# Dhanalakshmi Srinivasan Engineering College Perambalur
# Department of EEE

## QUESTION BANK

## *EE1353-HIGH VOLTAGE ENGINEERING*

### UNIT-I
### OVER VOLTAGES IN ELECTRICAL POWER SYSTEM

**PART-A**

1. What are the causes of over voltages in power system?
2. What are the causes of power frequency over voltages?
3. What are the different types of fault that may occur in power lines?
4. What are harmful effects of lightning?
5. Name the source of switching surges.
6. Mention the different kinds of over voltages.
7. What are temporary over voltages?
8. What is lightning phenomenon?
9. Define level of thunderstorm (or) isokeraunic level.
10. What are meant by switching surges?
11. State the different methods of protection against over voltages.
12. What is surge diverter?
13. What is a ground wire or shielded wire?
14. Define tower footing resistance.
15. Define shielding angle.
16. What are meant by ground rods and counter poise wires?
17. Compare switching surges and lightning surges.
18. Write the expression for voltage developed during lightning.
19. Why a simple spark gap cannot offer full protection against over voltages?
20. What are the measures to control over voltages due to switching and power frequency?
21. What are the causes of power frequency over voltages?

**PART-B**

1. Discuss the mechanism of lightning strokes and over voltages on transmission lines.
2. Discuss the different theories of charge formation of thunder clouds.
3. Discuss the effects of various faults and abnormal conditions occur in HV system. Also suggest the remedial measures for each item.
4. A). Give the mathematical model for lightning discharges and explain them.
   B). Explain the different characteristics of lightning strokes.

5. A). Explain the various methods to control switching over voltages.
   B). give a brief note on protection of transmission line using surge diverters.
6. Write short notes on:
   A). Rod gaps as protective devices.
   B). Ground wires for protection of over head lines.
7. What are the causes for power frequency over voltages? How they are controlled in power system?
8. What are the different methods employed for lightning protection of overhead lines?
9. A transmission line has the following line constant R=0.1ohm/km, L=1.26mH/km, C=0.009μF/km and G=0. If the line is a 3 phase line and is charged from one end at a line voltage of 230kv, find the rise in voltage at the other end, if the line length is 400km.
10. A 3 phase single circuit transmission line is 400km long. If the line is rated for 220kv and has the parameters R=0.1ohm/km, L=1.26mH/km, C=0.009 μF/km and G=0 find
    A). the surge impedance and
    B). velocity of propagation neglecting the resistance of the line.
    If a surge of 150kv and infinitely long tail strikes at one end of the line, what is the time taken for the surge to travel the other end of the line?

## UNIT-II
## ELECTRICAL BREAKDOWN IN GASES, SOLIDS AND LIQUIDS

## PART-A

1. Define gas law.
2. State Paschen's law.
3. Which insulation is used in high voltage circuit breaker of large power rating?
4. What are electronegative gases? Give example.
5. What is time lag in breakdown of dielectric medium?
6. Define statistical time lag and formative time lag.
7. Name the different secondary ionization process.
8. Name the three properties of composite dielectrics that are important to their performance.
9. Name the various mechanism of vacuum breakdown.
10. Define uniform and non-uniform fields and give example for each.
11. What is meant by corona discharges?
12. Define the following as applied to disruptive discharges
    a. Flash over
    b. Spark over.
13. What is meant by Townsend's discharge? Explain its main feature.

14. What are pure liquids dielectrics?
15. What are the gases used as gaseous dielectrics?
16. What is breakdown voltage?
17. What is ionization?
18. Define Townsend's first ionization co-efficient.
19. Define Townsend's second ionization co-efficient.
20. What is streamer?
21. Name the various mechanism of breakdown in solid dielectrics.
22. What is tracking?
23. What is treeing?
24. What are the methods used to prevent treeing and tracking?
25. What is tracking index?
26. What is called a composite dielectric?
27. What are the different theories related with liquid dielectric breakdown?
28. What are the limitations of Townsend's theory?
29. What are the requirements of good solid dielectrics?
30. Distinguish the term dielectric strength and breakdown voltage.
31. Distinguish between insulators and dielectrics and give example for each.

