GUJARAT TECHNOLOGICAL UNIVERSITY

BE 6 SEMESTER – OLD PAPER – SUMMER 2022 TO SUMMER 2026 – QUESTION BANK

Subject Name & Code: Element of Electrical Design - 3160918

Chapter 1: General Design Aspects

Repeated Questions:

1. Insulating Materials:

- **Q.** List the properties of good insulating materials? **(WINTER 2022, 3 Marks; WINTER 2024, 3 Marks; SUMMER 2025, 3 Marks)**
- **Q.** Give classification of insulating material used in electrical machines on the basis of maximum permissible temperature rise / operating temperature / thermal stability. **(SUMMER 2022, 4 Marks; SUMMER 2023, 7 Marks OR; WINTER 2023, 4 Marks; SUMMER 2024, 4 Marks)**

2. Magnetic Circuit and Flux Density:

- **Q.** Define the real and apparent flux densities in the tooth of d.c. machine armature and give difference between them. Also derive the relation between them. **(SUMMER 2022, 3 Marks; WINTER 2022, 7 Marks; SUMMER 2023, 4 Marks; WINTER 2023, 7 Marks OR; SUMMER 2025, 7 Marks; WINTER 2025, 4 Marks; SUMMER 2026, 3 Marks)**
- **Q.** Discuss B-H curve in magnetic circuit. **(WINTER 2023, 4 Marks; WINTER 2024, 3 Marks OR)**
- **Q.** Define and clearly explain the terms: (1) Stacking Factor (2) Gap contraction factor for slots and ducts **(WINTER 2022, 3 Marks; WINTER 2025, 4 Marks)**

3. MMF for Teeth:

- **Q.** List various methods for calculating the mmf required for tapered teeth & Explain any one. **(SUMMER 2022, 7 Marks; SUMMER 2024, 3 Marks; WINTER 2024, 4 Marks; SUMMER 2025, 3 Marks OR; SUMMER 2026, 4 Marks)**
- **Q.** State and explain methods for calculating MMF required for tooth in DC machine. **(WINTER 2022, 4 Marks OR; WINTER 2024, 4 Marks)**

4. Air Gap – MMF and Carter's Coefficient:

- **Q.** What is Carter's fringing curve? Why it is used. **(WINTER 2022, 3 Marks OR; WINTER 2024, 4 Marks OR; WINTER 2025, 3 Marks)**

5. Numerical Problems:

- **Q.** Determine the air gap length of DC Machine from the following data: Gross core length = 0.1 meter, Number of ducts = 1, Width of duct = 10 mm, Slot pitch = 24 mm, Slot Width = 12 mm, Carter's coefficient for slots and ducts = 0.3, Gap flux density at pole center = 0.65 T, Field MMF per pole = 3800 A, MMF required for iron parts of magnetic circuit = 600 A. **(SUMMER 2022, 7 Marks OR; WINTER 2023, 7 Marks; SUMMER 2026, 7 Marks)**

Other Important Questions:

1. Magnetic Circuit and Flux Density:

- **Q.** Give analogy between Magnetic circuit and Electrical circuit. **(WINTER 2025, 3 Marks)**
- **Q.** Derive the equation of gap contraction factor for slots. **(SUMMER 2025, 4 Marks)**
- **Q.** Describe how to calculate the magnetizing current in a machine with distributed winding. **(SUMMER 2025, 3 Marks)**

2. MMF for Teeth:

- **Q.** Discuss the factors to be considered for exact calculation of MMF for Teeth. **(SUMMER 2023, 3 Marks)**

3. Air Gap – MMF and Carter's Coefficient:

- **Q.** Derive an expression for the mmf required for the airgap in the case of slotted armature. **(WINTER 2025, 7 Marks)**

4. Numerical Problems:

- **Q.** A salient pole dc machine has a core length of 0.32m including four ducts of 10mm each, pole arc 0.19m, slot pitch 65.4mm, slot opening 5mm and a flux per pole 52mWb. Assume Carter's coefficient of 0.18 for opening/gap = 1 and 0.28 for opening/gap = 2, Calculate the mmf required for the air gap. **(SUMMER 2024, 7 Marks)**
- **Q.** Determine the MMF required for the airgap of a machine with open slots from the following particulars: Slot pitch = 4.3cm, Slot opening = 2.1cm, Gross length of core = 48cm, Pole arc = 18cm, Airgap length = 0.6cm, Flux per pole = 0.056 Wb, No. of ventilating ducts = 8, Width of each ventilating duct = 1.2cm. [Diagram required – refer to the original question paper] **(SUMMER 2025, 7 Marks)**

