GUJARAT TECHNOLOGICAL UNIVERSITY

BE 7 SEMESTER – OLD PAPER – SUMMER 2022 TO SUMMER 2026 – QUESTION BANK

Subject Name & Code: High Voltage Engineering - 3170917

Chapter 1: Electrostatic fields and field stress control

Repeated Questions:

1. Electrostatic Fields:

- **Q.** Give comparison between uniform and non-uniform Field. **(WINTER 2022, 3 Marks OR; SUMMER 2024, 4 Marks; WINTER 2024, 4 Marks OR; WINTER 2025, 3 Marks)**

Other Important Questions:

1. Basics of Electrostatic Fields and Stress:

- **Q.** Define Electric stress. Explain Electric field stress in homogeneous isotropic materials. **(WINTER 2025, 7 Marks)**
- **Q.** What voltage level is considered high voltage? **(SUMMER 2026, 3 Marks)**
- **Q.** Define the terms: breakdown, ionization, and homogeneous field. **(WINTER 2023, 3 Marks)**

Chapter 2: Numerical analysis of electrical fields in high voltage equipment

Repeated Questions:

1. Numerical Field Computation Methods:

- **Q.** Explain Finite Element Method (FEM) / What is Finite Element Method? Discuss procedure, advantages, limitations, elements and nodes. **(SUMMER 2023, 7 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 4 Marks; SUMMER 2025, 4 Marks; SUMMER 2026, 7 Marks OR)**
- **Q.** List / give methods for electric field computation and explain any one; also FDM advantages/disadvantages. **(SUMMER 2022, 7 Marks OR; WINTER 2022, 3 Marks; WINTER 2025, 7 Marks; SUMMER 2026, 3 Marks)**

Other Important Questions:

1. Numerical Field Computation Methods:

- **Q.** Explain any one numerical technique in detail with relevant equations (Charge simulation, Finite element, Finite difference, or Boundary element). **(SUMMER 2022, 7 Marks OR)**

Chapter 3: Electrical breakdown in gases

Repeated Questions:

1. Townsend Mechanism and Breakdown Theories:

- **Q.** Define Townsend's first and second ionization coefficients. Obtain current growth equation due to first and second ionization / derive first ionization coefficients. **(WINTER 2022, 4 Marks; SUMMER 2023, 3 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 7 Marks - second alternative; WINTER 2024, 4 Marks; SUMMER 2025, 3 Marks; WINTER 2025, 7 Marks OR)**
- **Q.** Compare breakdown mechanisms — Townsend's theory and Streamer theory / streamer mechanism and difference from Townsend discharge. **(SUMMER 2022, 7 Marks; SUMMER 2026, 7 Marks)**

2. Paschen's Law and Breakdown Criteria:

- **Q.** Paschen's Law – statement, relation between breakdown voltage and product of pressure and electrode distance, minimum voltage under given p×d condition. **(WINTER 2023, 7 Marks; SUMMER 2025, 7 Marks; SUMMER 2026, 4 Marks)**
- **Q.** Electronegative gases – why breakdown strength is higher / analyse and discuss criteria for breakdown. **(WINTER 2022, 7 Marks; WINTER 2024, 3 Marks; SUMMER 2025, 3 Marks OR)**
- **Q.** Factors affecting breakdown of gases / factors affecting ionization process and processes responsible for gaseous breakdown. **(WINTER 2022, 4 Marks; SUMMER 2024, 4 Marks OR; WINTER 2024, 4 Marks OR)**

3. Corona and Time Lags:

- **Q.** Corona discharge – factors affecting corona losses and elimination of corona loss. **(SUMMER 2024, 7 Marks; WINTER 2024, 7 Marks; SUMMER 2025, 7 Marks)**
- **Q.** Time lags for breakdown – components / factors affecting components / statistical, formative and total time lag. **(SUMMER 2023, 3 Marks; SUMMER 2023, 4 Marks; SUMMER 2025, 3 Marks; WINTER 2025, 4 Marks)**

Other Important Questions:

1. Breakdown Theories and Criteria:

- **Q.** Explain the Townsend's criterion for a spark. **(SUMMER 2023, 4 Marks)**
- **Q.** Discuss various criteria suggested by researchers for transition from avalanche to streamer. **(SUMMER 2023, 7 Marks)**
- **Q.** Describe Townsend's breakdown model in gases. Explain key assumptions and principles including role of ionization and electron multiplication. **(SUMMER 2026, 7 Marks)**
- **Q.** Discuss post breakdown phenomenon. **(WINTER 2023, 3 Marks)**

2. Breakdown Voltage and Paschen Curve:

- **Q.** Sketch the graph for Breakdown voltage–PD curve for gaseous insulating media with proper indications and nomenclature on X and Y axis. [Diagram required – refer to the original question paper] **(SUMMER 2022, 3 Marks)**
- **Q.** What will be standard breakdown strength of air for small gaps (1 mm) and large gaps (20 cm) under uniform field conditions and standard atmospheric conditions? **(SUMMER 2022, 4 Marks)**

Chapter 4: Breakdown in liquid and solid dielectrics

Repeated Questions:

1. Liquid Dielectrics:

- **Q.** Differentiate between Commercial Liquid and pure Liquid. **(WINTER 2022, 3 Marks; WINTER 2025, 3 Marks)**
- **Q.** Purification and breakdown test for liquid dielectric / transformer oil / purification test cell system. **(SUMMER 2022, 7 Marks; WINTER 2022, 4 Marks; WINTER 2023, 4 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 4 Marks; SUMMER 2025, 4 Marks; WINTER 2025, 4 Marks OR)**
- **Q.** Enlist different theories of breakdown in commercial liquids and explain any one of them. **(WINTER 2022, 7 Marks; WINTER 2025, 7 Marks OR)**

2. Solid Dielectrics:

- **Q.** Treeing and tracking related to solid breakdown / solid breakdown due to treeing & tracking. **(WINTER 2022, 7 Marks OR; WINTER 2023, 4 Marks; SUMMER 2025, 4 Marks; WINTER 2025, 4 Marks; SUMMER 2026, 4 Marks)**
- **Q.** Enlist the breakdown mechanisms for solid dielectric. **(SUMMER 2022, 3 Marks; WINTER 2025, 3 Marks)**
- **Q.** Thermal breakdown in solid dielectric. **(SUMMER 2022, 4 Marks; WINTER 2025, 3 Marks OR; SUMMER 2026, 4 Marks)**

3. Vacuum Breakdown:

- **Q.** Particle exchange mechanism for vacuum breakdown. **(WINTER 2023, 4 Marks; WINTER 2025, 4 Marks)**

Other Important Questions:

1. Liquid Dielectrics:

- **Q.** Explain suspended particle theory related to liquid breakdown. **(WINTER 2024, 3 Marks)**
- **Q.** Explain properties of transformer oil. **(WINTER 2022, 4 Marks)**
- **Q.** Discuss significance of transformer oil filtration and testing in maintaining reliability of power transformers. What role does transformer oil play in electrical insulation? **(SUMMER 2026, 7 Marks)**

Chapter 5: Generation of high voltages

Repeated Questions:

1. High D.C. Voltage Generation:

- **Q.** Van de Graaff generator – construction, working, neat sketch, applications, merits/demerits, role in generating high voltages. [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks OR; WINTER 2022, 3 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 7 Marks; WINTER 2024, 7 Marks; SUMMER 2025, 4 Marks; WINTER 2025, 4 Marks; SUMMER 2026, 4 Marks)**
- **Q.** Cockcroft–Walton voltage multiplier circuit – construction, operation unloaded/loaded, five-stage / basic operation. [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks; SUMMER 2023, 7 Marks; SUMMER 2024, 7 Marks; SUMMER 2026, 7 Marks)**
- **Q.** Rectifier circuits for high D.C. voltages – half-wave rectifier vs voltage doubler / full-wave rectifier. **(SUMMER 2023, 4 Marks; WINTER 2023)**