**PART-B**

1. State the criteria for sparking potential and hence obtain the relation between sparking potential and (*pd*) values (Paschen's law). Discuss on the nature of variations of sparking potential with (*pd*) values.
2. A).Explain why electronegative gases have high breakdown strength.
   B).Discuss Meek's theory of breakdown in gases under non-uniform fields.
3. A). Explain streamer theory of breakdown in air at atmospheric pressure.
   B). explain about time lag in gas breakdown.
4. Discuss in details, about the breakdown of vacuum medium.
5. A). What is electrical avalanche? How do avalanche give rise to an electrical breakdown in case of Townsend's type of discharge.
6. Discuss the various mechanism of vacuum breakdown?
7. What are the factors that influence conduction in pure liquid dielectrics and in commercial liquid dielectrics?
8. Explain the various theories which explain breakdown in commercial liquids dielectrics.
9. Deduce the Townsend's breakdown criteria. Also define the Townsend's primary and secondary ionization co-efficient.
10. Explain clearly breakdown in non-uniform fields and corona discharges.
11. Explain various theories of breakdown mechanism of the commercial liquid dielectrics.
12. Explain the characteristics of liquid dielectrics.

13. Explain the different mechanisms by which the breakdown occurs in solid dielectrics.
14. In an experiment of gas it was found that at steady current of 5.5x10-8 A with 0.4cm separation between the plates for constant filed, if the separation reduces to a 1cm results in a current of $5.5X10^{-9}$A, find the Townsend's primary ionization co-efficient..
15. What will be the breakdown strength of air be for small gaps(1mm) and large gaps(20cm) under uniform field condition and standard atmospheric conditions.
16. A solid specimen of dielectric has a dielectric constant of 4.2 and tan $\delta$ =0.001 at a frequency of 50Hz. If it is subjected to an alternating filed of 50kv/cm, calculate the heat generated in the specimen due to the dielectric loss.

## UNIT-III
## GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS

## PART-A

1. Give some uses of HVDC.
2. What are the applications of impulse current wave forms of high magnitude?
3. Explain the necessity for generating impulse currents and mention the features of impulse current generators.
4. How are capacitances connected in an impulse current generator?
5. What are the types of wave form will be available in impulse current generator output?
6. Draw a circuit diagram of a simple voltage doubler.
7. Write the expression to find the optimum number of stages and %ripple in a voltage multiplier circuit.
8. What is tesla coil?
9. Draw a simple tesla coil equivalent circuit for generation of high frequency AC high voltage.
10. What are the advantages of high frequency resonant transformer used in HVAC generation?
11. Find the percentage ripple in the output voltage produced by an 8 stage cockroft-Walton multiplier circuit with a capacitance all equal to 0.005μF. The supply transformer secondary voltage is 125kv at a frequency of 150Hz and the load current is 5mA.
12. A cockroft Walton type voltage multiplier has 8 stages with capacitances all equal to 0.005μF. The supply transformer secondary voltage is 125kv at a frequency of 150Hz and the load current is 5mA.find the optimum number of stages for minimum voltage regulation.
13. A tesla coil has a primary winding rated for 10kv with 2μF capacitance on primary side and 1nF capacitance on secondary side. If the energy efficiency is 5%. Calculate the output voltage.

14. A 12 stage impulse generator has an 0.126μF capacitor. The wave front and wave tail resistances are 800ohms and 5000ohms respectively. If the load capacitor is 1000pF, find the front and tail times of the impulse wave produced.
15. What is voltage multiplier circuit?
16. Distinguish between electromagnetic and electrostatic machines.
17. Name the circuits used to generate HVDC.
18. What are the advantages and disadvantages of Deltatron circuit?
19. What are the limitations of Van de Graff generator?
20. What are the advantages and disadvantages of using cascaded transformer?
21. What are impulse wave specifications?
22. What is the front and tail time of a standard impulse wave? What are the tolerances allowed as per the specifications?
23. How is the wave front and wave tail times controlled in impulse generator circuits?
24. What is peak value?
25. Draw the standard impulse waveform and mark the standard specifications.
26. Give four components of a multistage impulse generator.
27. Define impulse voltage wave shape and mention its specification as per Indian standards.
28. What are the advantages of isolating transformer over cascade transformer units for generating high a.c voltages?