5. Leakage Reactance and Finite Element Method:

- **Q.** Discuss Leakage reactance calculation for various types of slots for DC machines. **(WINTER 2023, 4 Marks)**
- **Q.** What is finite element method (FEM) and finite element analysis (FEA)? Give advantages of FEA. **(WINTER 2023, 7 Marks)**

Chapter 2: Design of Starters and Field Regulators, Small Transformers and Choke Coils

Repeated Questions:

1. Small Transformer Design:

- **Q.** Explain design procedure of a small single phase transformer. / Give design steps for small single-phase transformer. **(SUMMER 2022, 7 Marks OR; WINTER 2022, 7 Marks OR; SUMMER 2023, 7 Marks; SUMMER 2024, 7 Marks; WINTER 2024, 7 Marks; SUMMER 2025, 7 Marks; WINTER 2025, 7 Marks; SUMMER 2026, 7 Marks)**
- **Q.** Draw different types of stampings used for making core of small transformer. [Diagram required – refer to the original question paper] **(SUMMER 2022, 3 Marks OR; WINTER 2022, 3 Marks)**

2. Choke Coil Design:

- **Q.** Explain steps for design of single phase variable choke coil. / Discuss the design procedure of 3-phase variable choke coil. Also draw the sketch of whole arrangement. / Give design steps for three phase variable choke coil. **(WINTER 2022, 7 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 7 Marks OR; WINTER 2024, 7 Marks; SUMMER 2025, 7 Marks OR; WINTER 2025, 7 Marks OR)**

3. Field Regulators:

- **Q.** Discuss function & necessity of field regulator in case of DC shunt generator / motor / series motor. **(SUMMER 2022, 3 Marks; WINTER 2022, 4 Marks; WINTER 2023, 3 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 4 Marks; WINTER 2024, 3 Marks; SUMMER 2025, 4 Marks; WINTER 2025, 4 Marks OR; SUMMER 2026, 3 Marks OR)**

4. DC Motor Starters:

- **Q.** Explain working of No Volt Coil and Overload Release coil in terms of three point starters for DC motor. **(SUMMER 2023, 3 Marks; SUMMER 2025, 3 Marks; SUMMER 2026, 3 Marks)**
- **Q.** Why is starter required in case of DC motors? Explain construction of three point starter in details. / Discuss the necessity of starter in DC motors and Induction motors. **(WINTER 2022, 4 Marks; SUMMER 2023, 4 Marks; SUMMER 2025, 3 Marks OR)**
- **Q.** Explain the grading of starting resistance for DC shunt motor starters. / Explain the grading of starting resistance for DC Series motor starters. **(SUMMER 2025, 7 Marks; SUMMER 2025, 7 Marks OR)**

5. Induction Motor Starters:

- **Q.** What are the various types of starter used for starting squirrel cage Induction motor? Explain one of starter in brief. **(SUMMER 2022, 4 Marks; WINTER 2022, 4 Marks OR; WINTER 2025, 4 Marks)**
- **Q.** What is soft starter? What are the benefits and advantages of soft starter? **(WINTER 2023, 3 Marks; WINTER 2024, 3 Marks; SUMMER 2026, 3 Marks)**

6. Starter Design (Numerical):

- **Q.** Calculate the steps in a 4 section rotor resistance starter for a 3 phase slip-ring induction motor from the following data [Data truncated in source – refer to the original question paper] **(WINTER 2022, 7 Marks OR; WINTER 2022, 7 Marks; WINTER 2024, 7 Marks OR; SUMMER 2025, 7 Marks OR; WINTER 2025, 7 Marks; SUMMER 2026, 7 Marks OR)**
- **Q.** Design a suitable 8 section starter for a dc shunt motor from the following data [Data truncated in source – refer to the original question paper] **(WINTER 2022, 7 Marks OR; WINTER 2023, 7 Marks; WINTER 2024, 7 Marks; WINTER 2025, 7 Marks OR)**

Other Important Questions:

1. Choke Coil Design:

- **Q.** What is choke coil? State the function of chokes used in Tube-lights. **(SUMMER 2022, 4 Marks OR)**