2. High A.C. Voltage Generation:

- **Q.** Cascade connection of transformers for high A.C. voltage / cascade transformer unit with isolating transformer. **(SUMMER 2022, 3 Marks OR; WINTER 2022, 7 Marks; WINTER 2024, 7 Marks OR)**
- **Q.** Resonant transformer / series-parallel resonant circuit – principle, advantages and disadvantages. **(SUMMER 2022, 4 Marks OR; WINTER 2022, 3 Marks; SUMMER 2023, 3 Marks; WINTER 2025, 3 Marks OR)**
- **Q.** Tesla coil with circuit and waveform. [Diagram required – refer to the original question paper] **(SUMMER 2024, 4 Marks; SUMMER 2025, 4 Marks)**

3. Impulse Voltage Generation:

- **Q.** Marx circuit and modified Marx circuit of multistage impulse generator / components and necessity. [Diagram required – refer to the original question paper] **(WINTER 2022, 4 Marks; SUMMER 2023, 7 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 7 Marks OR; WINTER 2024, 7 Marks OR; SUMMER 2025, 7 Marks; WINTER 2025, 4 Marks OR; SUMMER 2026, 7 Marks)**

4. Numerical Problems:

- **Q.** A 12-stage impulse generator has 0.126 µF capacitors. The wave front and wave tail resistances connected are 800 Ω and 5000 Ω respectively. If the load capacitor is 1000 pF, find the front and tail times of the impulse wave produced. **(WINTER 2022, 7 Marks; WINTER 2022 (OR); WINTER 2024, 7 Marks; SUMMER 2025, 7 Marks)**

Other Important Questions:

1. Impulse Voltage Generation (Theory):

- **Q.** How are switching impulse generated in Laboratory? Explain in brief. **(SUMMER 2024, 4 Marks)**
- **Q.** Define the terms: (i) Impulse voltages; (ii) Chopped wave; (iii) Impulse flash over voltage. **(SUMMER 2023, 3 Marks OR)**
- **Q.** Draw two simplified impulse generator circuits. [Diagram required – refer to the original question paper] **(SUMMER 2023, 4 Marks OR)**
- **Q.** Explain Trigatron gap. **(WINTER 2024, 3 Marks OR)**

2. HVAC and HVDC Generation (Theory):

- **Q.** Enlist the techniques (at least three for each) for HVAC and HVDC generation. **(SUMMER 2022, 3 Marks)**
- **Q.** Compare high voltage testing transformer with power transformer. **(SUMMER 2022, 4 Marks)**

- **Q.** Explain with neat sketch, testing transformer construction. [Diagram required – refer to the original question paper] **(WINTER 2023, 4 Marks)**

3. Numerical Problems:

- **Q.** A simple two-stage voltage multiplier circuit uses diodes and capacitors. If the input AC voltage to the first stage is 100 V (RMS) and the circuit operates at a frequency of 50 Hz, calculate the DC output voltage of the voltage multiplier. **(SUMMER 2026, 3 Marks OR)**
- **Q.** Ten stage Cockcroft-Walton circuit has all capacitors of 0.06 µF. Secondary voltage of supply transformer is 100 kV at 150 Hz. Load current is 1 mA. Determine: 1. Voltage Regulation, 2. Ripple, 3. Optimum number of stages for maximum output voltage. **(WINTER 2022, 7 Marks OR)**
- **Q.** A 10 stage Cockcroft-Walton circuit has all capacitors of 0.6 µF. The secondary voltage of the supply transformer is 100 kV at a frequency of 150 Hz. If the load current is 1 mA, determine: (1) percentage voltage regulation, (2) the ripple, (3) the optimum number of stages for maximum output voltage. **(SUMMER 2025, 7 Marks OR)**

Chapter 6: Measurement of high voltages

Repeated Questions:

1. Sphere Gap and Peak Voltage Measurement:

- **Q.** Sphere gap – requirements, disadvantages, use for peak value measurement, factors influencing voltage measurement. **(WINTER 2022, 3 Marks OR; SUMMER 2023, 3 Marks; SUMMER 2023, 4 Marks; WINTER 2023, 7 Marks OR; SUMMER 2024, 7 Marks OR; WINTER 2024, 3 Marks; SUMMER 2025, 7 Marks; SUMMER 2026, 7 Marks OR)**
- **Q.** Chubb–Fortescue method / circuit for peak high-voltage measurement. **(SUMMER 2022, 3 Marks - page 2, 3(a); SUMMER 2026, 4 Marks)**