**PART-B**

1. Describe the cascaded transformer connection to generate high alternating voltages.
2. With neat sketch explain the working principle of a cockroft-Walton voltage multiplier circuits.
3. Describe with neat diagram the principle of operation, advantages, limitations and applications of vande-graff generator.
4. Give the Marx circuit arrangement for multistage impulse generator. How is the basic arrangement modified to accommodate the wave time control resistances?
5. What is tesla coil? How is damped high frequency oscillations obtained from a tesla coil?
6. Explain any one method of generating HVAC at power frequency and discuss its limitations (or) features
7. What are the different forms of high voltages classified? Explain any one method of voltage multiplier circuits?
8. Draw and explain the circuits for producing impulse waves.
9. How impulse currents are generated? Explain with the neat diagram.
10. What are the components of multistage impulse generator? Explain.
11. Explain the principle of generation of high frequency AC high voltages briefly.
12. What is the principle of operation of resonant transformer? How it advantageous over cascaded transformers?

13. A 100kv, 400kv//250kv testing transformer has an 8% leakage reactance and 2% resistance on 100kva bus. A cable has to be tested at 5000kv using the above transformer as a resonant transformer at 50Hz. If the charging current of the cable at 5500kv is 0.4A, find the series inductance required. Assume 2% resistance for the inductor to be used and the connecting leads. Neglect dielectric loss of the cable. What will be the input voltage to the transformer?

## UNIT-IV
## MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS

### PART-A

1. What are the general methods used for measurement of high frequency and impulse currents?
2. What are the factors influencing the spark over voltage of sphere gaps?
3. Draw the equivalent circuit of a resistor unit used in HV measurement.
4. What is the high voltage DC measurement techniques used?
5. For what measurement are hall generators normally used?
6. What type of measuring devices is preferred for measurement of impulse currents of short duration?
7. Draw the simple circuit of peak reading voltmeter measurement and its equivalent circuit.
8. List the factors that are influencing the peak voltage measurement using sphere gap.
9. What are the advantages of CVT measurement of HVAC? (or) Why are the capacitive voltage dividers preferred for high A.C voltages measurement?
10. Calculate the correction factors for atmospheric conditions, if the laboratory temperature is $37^{o}$C, the atmospheric pressure is 750mmHg and the wet bulb temperature is $27^{o}$C.
11. What are the limitations of generating voltmeter?
12. State the demerits of CVT measurement for HVAC measurement.
13. What are the different methods used for measurement of high DC currents?
14. What is generating voltmeter?
15. What are the types of peak reading AC voltmeter?
16. What are the uses of peak reading voltmeters for impulse voltage?
17. Define Hall Effect.
18. Define Faraday Effect.
19. What is the advantage of using faraday generator?
20. State the advantages of using Ragowski coil for measurement of high frequency AC.
21. What are the merits of choosing digital techniques for HV measurements?
22. List the elements that constitute error in the measurement of impulse voltage using potential dividers.

23. Explain the merits and demerits of analog and digital techniques used for high voltage measurements.
24. What are impulse current shunts? Mention their design criteria.
25. What are the limitations of generating voltmeter?