2. DC Motor Starters:

- **Q.** Explain the working of 4-point starter with neat sketch for DC motor. [Diagram required – refer to the original question paper] **(SUMMER 2026, 4 Marks OR)**
- **Q.** Prove that the section resistances of d.c. shunt motor starters are in geometrical progression. **(SUMMER 2022, 7 Marks)**

3. Induction Motor Starters:

- **Q.** Why the starting current of 3-phase induction motor is so high? What are consequences of it? **(WINTER 2025, 3 Marks)**
- **Q.** For what size of motors, D.O.L. starter is generally used? Is there any device provided in D.O.L. starter to reduce starting current? **(WINTER 2025, 3 Marks OR)**
- **Q.** Why starter is necessary for starting 3-phase induction motor? **(WINTER 2023, 4 Marks)**
- **Q.** Explain the working of auto transformer starter with neat sketch for squirrel cage induction motor. [Diagram required – refer to the original question paper] **(SUMMER 2025, 4 Marks OR)**
- **Q.** Explain the working of star delta starter with neat sketch for squirrel cage induction motor. [Diagram required – refer to the original question paper] **(SUMMER 2022, 4 Marks)**

4. Starter Design (Numerical):

- **Q.** Design a suitable 5 section starter for a 7.5kW, 250V, 1000rpm DC shunt motor from the following data: Maximum starting torque = 1.5 times the full load torque, Armature circuit resistance = 0.5 ohm, Full load efficiency = 85% **(SUMMER 2024, 7 Marks)**
- **Q.** Find the resistance of each section of a rotor resistance starter of a slip-ring induction motor having a full-load slip of 3%. Use 9 studs. Assume maximum starting current = full load current. Also determine the slip at various studs. **(SUMMER 2024, 7 Marks OR)**

Chapter 3: Armature Windings

Repeated Questions:

1. DC Armature Windings (Theory):

- **Q.** Define the following terms used in armature winding design: (1) back pitch (2) Commutator pitch (3) winding pitch / Front pitch / pole pitch **(WINTER 2022, 3 Marks; SUMMER 2023, 3 Marks; WINTER 2023, 3 Marks; SUMMER 2024, 3 Marks OR; WINTER 2024, 3 Marks; SUMMER 2025, 3 Marks; WINTER 2025, 3 Marks OR; SUMMER 2026, 3 Marks)**
- **Q.** Give the comparison between Lap winding and Wave winding. / Compare Simplex lap winding & Simplex wave winding. **(SUMMER 2022, 3 Marks; SUMMER 2023, 4 Marks; WINTER 2023, 3 Marks; SUMMER 2024, 3 Marks; WINTER 2024, 4 Marks OR; SUMMER 2025, 4 Marks OR; WINTER 2025, 4 Marks OR; SUMMER 2026, 4 Marks)**
- **Q.** Explain the use of dummy coils and equalizer connections in d.c. armature windings. Also explain why equalizer connections are not necessary in case of wave windings? / Justify the use of dummy coils and equalizer connections [Data truncated in source – refer to the original question paper] **(SUMMER 2022, 4 Marks; WINTER 2022, 4 Marks OR; WINTER 2022, 4 Marks; SUMMER 2023, 4 Marks OR; WINTER 2023, 4 Marks OR; SUMMER 2024, 4 Marks OR; WINTER 2024, 4 Marks; SUMMER 2025, 4 Marks; WINTER 2025, 4 Marks)**
- **Q.** Compare closed windings and open windings. **(WINTER 2022, 3 Marks OR; WINTER 2022, 3 Marks)**

2. AC Armature Windings (Theory):

- **Q.** Differentiate between single layer and double layer winding. **(WINTER 2022, 3 Marks OR; WINTER 2023, 3 Marks OR; SUMMER 2024, 3 Marks; WINTER 2024, 4 Marks; WINTER 2025, 3 Marks)**

3. Winding Design (Numerical):

- **Q.** Design and develop a mush winding for a 3-phase, X-pole, Y-slots stator [Data truncated in source – refer to the original question paper] **(WINTER 2022, 7 Marks; SUMMER 2024, 7 Marks; WINTER 2024, 7 Marks; SUMMER 2025, 7 Marks OR; WINTER 2025, 7 Marks OR; SUMMER 2026, 7 Marks OR)**
- **Q.** Find the front pitch, back pitch, winding pitch and commutator pitch for a simplex wave wound X slots, 4-pole d.c armature [Data truncated in source – refer to the original question paper] Draw the winding diagram in developed form. Also draw the sequence diagram to indicate the position of brushes. (Various Data) **(SUMMER 2022, 7 Marks; SUMMER 2024, 7 Marks OR; WINTER 2024, 7 Marks OR; SUMMER 2025, 7 Marks; SUMMER 2026, 7 Marks)**