2. Voltmeters, Hall Effect and CVT:

- **Q.** Electrostatic voltmeter – principle, construction, advantages, limitations. **(WINTER 2022, 4 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 7 Marks; SUMMER 2025, 4 Marks; WINTER 2025, 7 Marks OR)**
- **Q.** Generating voltmeter – method/detail. **(SUMMER 2022, 7 Marks - page 2, 3(c); WINTER 2022, 3 Marks OR; WINTER 2024, 4 Marks; WINTER 2025, 3 Marks - second set)**
- **Q.** Capacitance voltage transformer (CVT) – schematic, equivalent circuit, phasor diagram, tuned CVT. [Diagram required – refer to the original question paper] **(WINTER 2022, 7 Marks; WINTER 2023, 7 Marks; WINTER 2023, 7 Marks OR; WINTER 2025, 7 Marks)**
- **Q.** Hall effect in Hall generator. **(WINTER 2023, 4 Marks; SUMMER 2024, 3 Marks OR; WINTER 2024, 3 Marks OR; SUMMER 2025, 3 Marks OR)**

3. D.C. and Impulse Voltage Measurement:

- **Q.** Potential divider method for high voltage DC measurement and limitations / resistance and capacitance potential dividers. **(SUMMER 2023, 3 Marks OR; SUMMER 2023, 7 Marks OR; WINTER 2023, 4 Marks; SUMMER 2024, 4 Marks OR)**
- **Q.** High D.C. voltage measurement methods and limitations. **(WINTER 2022, 3 Marks OR; SUMMER 2025, 4 Marks; WINTER 2025, 3 Marks - second set)**
- **Q.** Front time and tail time of impulse voltage / standard lightning impulse waveform. [Diagram required – refer to the original question paper] **(WINTER 2023, 3 Marks; SUMMER 2024, 3 Marks; SUMMER 2026, 3 Marks)**

Other Important Questions:

1. Measurement Techniques (Theory):

- **Q.** Enlist a table for High voltage measurement techniques for DC Voltages, AC voltages (Power frequency) and Impulse voltages. **(SUMMER 2022, 3 Marks - page 2, 3(b))**
- **Q.** Explain with neat diagram how rod gaps can be used for measurement of high voltages. Compare its performance with a sphere gap. [Diagram required – refer to the original question paper] **(SUMMER 2023, 7 Marks)**
- **Q.** What are the problems associated with measurement of very high impulse voltages? **(SUMMER 2023, 4 Marks OR)**
- **Q.** Describe the working principle of a spark gap in measuring peak voltages. What are the key factors that influence the spark gap's performance? **(SUMMER 2026, 7 Marks OR)**

2. Numerical Problems:

- **Q.** A generating voltmeter has to be designed so that it can have range from 20 kV to 200 kV DC. If the indicating meter reads minimum current of 2 μA, what should be the capacitance of the generating voltmeter be? What should be the upper range of the meter? Assume driving motor has synchronous speed of 1500 rpm. **(SUMMER 2026, 4 Marks)**

Chapter 7: Over voltages and insulation coordination

Repeated Questions:

1. Lightning:

- **Q.** Lightning mechanism / lightning strokes / over voltages due to lightning / components of lightning strike. [Diagram required – refer to the original question paper] **(SUMMER 2022, 4 Marks; WINTER 2022, 7 Marks; SUMMER 2024, 4 Marks OR; WINTER 2024, 7 Marks; SUMMER 2026, 4 Marks)**

2. Insulation Coordination:

- **Q.** Insulation co-ordination – meaning, protective device selection, optimal insulation level, factors considered. **(SUMMER 2022, 7 Marks; SUMMER 2024, 7 Marks OR; WINTER 2024, 7 Marks; SUMMER 2025, 7 Marks; SUMMER 2026, 7 Marks)**

3. Surge Arresters:

- **Q.** Surge arrester / lightning arrester – function, importance, application in power system. **(SUMMER 2022, 3 Marks; WINTER 2023, 3 Marks OR; SUMMER 2024, 3 Marks; WINTER 2024, 3 Marks OR; SUMMER 2025, 3 Marks; SUMMER 2026, 3 Marks)**
- **Q.** Metal Oxide Arrestor. **(WINTER 2024, 3 Marks; WINTER 2025, 4 Marks)**

