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

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. / B. Tech. (Full Time) - END SEMESTER EXAMINATIONS, NOVEMBER / DECEMBER 2024

ELECTRICAL AND ELECTRONICS ENGINEERING
Semester IV
EE5403 ELECTRICAL MACHINES – I
(Regulation 2019)

Time: 3hrs　　　　Max.Marks: 100

This course is to provide the fundamental knowledge to the students to	
CO 1	Understand the concepts of magnetic circuits.
CO 2	Understand the concepts of induced EMF and torque in both stationary and rotating machines.
CO 3	Understand the operation of DC machine.
CO 4	Analyse the differences in operation of different DC machine configurations.
CO 5	Analyse the single phase and three phase transformers circuits.

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	Define MMF in the magnetic circuits.	2	1	L1
2	Compare linear and non-linear magnetic circuits.	2	2	L1
3	List the factors that affect electromagnetic force in electrical machines.	2	2	L1
4	Sketch the magnetic structure of DC machines.	2	3	L1
5	Name the functions of pole and pole faces of DC machines.	2	3	L1
6	Write, how back EMF controls the starting current in DC machines?	2	4	L2
7	Why DC series motor cannot be started with no-load?	2	4	L2
8	Draw the phasor diagram of no-load current components in transformers.	2	5	L2
9	Interpret the indication of wattmeter readings, which is connected with transformer during open circuit and short circuit test.	2	5	L2
10	Write the significance of cooling tubes connected with distribution transformers.	2	5	L2

PART- B (5 x 13 = 65 Marks)
(Restrict to a maximum of 2 subdivisions)

Q. No	Questions	Marks	CO	BL
11 (a)	Draw the schematic view of magnetic fields produced by a bar magnet and current carrying coil (1) through air medium (2) through a combination of iron and air medium	13	1	L3
	OR			
11 (b) (i)	Draw and explain, any two connections related to three phase transformers. Also mention its vector group.	7	5	L3
(ii)	Describe, how tap-changers are used in the transformers? Also highlight its merit and demerits.	6	5	L3

12 (a)	By considering the attracted armature relay, derive the expressions for field energy and co-energy stored in the magnetic circuit for the following: (1) without movement in the attracted armature relay (2) with movement in the attracted armature relay	**13**	2	L3
	OR			
12 (b)	With the help of attracted armature relay and suitable assumptions, derive the expressions for mechanical force developed as a partial derivative of stored energy. Derive the same for the case of linear and non-linear magnetic circuits.	**13**	2	L3
13 (a) (i)	From the basics, derive the expression for the EMF induced in the DC machines.	**7**	3	L4
(ii)	Write a short note on armature reaction in DC machines and also write the methods adopted to overcome the same.	**6**	3	L4
	OR			
13 (b) (i)	Sketch and elucidate the following: (1) field produced by the field winding excitation with armature winding open (2) air-gap flux density distribution in the DC machine.	**7**	3	L4
(ii)	A 4 – pole DC motor is lap wound with 4000 conductors. The pole shoe is 20 cm long and the average flux density over one pole pitch is 0.4 T, the armature diameter being 30 cm. Find the torque and gross mechanical power developed when the motor is drawing 25 A and running at 1500 rpm.	**6**	3	L4
14 (a) (i)	Draw and explain the electrical and mechanical characteristics of DC shunt and DC series motor.	**7**		L4
(ii)	A 250 V, DC shunt motor has $R_f = 150\ \Omega$ and $R_a = 0.6\ \Omega$. The motor operates on no-load with a full field flux at its base speed of 1000 rpm with $I_a = 5$ A. If the machine drives a load requiring a torque of 100 Nm, calculate armature current and speed of motor. If motor is required to develop 10 kW at 1200 rpm, what is the required value of the external series resistance in the field circuit? Neglect saturation and armature reaction.	**6**	4	L4
	OR			
14 (b) (i)	Explain various types of field excitations suitable for DC machines. Draw the relevant sketches.	**7**	4	L4
(ii)	A 200 V, DC shunt motor has $R_f = 240\ \Omega$, $R_a = 0.1\ \Omega$ and rotational loss 236 W. On full load, the line current is 9.8 A with the motor running at 1450 rpm. Determine: (1) the mechanical power developed, (2) the power output, (3) the load torque and (4) the full load efficiency.	**6**	4	L4
15 (a) (i)	Step by step, develop the equivalent circuit of single phase transformer. Assume the necessary assumptions.	**7**	5	L4
(ii)	A 500 kVA transformer has an efficiency of 95 % at full load and also at 60 % of full load; both at unity p.f. (1) separate out the losses of the transformer, (2) determine the efficiency of the transformer at 75 % of full load.	**6**	5	L4
	OR			

15 (b) (i)	Write a technical note on Scott connection of a transformer.	**7**	5	L4
(ii)	A 5 kVA distribution transformer has a full load efficiency of 95 % at which copper loss equals iron loss. The transformer is loaded 24 hours as given below: No load for 10 hours 25 % load for 7 hours Half load for 5 hours Full load for 2 hours. Calculate all-day efficiency of the transformer.	**6**	5	L4

PART- C (1 x 15 = 15 Marks)

(Q.No.16 is compulsory)

Q. No	Questions	Marks	CO	BL
16.	A 5 kVA, 500/250 V, 50 Hz, single phase transformer gave the following readings. OC Test : 500 V, 1 A, 50 W (LV side open) SC Test : 25 V, 10 A, 60 W (LV side shorted) Determine (1) the efficiency on full load , 0.8 p.f. lagging, (2) the voltage regulation on full load, 0.8 p.f. leading, (3) the efficiency on 60 % of full load, 0.8 p.f. leading (4) draw the equivalent circuit referred to primary and insert all the values in it.	**15**	5	L5