

Enrollment No./Seat No.:

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering - SEMESTER - III EXAMINATION - WINTER 2025

Subject Code: BE03024021

Date: 17-12-2025

Subject Name: Electrical Machines and Applications- I

Time: 10:30 AM TO 01:00 PM

Total Marks: 70

Instructions

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

	Marks
Q.1 (a) State the principle of Electromechanical Energy Conversion. Also, state the formula for the energy stored in a magnetic field system.	03
(b) Explain the concept of Co-energy and derive the expression for the magnetic force in a singly excited linear magnetic system using the energy stored in the field.	04
(c) With the help of a neat diagram, explain the construction, working principle, and applications of a PMDC (Permanent Magnet DC) Motor.	07
Q.2 (a) Draw the neat cross-sectional view of a DC machine and list the function of any four major parts, such as yoke, pole shoe, and commutator.	03
(b) Explain the effect of Armature Reaction in a DC Generator and describe the function of a Compensating Winding used to counter its effects.	04
(c) A 4-pole, wave-connected DC generator has 60 slots with 10 conductors per slot. The armature resistance is 0.1Ω . When driven at 1200 rpm, the generator supplies a load of 10Ω resistance at 200 V. Find (i) the total armature current (I_a) and (ii) the flux per pole (Φ). Neglect shunt field current for approximation.	07
OR	
(c) A 230 V DC series motor draws an armature current of 40 A and runs at 900 rpm. The armature resistance and series field resistance are 0.1Ω and 0.2Ω , respectively. Assuming the flux is reduced by 50% due to saturation when the current increases from 40 A to 60 A, calculate the new speed when the motor draws 60 A.	07
Q.3 (a) Define All-day Efficiency for a transformer. Why is it more significant for a distribution transformer than a power transformer?	03
(b) Draw the Phasor Diagram of a single-phase transformer operating at a lagging power factor load. Clearly show the primary and secondary voltages and currents.	04
(c) The maximum efficiency of a 100 kVA single-phase transformer is 98% and occurs at 80% of full load at unity power factor. Calculate the (i) iron loss and (ii) full-load copper loss of the transformer.	07
OR	
(a) Derive the EMF equation of single-phase transformer.	03

- (b) Draw the vector diagram of single-phase transformer considering the effect of winding resistance and magnetic leakage for capacitive load and explain in brief. 04
- (c) A 20 kVA, 2000/200 V single-phase transformer has 66 turns in the secondary winding. If the core cross-sectional area is 40 cm², calculate (i) the number of turns in the primary winding, (ii) the maximum flux density in the core, and (iii) the full-load primary current. Assume 50 Hz supply. 07
- Q.4** (a) List and briefly describe the essential conditions that must be fulfilled for the successful parallel operation of two single-phase transformers. 03
- (b) Explain the principle of operation and draw the schematic diagram of a 3-point starter used for a DC shunt motor. 04
- (c) With the help of necessary diagrams, explain the Y- Δ (Star-Delta) and Δ -Y (Delta-Star) connection of a three-phase transformer. State one main application for each connection. 07
- OR**
- (a) Explain Core type and Shell type single-phase transformer. 03
- (b) Explain the principle of operation and draw the schematic diagram of a 4-point starter used for a DC shunt motor. 04
- (c) With the help of necessary diagrams, explain the connection of a Scott-connected transformer. State the main purpose of this connection. 07
- Q.5** (a) Why is a Δ - Δ connected three-phase transformer bank converted to an open-delta (V-V) connection? Calculate the power rating of the open-delta bank if the original rating was 100 kVA. 03
- (b) With the help of neat sketches, explain the working and torque-speed characteristics of a Variable Reluctance Stepper Motor. 04
- (c) Describe the concept of reactance voltage during commutation in a DC machine. Explain the role of interpoles in improving commutation. 07
- OR**
- (a) A magnetic field system has a coil with a current of 5 A and an inductance of 0.1 H. The air gap length is 0.5 mm. Calculate the magnetic force developed in the system. 03
- (b) Draw and Explain Power Flow Diagram for DC Generator and DC Motor. 04
- (c) Define Generator. Explain the Classification of DC Generator with diagram. Derive EMF equation of DC Generator. 07