Other Important Questions:

1. DC Armature Windings (Theory):

- **Q.** Define and explain the progressive and retrogressive lap windings. **(SUMMER 2024, 4 Marks)**

2. AC Armature Windings (Theory):

- **Q.** Write a detailed note on various types of AC armature winding and explain any one with example. **(SUMMER 2023, 7 Marks)**
- **Q.** What is difference between Full pitch winding and chorded winding. **(SUMMER 2023, 3 Marks OR)**
- **Q.** Classify various types of AC armature windings. **(SUMMER 2024, 4 Marks OR)**
- **Q.** Compare mush winding and double layer winding for three phase AC machine. **(SUMMER 2025, 4 Marks OR)**

3. Winding Design (Numerical):

- **Q.** Calculate the front pitch, back pitch and winding pitch for a simplex lap wound 24 slots, 4 pole d.c. armature. Make the winding table and draw the winding diagram in developed form. **(WINTER 2025, 7 Marks)**
- **Q.** Find and give comments whether the following lap windings are symmetrical or not: (i) 4-pole, 22-slots, 22 coils (ii) 6-pole, 19-slots, 19 coils. **(SUMMER 2023, 7 Marks OR)**

Chapter 4: Estimation and Costing for Residential and Commercial wiring

Repeated Questions:

1. Wiring Systems and Rules:

- **Q.** State the rules for electrical wiring as per IS. **(SUMMER 2022, 4 Marks OR; WINTER 2022, 3 Marks OR; WINTER 2023, 3 Marks OR; SUMMER 2024, 3 Marks; WINTER 2024, 3 Marks OR; WINTER 2025, 4 Marks; SUMMER 2026, 4 Marks OR)**
- **Q.** Explain the factors to be considered while selecting the type of electrical wiring. **(SUMMER 2022, 3 Marks; WINTER 2022, 3 Marks OR; SUMMER 2023, 7 Marks OR; WINTER 2023, 3 Marks; WINTER 2024, 3 Marks)**
- **Q.** Explain with neat sketches, the different systems of wiring used for domestic installations. / Describe and compare the different systems of wiring used for domestic installations. **(SUMMER 2022, 7 Marks OR; WINTER 2023, 7 Marks OR; SUMMER 2024, 7 Marks OR; WINTER 2024, 7 Marks)**
- **Q.** What are the types of wiring system? Explain any one in brief. / Discuss types of electrical wiring. **(SUMMER 2023, 7 Marks OR; SUMMER 2024, 4 Marks; SUMMER 2025, 4 Marks)**

2. Loads (Theory):

- **Q.** Discuss the different types of loads with examples. / What is electric load? Give examples and classify different types of loads. **(SUMMER 2022, 4 Marks OR; WINTER 2022, 7 Marks; WINTER 2023, 4 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 7 Marks OR; SUMMER 2025, 4 Marks; WINTER 2025, 4 Marks OR)**

3. Wiring Diagrams and Installation Planning:

- **Q.** Explain the installation plan, wiring diagram and single line diagram for electric wiring based on a given load. Also give the rules for deciding the number of sub circuits and power circuit. **(SUMMER 2022, 7 Marks OR; SUMMER 2023, 7 Marks; WINTER 2023, 7 Marks OR; WINTER 2024, 7 Marks OR; SUMMER 2026, 7 Marks OR)**
- **Q.** A room of size 4 m × 3 m is required to be provided with lamp, fan, tube light and one 5A 3-pin socket outlet [Data truncated in source – refer to the original question paper] Do the following: (1) Mark the location of electrical points and draw the installation plan. (2) Draw the wiring and schematic diagram. (3) Calculate the length of PVC conduit / phase and neutral wire / earth wire. **(SUMMER 2022, 7 Marks; WINTER 2025, 7 Marks OR; SUMMER 2026, 7 Marks)**
- **Q.** Define wiring diagram and schematic diagram. Draw a wiring diagram and schematic for light and fan circuit. / Explain using suitable example. **(SUMMER 2023, 4 Marks; SUMMER 2024, 4 Marks OR; SUMMER 2026, 4 Marks)**

