Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. / B. Tech. (Full Time) - END SEMESTER EXAMINATIONS, APRIL / MAY 2024

ELECTRICAL AND ELECTRONICS ENGINEERING

Semester V

EE5501 ELECTRICAL MACHINES - II

(Regulation 2019)

Time: 3hrs Max.Marks: 100

CO 1	Understand the concepts of windings, MMFs and rotating magnetic fields.
CO 2	Understand the operation of ac machines.
CO 3	Analyse the performance characteristics of ac machines.
CO 4	Analyse the starting and speed control of ac machines.
CO 5	Understand the field applications of ac machines.

BL – Bloom's Taxonomy Levels

(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analysing, L5 - Evaluating, L6 - Creating)

PART- A (10 x 2 = 20 Marks)

(Answer all Questions)

Q. No	Questions	Marks	CO	BL
1	Compare full-pitch coil and short-pitch coil.	2	1	1
2	Define the winding distribution factor.	2	1	1
3	Draw the magnetic field produced by a single winding and the magnetic field produced by two windings which is spatially shifted by 90° degree.	2	2	2
4	What you mean by slip in induction motor?	2	2	2
5	Draw the power stages of three phase induction motor.	2	3	2
6	Sketch the Torque – Speed characteristics of three phase slip ring induction motor for various rotor resistances.	2	3	2
7	Write the concept of regenerative braking in an induction machine.	2	4	1
8	Mention the role of the capacitor in single-phase induction motor.	2	4	1
9	Mention the components of synchronous impedance.	2	5	2
10	Write the significance of the two reaction theories.	2	5	2

PART- B (5 x 13 = 65 Marks)

(Restrict to a maximum of 2 subdivisions)

Q. No	Questions	Marks	CO	BL
11 (a)	Draw and explain the air-gap MMF distribution with fixed current through (1) Concentrated winding (2) Distributed winding (3) Sinusoidally distributed winding	13	1	3
	(OR)			
11 (b) (i)	Find the value of the distribution factor for a synchronous machine with 9 slots per pole for the following cases: (1) One winding in all the slots. (2) One winding using only the first (2/3) of slots/pole. (3) Three equal windings placed sequentially in 60° group.	7	1	3

(ii)	Calculate the pitch factor for the following: (1) 36 stator slots, 4-poles, coil span 1 to 8 (2) 72 stator slots, 6-poles, coil span 1 to 10 (3) 96 stator slots, 6-poles, coil span 1 to 12, Sketch three coil spans.	**6**	1	3
12 (a)	Write a technical note on the following: (1) Magnetic field produced in a single winding by fixed current (2) Magnetic field produced in a single winding by alternating current. Also correlate the same with pulsating magnetic field and rotating magnetic field	**13**	2	3
	(OR)			
12 (b) (i)	From the basics, develop the mathematical expression for starting torque and maximum torque developed in three-phase induction motor.	**7**	2	3
(ii)	A 4-pole, 3 phase induction motor operates from the supply whose frequency is 50Hz, calculate, (1) The speed at which the magnetic field of the stator is rotating (2) The speed of the rotor when the slip is 0.04. (3) The frequency of the rotor current when the slip is 0.03. (4) The frequency of the rotor current at stand still.	**6**	2	3
13 (a) (i)	With necessary assumptions, step by step, develop the per phase equivalent circuit of three phase induction motor.	**7**	3	4
(ii)	A 440V, 3 phase, 50Hz, 4 pole, star connected induction motor has a full load speed of 1425 rpm. The rotor has an impedance of (0.4 + j 4) Ω and rotor to stator turns ratio of 0.8. calculate: (1) full load torque, (2) full load rotor copper loss, (3) power output if windage and friction losses amount to 500W (4) starting torque.	**6**	3	4
	(OR)			
13 (b) (i)	The power input to the rotor of a 440V, 50Hz, 6 pole, three phase induction motor is 100 kW. The rotor EMF is observed to make 120 cycle per minute, calculate (1) the slip, (2) the rotor speed, (3) mechanical power developed (5) the rotor copper loss per phase and (5) speed of stator field with respect to rotor.	**7**	3	4
(ii)	Write a short note on the doubly fed induction machine.	**6**	3	4
14 (a) (i)	Prove, single phase induction motor is not self-starting. Assume necessary assumptions.	**7**	4	4
(ii)	A 250 W, 230 V, 50 Hz, capacitor start motor has the following constants for the main and auxiliary winding. Main winding Z_m = (4.5 + j 3.7) Ω, Auxiliary winding Z_a = (9.5 + j 3.5) Ω. Determine the value of the starting capacitor that will place the main and auxiliary winding currents in quadrature at starting.	**6**	4	4
	(OR)			
14 (b)	Draw the control circuit and explain, all the starting schemes suitable for single phase induction motor. Also list its applications.	**13**	4	4
15 (a) (i)	With necessary sketches, explain the armature reaction in synchronous machine with lagging, unity and leading power factor loads.	**7**	5	4

(ii)	The stator of a 3 phase, 16 pole alternator has 144 slots and there are 4 conditions per slots connected in two layers and the conductors of each phase are connected in series. If the speed of the alternator is 375rpm, calculate the EMF induced per phase. Resultant flux in the air gap is 5×10^{-2} Wb per pole, sinusoidally distributed. Assume the coil span as 150° electrical.	**6**	5	4
	(OR)			
15 (b)	Write a short note on the following (1) V – curves in synchronous machine (2) Parallel operation of alternators.	 **7** **6**	 5 5	 4 4

PART- C (1 x 15 = 15 Marks)

(Q.No.16 is compulsory)

Q. No	Questions	Marks	CO	BL
16.	Draw the circle diagram from no load and short circuit test of a 3 phase, 14.92 kW, 400 V, 6-pole induction motor from the following test results (line values). No load : 400 V, 11 A, Power Factor = 0.2 Short circuit : 100 V, 25 A, Power Factor = 0.4 Rotor copper loss at stand still is half the total copper loss. From the diagram find the (1) Line current, slip, efficiency, and power factor at full load (2) the maximum torque.	**15**	3	5