Reg. No. : [| | | | | | | | | | |]

Question Paper Code : 52959

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Fifth Semester

Electrical and Electronics Engineering

EE 6504 — ELECTRICAL MACHINES – II

(Regulation 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is a distributed winding and what is meant by distribution factor?

2. What are the factors affecting the synchronous generator terminal voltage?

3. How can the speed of an synchronous motor be varied?

4. What is a damper winding? What is the function of it and where it is located?

5. What is meant by standstill reactance of induction motor's rotor? How does it vary with speed?

6. Write the expression for the resistance in the circuit model, the loss in which is equivalent to the mechanical power developed.

7. What are the methods used in starting squirrel cage induction motor?

8. Compare and contrast the speed control features of induction motor with DC shunt motor.

9. What is the advantage of a capacitor start motor over a resistance split phase motor?

10. Give reasons for the low efficiency of hysteresis and reluctance motors.

PART B — (5 × 13 = 65 marks)

11. (a) Draw the open-circuit and short-circuit characteristics using the data given below for a 150 MW, 13 kV, 0.85 pf, 50 Hz synchronous generator.

Open – circuit characteristic

I_f(A)	200	450	600	850	1200
V_{OC} (line) (kv)	4	8.7	10.8	13.3	15.4

Short – circuit characteristic I_f = 750 A, I_{SC} = 8000 A

(i) Determine the unsaturated synchronous reactance of the machine.

(ii) Determine the saturated synchronous reactance of the machine.

Or

(b) Describe with neat sketch,

(i) The basic principle of operation of three phase alternator

(ii) Advantages of having stationary armature

(iii) Details of construction with types of rotor.

12. (a) Draw the power flow diagram, equivalent circuit of a synchronous motor and derive the expressions for power developed by a synchronous motor.

Or

(b) A 1000 kVA, 11 kV, 3ph star connected synchronous motor has an armature resistance and reactance per phase of 3.5 and 40 respectively. Determine the induced emf and angular retardation of the rotor when fully loaded at

(i) Unity p.f,

(ii) 0.8 p.f, lagging,

(iii) 0.8 p.f, leading

13. (a) A 6–pole, 50 Hz, 3–phase induction motor running on full load develops a useful torque of 160 Nm when the rotor emf makes 120 complete cycles per minute. Calculate the shaft power output. If the mechanical torque lost in friction and that for core–loss is 10 Nm. Calculate :

(i) the copper-loss in the rotor windings,

(ii) the input to the motor, and

(iii) the efficiency

The total stator loss is given to be 800 W.

Or

(b) A 400 V, 3–phase, 6–pole, 50 Hz induction motor give the following test results:

No–load	400 V	8 V	0.16 power factor
Blocked–rotor	200 V	39 A	0.36 power factor

Determine the mechanical output, torque and slip when the motor draws a current of 30 A from the mains. Assume the stator and rotor copper losses to be equal. Use circle diagram method.

14. (a) Describe, various methods of starting of 3 phase squirrel cage induction motors.

Or

(b) A 150 kW, 3000 V, 50 Hz, 6–pole star–connected induction motor has a star–connected slip–ring rotor with a transformation ratio of 3.6 (stator/rotor). The rotor resistance is 0.1 W/phase and its per phase leakage inductance is 3.61 mH. The stator impedance may be neglected. Find :

(i) the starting current and torque on rated voltage with short-circuited slip–rings and

(ii) the necessary external resistance to reduce the rated–voltage starting current to 30 A and the corresponding starting torque.

15. (a) Develop the circuit model of a single–winding (referred to as the main winding), single–phase motor on semi–quantitative basis.

Or

(b) Derive the expressions for main field EMF, cross field EMF with circuit model and phasor diagram of AC series motor.

PART C — (1 × 15 = 15 marks)

16. (a) A (0.5) kW, 4–pole, 50 Hz, 220 V, two–value capacitor motor has the following circuit model parameters:

R_{1m} = 4.2 W, X_{1m} = 11.3 W R_{1a} = 5.16 W, X_{1a} = 12.1 W

X = 250 W, a = 1.05 W R_2 = 7.48 W, X_2 = 7.2 W

Friction, windage and core losses = 45 W

(i) Calculate the starting torque and current if the two capacitors in parallel equal to 70 mF.

(ii) Calculate the value of the run capacitor for zero backward field when the motor is running at a slip of 0.04. What is the meaning of the associated resistance value?

(iii) Calculate the motor performance for the value of the run capacitor as in part (ii). Assume R_C = 0.

Or

(b) The circuit model parameters in Ω/phase (referred to stator) of a 2 – phase, 1 kW, 220 V, 4–pole, 50 Hz squirrel– cage motor are given below:

$R_1 = 3$ W $R_2 = 2.6$ W $X_1 = X2 = 2.7$ W $X = 110$ W

The windage, friction and core losses equal 200 W. The applied voltages are adjusted such that $Va = 110 - \underline{|90^\circ}$ and $Vm = 220 - \underline{|0^\circ}$

(i) Calculate the starting torque and starting current (in each phase).

(ii) Calculate the motor performance at s = 0.04.

(iii) With the motor running at s = 0.04, the phase a gets open–circuited What voltage will be developed across this phase?