

GUJARAT TECHNOLOGICAL UNIVERSITY

BE-7 SEMESTER – OLD PAPER – S22 TO S25 – QUESTION BANK

Subject Name & Code:

High Voltage Engineering- 3170917

Unit 1: Electrostatic Fields and Field Stress Control

Repeated Questions:

1. **Give comparison between uniform and non-uniform field.**
 - Appeared in: S24 (Q1b, 04 marks), W22 (Q4a, 03 marks), W24 (Q5b, 04 marks)
2. **Explain Finite Element Method (FEM). / What is Finite Element Method? Brief it for solving the field problems.**
 - Appeared in: S24 (Q3b, 04 marks), S25 (Q3b, 04 marks), W24 (Q5b, 04 marks), S23 (Q1c, 07 marks)

Other Important Questions:

3. List out different methods of calculation of electric field and list out advantage and disadvantages of Finite Difference Method (FDM). (W22 - Q1a, 03 marks)
4. What is the principle of operation of a resonant transformer? List out its advantage and disadvantages. (W22 - Q5a, 03 marks)
5. Find out advantages and disadvantages of Resonant transformer. (S22 - Q3b, 04 marks)
6. Discuss its advantages and disadvantages of series parallel resonant circuit. (S23 - Q3a, 03 marks)
7. Explain with neat diagram the principle & construction of an electrostatic voltmeter. (S24 - Q2c, 07 marks), (S25 - Q5b, 04 marks)
8. Explain with neat diagram the principles of operations of an electrostatic voltmeter. Discuss its advantages and Limitations for high voltage measurements. (W22 - Q3b, 04 marks)
9. Explain electrostatic voltmeter in brief. (W23 - Q3c, 07 marks)

Unit 2: Numerical Analysis of Electrical Fields in High Voltage Equipment

Repeated Questions:

1. **What is Finite Element Method (FEM)? Brief it for solving the field problems. / Explain Finite Element Method (FEM).**
 - Appeared in: S25 (Q3b, 04 marks), W24 (Q5b, 04 marks), S24 (Q3b, 04 marks), S23 (Q1c, 07 marks)

Other Important Questions:

2. List out different methods of calculation of electric field and list out advantage and disadvantages of Finite Difference Method (FDM). (W22 - Q1a, 03 marks)
3. Explain any one numerical technique in detail with relevant equations (Charge simulation, Finite element, Finite difference, or Boundary element). (S22 - Q2c(OR), 07 marks)
4. What is Finite Element Method for evaluation of field distribution? Discuss the procedure associated with this method and discuss its advantages and limitations. (S23 - Q1c, 07 marks)

Unit 3: Electrical Breakdown in Gases

Repeated Questions:

1. **Define Townsend's first and second ionization coefficients. Obtain Current growth equation due to first and second ionization.**
 - Appeared in: S24 (Q2c(OR), 07 marks), W23 (Q5c, 07 marks), S25 (Q1a, 03 marks), W24 (Q1b, 04 marks)
2. **What is Paschen's law? Explain minimum voltage for breakdown under a given pd condition.**
 - Appeared in: W23 (Q2c, 07 marks), W24 (Q2c(OR), 07 marks), S25 (Q4c, 07 marks)
3. **Explain how a sphere gap can be used to measure the peak value of voltages. What are the parameters and factors that influence such voltage measurement?**
 - Appeared in: W22 (Q3a, 03 marks), W23 (Q2c(OR), 07 marks), S25 (Q3c, 07 marks), W24 (Q4a, 03 marks)
4. **Why is the breakdown strength higher in electronegative gases than in other gases?**
 - Appeared in: S25 (Q3a(OR), 03 marks), W24 (Q1a, 03 marks)

Other Important Questions:

5. Explain partial discharge. (S24 - Q1a, 03 marks)
6. Define the terms: breakdown, ionization, and homogeneous field. (W23 - Q1a, 03 marks)
7. Apply Townsend's Law to derive it's first ionization coefficients with their characteristics. (W22 - Q1b, 04 marks)
8. Analyze Electronegative gases & Discuss the criteria for its breakdown. (W22 - Q1c, 07 marks)
9. Sketch the graph for Breakdown voltage-PD curve for gaseous insulating media with proper indications and nomenclature on X and Y axis. (S22 - Q2a, 03 marks)
10. 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? (S22 - Q2b, 04 marks)
11. Compare the breakdown mechanisms (Townsend's & Streamer Theory) for gaseous insulating medium. (S22 - Q2c, 07 marks)
12. What is time-lag? Discuss its components. (S23 - Q1a, 03 marks)
13. Define the terms: Statistical time lag, formative time lag, total time. (S25 - Q2a, 03 marks)
14. Discuss the factors which affects the components of time lag. (S23 - Q1b, 04 marks)
15. Explain the Townsends criterion for a spark. (S23 - Q2b, 04 marks)
16. Discuss various criteria suggested by researchers for transition from avalanche to streamer. (S23 - Q2c, 07 marks)

17. State and explain Paschen's law. Derive expression for $(pd)_{min}$ and V_{bmin} . Assume $A = 12$, $B = 365$ and $\gamma = 0.02$ for air. Determine $(pd)_{min}$ and V_{bmin} . (S23 - Q2c(OR), 07 marks)
18. Discuss factors affecting breakdown of gases. (S24 - Q4b(OR), 04 marks), (W22 - Q4a, 03 marks)
19. Enlist factors affecting ionization process and state processes responsible for gaseous breakdown. (W24 - Q4b, 04 marks)
20. Draw & Discuss Equivalent circuit of partial discharge. (W23 - Q3a, 03 marks), (S25 - Q3a, 03 marks)
21. Explain particle exchange mechanism for vacuum breakdown. (W23 - Q3b, 04 marks)
22. Discuss post breakdown phenomenon. (W23 - Q3a(OR), 03 marks)
23. A steady current of $600\mu A$ flows through the plane electrodes separated by a distance of 0.5cm when a voltage of 10kV is applied. Determine the Townsend's first ionization constant if a current of $60\mu A$ flows when the distance of separation is reduced to 0.1cm and the field is kept constant at previous value. (W24 - Q5c, 07 marks)

Unit 4: Breakdown in Liquid and Solid Dielectrics

Repeated Questions:

1. **Explain treeing and tracking related to solid breakdown.**
 - Appeared in: **W22 (Q2c, 07 marks), W23 (Q1b, 04 marks), S25 (Q2b, 04 marks)**
2. **What are the commercial liquids? Explain purification test cell system related to liquids.**
 - Appeared in: **W23 (Q3b(OR), 04 marks), S25 (Q3b(OR), 04 marks), W24 (Q2b, 04 marks)**
3. **Explain purification and breakdown tests for Liquid Dielectric.**
 - Appeared in: **W22 (Q2b, 04 marks), S22 (Q3c, 07 marks)**

Other Important Questions:

4. What is difference between Commercial Liquid and pure Liquid? (W22 - Q2a, 03 marks)
5. Enlist different theories of breakdown in commercial liquids and explain any one of them. (W22 - Q2c, 07 marks)
6. Which gases are generally observed while performing dissolved gas analysis of transformer oil? (S22 - Q1a, 03 marks)
7. Draw and explore the Duval's triangle. (S22 - Q1b, 04 marks)
8. Enlist the breakdown mechanisms for solid dielectric. (S22 - Q3a, 03 marks)
9. What is thermal breakdown in solid dielectric? (S22 - Q3b, 04 marks)
10. Explain suspended particle theory related to liquid breakdown. (W24 - Q2a, 03 marks)
11. Explain properties of transformer oil. (W22 - Q5b, 04 marks)
12. Explain breakdown test for Transformer oil. (S24 - Q4b, 04 marks)

Unit 5: Generation of High Voltages

Repeated Questions:

1. **Describe the working of a Van de Graff generator with a neat sketch. / Draw symbolic Construction of Van-De-Graff generator and explain its working. Also mention its applications with merits and demerits.**
 - Appeared in: S24 (Q3c, 07 marks), W22 (Q3a, 03 marks), W23 (Q1c, 07 marks), W24 (Q3c, 07 marks)
2. **Draw and explain Marx circuit and modified Marx circuit of multistage impulse generator. / Differentiate between Marx & modified Marx circuit for multistage impulse generators with circuit.**
 - Appeared in: S24 (Q3c(OR), 07 marks), W22 (Q3b, 04 marks), W23 (Q2b, 04 marks), S25 (Q2c, 07 marks)
3. **Explain Cockcroft-Walton voltage multiplier circuit.**
 - Appeared in: S22 (Q4c, 07 marks), S23 (Q3c, 07 marks)

Other Important Questions:

4. How are switching impulse generated in Laboratory, Explain in brief. (S24 - Q2b, 04 marks)
5. Explain Voltage Multiplier Circuit for generation of High Voltage. (S24 - Q4c, 07 marks)
6. Explain Tesla coil with its circuit & Waveform. (S24 - Q5b, 04 marks), (S25 - Q4b(OR), 04 marks)
7. Develop Marx circuit for multistage impulse generators. (W22 - Q3b, 04 marks)
8. Construct the three stage cascade connection of transformers for producing very high A.C voltages. (W22 - Q3c, 07 marks)
9. Elucidate a generator which converts mechanical energy into electrostatic energy with relevant sketches? How is such generator fitted in laboratory? (S22 - Q3c(OR), 07 marks)
10. Enlist the techniques (at least three for each) for HVAC and HVDC generation. (S22 - Q4a, 03 marks)
11. Compare high voltage testing transformer with power transformer. (S22 - Q4b, 04 marks)
12. Represent the Chhub and Fortescue circuit. (S22 - Q4a(OR), 03 marks)
13. Explain with diagrams, full wave rectifier circuit for producing high d.c.voltages. (W23 - Q2a, 03 marks)
14. Compare the performance of half wave rectifier and voltage doubler circuits for generation of high d.c. voltages. (S23 - Q3b, 04 marks)
15. Define the terms (i) Impulse voltages; (ii) Chopped wave; (iii) Impulse flash over voltage. (S23 - Q3a(OR), 03 marks)
16. Draw two simplified impulse generator circuits. (S23 - Q3b(OR), 04 marks)
17. Describe the construction, principle of operation and application of a multistage Marx's Surge Generator. (S23 - Q3c(OR), 07 marks)
18. List advantages, disadvantages and applications of Van de Graff generator. (S25 - Q1b, 04 marks)
19. Explain cascade transformer unit with isolating transformer for high alternating voltage generation. (W24 - Q3c(OR), 07 marks)
20. Discuss the modified Marx circuit for generating an impulse wave and components used in it. (W24 - Q4c(OR), 07 marks)
21. A ten stage Cockcroft-Walton circuit has all capacitors of $0.06 \mu\text{F}$. The secondary voltage of the supply transformer is 100 kV at a frequency of 150 Hz. If the load current is 1mA determine: 1. Voltage Regulation, 2. The Ripple, 3. The optimum number of stages for

- maximum output voltage. (W22 - Q5c, 07 marks)
22. A 10 stage Cockcroft-Walton circuit has all capacitors of $0.06 \mu\text{F}$. 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 (c) The optimum number of stages for maximum output voltage. (S25 - Q3c(OR), 07 marks)
23. A 12-stage impulse generator has $0.126 \mu\text{F}$ capacitors. The wave front and the wave tail resistances connected are 800Ω and 5000Ω respectively. If the load capacitor is 1000 pF , find the front and tail times of the impulse wave produced. (W22 - Q5c(OR), 07 marks), (S25 - Q5c, 07 marks), (W24 - Q4c, 07 marks)
24. A cascade transformer has four stages. What should be the power rating of the first (bottom most) transformer if the power rating of the last (Topmost) transformer is 'P'. (S22 - Q3a(OR), 03 marks)