Other Important Questions:

1. Overvoltages and BIL:

- **Q.** List out the causes of overvoltage in power system. **(SUMMER 2024, 4 Marks OR)**
- **Q.** What are BILS? Explain their significance in power system studies. **(SUMMER 2023, 4 Marks)**

2. Arresters:

- **Q.** Explain clearly how the rating of a lightning arrester is selected. **(SUMMER 2023, 3 Marks OR)**
- **Q.** Discuss Rod Gap Arrester. **(WINTER 2023, 4 Marks OR)**

Chapter 8: Non-destructive test techniques

Repeated Questions:

1. Insulation Diagnostics:

- **Q.** High voltage Schering bridge for tanδ and capacitance measurement of insulators / balanced condition / phasor diagram. [Diagram required – refer to the original question paper] **(WINTER 2022, 4 Marks OR; SUMMER 2023, 7 Marks OR; SUMMER 2024, 7 Marks; SUMMER 2025, 7 Marks; WINTER 2025, 7 Marks)**
- **Q.** Dissolved gas analysis (DGA) – gases observed, fault identification; Duval's triangle. **(SUMMER 2022, 3 Marks; SUMMER 2022, 4 Marks; SUMMER 2026, 3 Marks OR)**
- **Q.** Frequency Response Analysis / Sweep Frequency Response Analysis / mechanical integrity monitoring of transformer. **(SUMMER 2022, 7 Marks; SUMMER 2024, 3 Marks; SUMMER 2026, 3 Marks OR)**

2. Partial Discharge:

- **Q.** Partial discharge – definition, internal vs external, equivalent circuit. [Diagram required – refer to the original question paper] **(SUMMER 2023, 3 Marks; WINTER 2023, 3 Marks; WINTER 2023, 3 Marks OR; SUMMER 2024, 3 Marks; SUMMER 2025, 3 Marks; WINTER 2025, 3 Marks)**
- **Q.** Partial discharge detection / display / balanced detection / Digital PD Analyser / basic principle of PD measurements. **(WINTER 2023, 7 Marks OR; WINTER 2023, 3 Marks OR; WINTER 2024, 4 Marks OR; SUMMER 2025, 4 Marks OR; SUMMER 2026, 4 Marks OR)**

Other Important Questions:

1. Dielectric Loss Measurement:

- **Q.** What is the principle behind dielectric loss measurement in insulation testing, and why is it important? **(SUMMER 2026, 3 Marks)**

Chapter 9: High voltage testing

Repeated Questions:

1. High Voltage Laboratory and Equipment Testing:

- **Q.** Common test facilities available in High Voltage Lab. **(WINTER 2023, 3 Marks; SUMMER 2024, 3 Marks OR; WINTER 2024, 4 Marks; SUMMER 2025, 7 Marks OR; WINTER 2025, 3 Marks)**
- **Q.** High voltage testing of insulators / bushings / power frequency tests of insulator. **(WINTER 2022, 4 Marks; SUMMER 2024, 3 Marks; SUMMER 2024, 3 Marks OR; WINTER 2024, 3 Marks; SUMMER 2025, 3 Marks; SUMMER 2025, 3 Marks OR; WINTER 2025, 4 Marks - second set; SUMMER 2026, 7 Marks)**
- **Q.** Tests to be carried out on circuit breaker. **(SUMMER 2023, 7 Marks; WINTER 2025, 7 Marks - second set)**
- **Q.** High voltage tests to be performed on power transformer / impulse testing of power transformer. **(SUMMER 2022, 7 Marks OR; WINTER 2022, 4 Marks OR; WINTER 2025, 7 Marks)**

Other Important Questions:

1. Radio Interference and Cable Testing:

- **Q.** How to measure radio interference? **(SUMMER 2022, 3 Marks OR)**
- **Q.** Enlist the high voltage test on cables. Describe any one in brief. **(SUMMER 2022, 4 Marks OR)**
- **Q.** Write a short note on the cable sample preparation before it is subjected to various tests. **(SUMMER 2023)**

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