4. Estimation and Costing:

- **Q.** Calculate the total cost of electrical energy for 30 days, at the rate of Rs. X per unit based on the given domestic loads. (Various Data) **(WINTER 2022, 7 Marks OR; SUMMER 2023, 7 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 7 Marks; WINTER 2025, 7 Marks; SUMMER 2026, 7 Marks)**
- **Q.** Write steps to estimate the cost of electrical wiring installation for building. **(SUMMER 2024, 3 Marks OR; SUMMER 2026, 3 Marks)**

Other Important Questions:

1. Wiring Systems and Rules:

- **Q.** List any three guidelines for estimation of internal wiring. **(SUMMER 2025, 3 Marks)**

2. Loads (Theory):

- **Q.** Define the following terms in illumination scheme: (1) Luminous flux (2) Lumens (3) Illumination (4) Lux **(WINTER 2025, 3 Marks)**

3. Estimation and Costing:

- **Q.** Explain importance of estimation. **(SUMMER 2024, 3 Marks)**
- **Q.** List out the essential elements of estimating and costing before starting any electrical project. **(SUMMER 2023, 4 Marks OR)**

4. Load Factors (Numerical):

- **Q.** Generating station has connected load of 50MW and maximum demand of 35MW. The units generated 75×10^6 per annum. Calculate (1) Demand factor (2) Load factor. **(WINTER 2022, 4 Marks)**
- **Q.** Find the diversity factor of a power station which supplies the following loads: Load A: Motor load of 150kW between 10 a.m. to 7 p.m. Load B: Lighting load of 50kW between 7 p.m. to 11 p.m. Load C: Pumping load of 60kW between 3 p.m. to 10 a.m. **(SUMMER 2022, 7 Marks)**

Chapter 5: Design consideration of Electrical Installation

Repeated Questions:

1. Conductor Size, Load Assessment and Sub-circuits:

- **Q.** Explain the importance of (a) current carrying capacity and (b) voltage drop while determining the size of conductor. / Discuss in brief points to be considered while determination of the size of conductor. **(SUMMER 2022, 3 Marks OR; WINTER 2022, 4 Marks; SUMMER 2023, 3 Marks; WINTER 2024, 4 Marks OR; SUMMER 2026, 3 Marks)**
- **Q.** Define / Give the definition of the following terms with respect to load assessment: (1) maximum demand (2) load factor (3) diversity factor / demand factor **(SUMMER 2022, 3 Marks OR; SUMMER 2023, 3 Marks; WINTER 2023, 3 Marks OR; WINTER 2024, 3 Marks OR; SUMMER 2025, 3 Marks OR)**
- **Q.** How can you determine the number of sub circuits, rating of main switch and distribution board? **(SUMMER 2023, 3 Marks OR; SUMMER 2026, 3 Marks OR)**

2. Supply System, Control Panel and Service Connection:

- **Q.** What is control panel? State and explain the various components/devices used in the control panel. **(SUMMER 2022, 4 Marks; WINTER 2023, 4 Marks OR; WINTER 2024, 4 Marks; SUMMER 2026, 4 Marks)**
- **Q.** Which materials are required for installation of service connection? **(SUMMER 2023, 3 Marks OR; SUMMER 2026, 3 Marks OR)**
- **Q.** Why AC system is preferred over DC system for transmission and distribution of electrical energy? **(SUMMER 2022, 3 Marks; SUMMER 2026, 4 Marks OR)**

Other Important Questions:

1. Conductor Size, Load Assessment and Sub-circuits:

- **Q.** Explain the selection of permissible voltage drop and conductor size during design of an electric wiring. **(SUMMER 2023, 4 Marks)**
- **Q.** Explain the load assessment and permissible voltage drop for electrical installation. **(SUMMER 2022, 4 Marks)**

2. Supply System, Control Panel and Service Connection:

- **Q.** State the material used for loading rheostat and give its desirable properties. **(WINTER 2025, 3 Marks OR)**
- **Q.** What is electric power supply system? With help of a single line diagram explain typical ac power supply system. [Diagram required – refer to the original question paper] **(SUMMER 2026, 7 Marks OR)**

3. Lighting Design:

- **Q.** Discuss the significance of (i) Space to height ratio (ii) Utilization factor and (iii) Depreciation factor in the design of lighting system. **(WINTER 2022, 4 Marks OR)**

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