disconneted ? Justify your answer. 2

11. a) A 1·0 MVA, 11 kV, 3-phase, *Y*-connected alternator has an effective resistance of 2Ω per phase. The characteristics on open-circuit and with full load current at zero power factor and core losses (on open circuit) are given below :

Field current (A)	*Open ckt Voltage, V (line value)*	*Core loss, kW*	*Saturation curve, zero p.f., V*
40	—	—	0
50	7000	7·5	—
110	12500	16·6	8500
140	13750	22·4	10500
180	15000	33·5	12400

Deduce by the zero power-factor method

i) the percentage regulation for full load at a p.f. of 0·8 lag and

ii) the efficiency at this load, given that the field circuit has a resistance of 0·5 Ω and that the mechanical and additional losses add up to 10 kW. Draw the phasor diagram. 5 + 2

b) Define regulation of an alternator. Name the different methods of determination of regulation of an alternator. Which of these methods is known 'optimistic' and why ? Briefly describe the method only. 1 + 2 + 5