**PART-B**

1. Tabulate the high voltage and high currents measurements technique for different types of voltages and currents.
2. Discuss the various techniques for measurement of impulse voltage.
3. Explain with diagram the extended series resistance for high ac voltage measurements.
4. Explain with diagram the generating voltmeter.
5. With neat sketch explain the principle of operation of an electrostatic voltmeter for HVAC measurement. What are merits and demerits?
6. What is CVT? Explain through phasor diagram how a tuned CVT can be used HVAC measurement in substations.
7. Explain sphere gap for measurement of high voltage with diagrams.
8. How do you measure the HVDC using sphere gap? State the factors influencing the measurements?
9. Discuss the effect of humidity on the measurement using sphere gaps.
10. Explain potential divider method of measuring impulse voltage.
11. Explain the operation of peak reading voltmeter.
12. How DC are measured using hall generators.
13. What are atmospheric correction factors? Explain their significance in high voltage measurements.
14. What is meant by 50% disruptive discharge as applied to impulse voltages. Discuss any one method to obtain the same.
15. Describe a new scheme of current transformer measurement introducing electro-optical technique for EHV systems.
16. Explain the construction and operation of different types of shunt.
17. Explain the operation of Faraday generator.
18. Draw schematic diagram the use of CRO for measurement of impulse voltage. Describe the operation of this circuit. What are the steps to be taken to achieve constant and accurate result?
19. What are the different types if resistive shunts used for impulse current measurements? Discuss their characteristics and limitations.
20. With neat diagram, illustrate the measurement of HVAC using digital technique.
21. The effective diameter of the moving disc of an electrostatic voltmeter is 15cm with a separation of 1.5cm. Find the weight in grams that is necessary to be added to balance the

moving plate when measuring a voltage of 50kV D.C. Derive any formula used. What is force of attraction between the plates when they are balanced?

## UNIT-V
## HIGH VOLTAGE TESTING AND INSULATION COORDINATION

### PART-A

1. Name the different types of standard tests conducted on high voltage apparatus.
2. What is the test conducted on bushings?
3. Define withstand voltage.
4. Define impulse voltage.
5. Differentiate type test and routine test. (or) What do you mean by type tests and routine test?
6. Define the term 'ac test voltage' referred to HV testing.
7. Give the values of reference atmospheric conditions as per Indian standard specification.
8. Define disruptive discharge voltage.
9. What are the demerits of synthetic testing of circuit breakers?
10. Define creeping distance.
11. What is insulation co-ordination?
12. Define 50% and 100% flashes over voltage.
13. Differentiate flashover and puncture.
14. What are the different tests done on insulators?
15. What are impulse test?
16. What is the significance of impulse tests?
17. What is an isolator?
18. What are the test conducted on isolators and circuit breakers?
19. What is the test conducted on transformer?
20. What are partial discharges?
21. What is the test conducted on surge arresters?
22. What is the test conducted on cables?
23. Why is insulation coordination needed?
24. State the principle that is followed in the insulation design of EHV and UHV substations.
25. Explain the reasons for conducting wet tests on high voltage apparatus and give the specifications for the water used for wet tests.
26. What are the equipment and devices needed for conducting impulse test on HV equipments?

**PART-B**

1. Explain with neat diagram the impulse testing of transformer. What is the procedure adopted in location of fault?
2. Define the various terms used in testing of HV apparatus in various standards.
3. Explain in detail all the tests done on transformers.
4. Explain the principle and importance of power frequency tests carried out in power transformer.
5. Explain the impulse testing procedure for insulators.
6. A). What is the impulse test done on insulator? Explain.
   B). Explain the synthetic of circuit breakers.
3. What are the different types conducted cables?
4. Explain insulation co-ordination. How are the protective device chosen for optimal insulation level in power systems?
5. What are the different tests conducted on surge diverter.
6. What are the different tests conducted on bushings. Explain them.
7. What are the different power frequency tests done on Bushings? Mention the procedure for testing.
8. What are the significance of short circuit tests on circuit breakers? How are they conducted in HV laboratories?
9. Draw a neat diagram of high voltage Schering's Bridge and describe various features of the bridge.
10. Explain any one method of measuring RIV of transmission line with neat diagram.
11. What is meant by insulation coordination? How are the protective devices chosen for optimal insulation level in a power system?
12. Discuss the various test carried out in a circuit breaker and isolator switches at HV labs.
13. Explain the following terms:
    i). with stand voltage
    ii). Flash over voltage
    iii). 50% flash over voltage
    iv). Wet and dry frequency test as referred to HV testing.
14. Explain the following terms used in HV testing as per the standards.
    i). disruptive discharge voltage
    ii). Creepage distance
    iii). Impulse voltage
    iv). 100% flash over voltage.