Unit 6: Measurement of High Voltages

Repeated Questions:

1. **Explain High voltage Schering bridge for $\tan\delta$ and capacitance measurement of Insulators.**
 - Appeared in: S24 (Q1c, 07 marks), W22 (Q5b, 04 marks), S25 (Q1c, 07 marks)
2. **How Potential Divider method used for measurement of high voltage DC with its limitations.**
 - Appeared in: S24 (Q3b(OR), 04 marks), W23 (Q4b, 04 marks)
3. **Explain front and tail times of an impulse wave with neat sketch.**
 - Appeared in: S24 (Q4a, 03 marks), W23 (Q4a, 03 marks)

Other Important Questions:

4. Discuss high voltage Schering bridge. (W22 - Q5b, 04 marks)
5. Enlist a table for High voltage measurement techniques for DC Voltages, AC voltages (Power frequency) and Impulse voltages. (S22 - Q4b(OR), 04 marks)
6. Sketch and explore generating voltmeter in detail. (S22 - Q4c(OR), 07 marks)
7. What are the different methods of high DC voltage Measurement? Explain generating voltmeter method in detail. (W22 - Q5a(OR), 03 marks)
8. Explain generating voltmeters used for measuring high voltage. (W24 - Q3b, 04 marks)
9. Explain capacitance voltage transformer with its schematic representation, Equivalent circuit & Phasor diagram. (W22 - Q3c, 07 marks), (W23 - Q3c, 07 marks)
10. What is capacitance voltage transformer (CVT)? Explain tuned CVT for voltage measurement with phasor diagram. (W23 - Q4c(OR), 07 marks)
11. What are the requirements of a sphere gap for measurement of high voltages? (S23 - Q4a, 03 marks)
12. Discuss the disadvantages of sphere gap for measurements of high voltages. (S23 - Q4b, 04 marks)
13. Explain with neat diagram how rod gaps can be used for measurement of high voltages. Compare its performance with a sphere gap. (S23 - Q4c, 07 marks)
14. Draw a simplified equivalent circuit of a resistance potential divider. (S23 - Q4a(OR), 03 marks)
15. What are the problems associated with measurement of very high impulse voltages? (S23 - Q4b(OR), 04 marks)
16. Discuss and compare the performance of (i) resistance (ii) capacitance potential dividers for measurement of impulse voltages. (S23 - Q4c(OR), 07 marks)
17. List out the common test facilities available in High Voltage Lab. (S24 - Q4a(OR), 03 marks), (S25 - Q2c(OR), 07 marks), (W24 - Q4b, 04 marks)
18. Discuss the different methods of measuring high D.C. Voltages. What are the limitations. (S25 - Q4b, 04 marks)
19. Explain Trigatron gap. (W24 - Q4a(OR), 03 marks)

Unit 7: Overvoltages and Insulation Coordination

Repeated Questions:

1. **What is meant by insulation co-ordination? How are the protective devices chosen for optimal insulation level in power system?**
 - Appeared in: S24 (Q4c(OR), 07 marks), W22 (Q4c, 07 marks), S22 (Q5c, 07 marks), S25 (Q4c(OR), 07 marks), W24 (Q5c, 07 marks)
2. **What is surge arrester? Explain in brief. / Explain its importance/application in power system.**
 - Appeared in: S24 (Q5a, 03 marks), S25 (Q5a, 03 marks), W24 (Q3a(OR), 03 marks)
3. **Explain corona discharge. What are different factor affecting Corona losses? How Corona loss can be eliminated?**
 - Appeared in: S24 (Q5c, 07 marks), S25 (Q5c, 07 marks), W24 (Q2c, 07 marks)

Other Important Questions:

4. List out the causes of overvoltage in power voltage. (S24 - Q5b(OR), 04 marks)
5. The lightning mechanism, energy in lightning nature of danger. (Syllabus)
6. What are the mechanisms by which lightning strokes develop and induce over voltages on overhead power lines? (W24 - Q1c, 07 marks)
7. Explain the lightning mechanism including stepped leader stroke and power return stroke with appropriate diagram. (W22 - Q4c(OR), 07 marks)
8. What are the components of lightning strike? Give a sketch of it. (S22 - Q5b, 04 marks)
9. Explain Metal Oxide Arrestor. (W24 - Q3a, 03 marks)
10. Discuss Rod Gap Arrester. (W23 - Q4b(OR), 04 marks)
11. Explain clearly how the rating of a lightning arrester is selected. (S23 - Q5a(OR), 03 marks)
12. What are BILS? Explain their significance in power system studies. (S23 - Q5b(OR), 04 marks)

Unit 8: Non-Destructive Test Techniques

Repeated Questions:

1. **Discuss power frequency tests of insulator.**
 - Appeared in: S24 (Q2a, 03 marks), S25 (Q5a(OR), 03 marks), W24 (Q5a, 03 marks)
2. **Explain Sweep Frequency Response Analysis (SFRA).**
 - Appeared in: S24 (Q3a, 03 marks)

Other Important Questions:

3. What is the present-day technique to monitor the mechanical integrity of big size power transformer? Discuss in detail. (S22 - Q1c, 07 marks)
4. Frequency Response Analysis Method (FRA)- Introduction, Sweep Frequency Response Analysis (SFRA), procedure, methods of interpretation of signature. (Syllabus)
5. Measurement of dc resistivity - dielectric loss and capacitance measurements, the Schering bridge, current comparator bridges, Tan Delta measurement. (Syllabus)
6. Partial-discharge (PD) measurements - the basic PD equivalent circuit, Dissolved gas analysis - Key gas method, Duval triangle. (Syllabus)
7. Draw a neat diagram of high voltage Schering bridge and analyse it for balanced condition. Draw its phasor diagram. Assume (i) Series equivalent (ii) Parallel equivalent representation of the insulating material. (S23 - Q5c(OR), 07 marks)
8. Discuss the method of balanced detection for locating partial discharges in electrical equipments. (S25 - Q5b(OR), 04 marks), (W24 - Q3b(OR), 04 marks)
9. What is partial Discharges? (W23 - Q5a(OR), 03 marks)
10. Explain how partial discharges in an insulation system or equipment can be detected and displayed. (W23 - Q5c(OR), 07 marks)
11. How to measure radio interference? (S22 - Q5a(OR), 03 marks)

Unit 8: High Voltage Testing

Repeated Questions:

1. **Explain high voltage test on Insulator.**
 - Appeared in: S24 (Q5a(OR), 03 marks), S25 (Q4a, 03 marks)

Other Important Questions:

2. Discuss H.V testing of overhead line insulator. (W22 - Q4b, 04 marks)
3. Enlist the high voltage test on cables. Describe any one in brief. (S22 - Q5b(OR), 04 marks)
4. Enlist the high voltage tests to be performed on power transformer and explain any one in detail with relevant sketch. (S22 - Q5c(OR), 07 marks)
5. Testing of insulators and bushings, testing of isolators and circuit breakers. Testing of cables, testing of transformers, testing of surge diverters. (Syllabus)
6. Explain briefly impulse testing of power transformer. (W22 - Q4b(OR), 04 marks)
7. What are partial discharges? Differentiate between internal and external discharges. (S23 - Q5a, 03 marks)
8. Write a short note on the cable sample preparation before it is subjected to various tests. (S23 - Q5b, 04 marks)
9. Describe various tests to be carried out on a circuit breaker. (S23 - Q5c, 07 marks)
10. Explain with neat sketch, testing transformer construction. (W23 - Q5b, 04 marks)
