

NOORUL ISLAM COLLEGE OF ENGINEERING. KUMARACOIL

Department of Electrical and Electronics Engineering

SEVENTH SEMESTER

HIGH VOLTAGE ENGINEERING (EE 1402)

UNIT I

1. What are the 2 types of over voltages?

Lightning over voltages, Switching over voltages.

2. Explain the various regions of the cloud.

The upper regions of the cloud are positively charged, whereas the lower region and the base are predominantly negative except the local region near the base and the head which is possible.

3. Mention the different theories of charge formation.

Simpson's theory, Reynold's theory and Mason's theory

4. What does a thunder cloud consist?

A thundercloud consists of super cooled water droplets moving upwards and large hailstones moving downwards.

5. Mention the requirements for the thunderclouds and charge formation of air currents.

Moisture and specific temperature range

6. What is back flashover?

When a direct lightning stroke occurs on a tower, the tower has to carry huge impulse currents. If the tower footing resistance is considerable, the potential of the tower rises to a large value, steeply with respect to the line and consequently a flashover may take place along the insulator strings. This is known as back flashover

7. State the parameters and the characteristics of the lightning strokes.

Amplitude of the current, the rate of rise, the probability distribution of them and the wave shapes of the lightning voltages and currents.

8. Define Isokeraunic level or thunderstorm days.

It is defined as the number of days in a year when the thunder is heard or recorded in a particular location. Often it does not distinguish between the groundstrokes and the cloud-to-cloud strokes.

9. State the factors influence the lightning induced voltages on transmission lines.

The ground conductivity, the leader strokes current and the corona.

10. State the attenuation and distortion of traveling waves.

The decrease in the magnitude of the wave as it propagates along the line is called attenuation.

The elongation or change of wave shapes that occur is called distortion.

11. When over voltages are generated in EHV system?

Over voltages are generated in EHV systems when there is a sudden release of internal energy stored either in the electrostatic form or in the electromagnetic form.

12. What are the causes for power frequency and its harmonic over voltages?

Sudden loss of loads, Disconnection of inductive loads or connection of capacitive loads, Ferranti effect, unsymmetrical faults and saturation in transformers etc.

13. What are the uses of shunt reactors?

- Used to limit the voltage rise due to ferranti effect.
- Used to reduce surges caused due to sudden energizing.

14. What is ground wire?

Ground wire is a conductor run parallel to the main conductor of the transmission line supported on the same tower and earthed at every equally and regularly spaced towers. It is run above the main conductor of the line.

15. What is the use of ground wire?

It shields the transmission line conductor from induced charges, from clouds as well as from a lightning discharge.

16. What is an expulsion gap?

Expulsion gap is a device, which consists of a spark gap together with an arc-quenching device, which extinguishes the current arc when the gap breaks over due to over voltage.

17. Mention the parts of an expulsion gap.

It consists of a rod gap in air in series with a second gap enclosed within a fiber tube.

18. What is a protector tube?

It is a device, which consists of a rod or spark gap in air formed by the line conductor and its high voltage terminal. It is mounted underneath the line conductor on a tower.

19. How are the insulation level and the protective safety margin arrived?

Selecting the risk of failure, the statistical safety factor and by fixing the withstand level of any equipment or apparatus corresponding to 90% or 95% of the withstand voltage.

20. Define Basic Impulse Level.

It is defined as the minimum insulation impulse withstands voltage of any power equipment or apparatus. The BIL of a power system is usually chosen as 25% to 30% more than the protective level offered by the protective devices.

21. State the main disadvantages of Zinc Oxide arrester.

It is the continuous flow of power frequency current and the consequent power loss.

22. Mention the various insulation levels in a substation.?

The bus bar insulation is the highest to ensure the continuity of supply in a substation. The circuit breakers, isolators, instrument and relay transformers are given the next lower limit level. The power transformers are the costliest and sensitive devices and the insulation level for it is the lowest.

23. What are surge arresters?

They are non-linear resistors in series with spark gaps, which act as fast switches.

24. What are the various types of surge arresters used for EHV and UHV systems?

Silicon carbide arresters with spark gaps, Silicon carbide arresters with current limiting gaps and the gapless metal oxide arresters.

25. Write the equation of surge admittance and surge impedance of the transmission line.

$$Y(S) = C/L ((S+\alpha - \beta)(S+\alpha + \beta))^{1/2}$$

$$Z(S) = L/C ((S+\alpha-\beta)(S+\alpha+\beta))^{1/2}$$

Where α is the attenuation constant and β is the wavelength constant.

UNIT II

26. Mention the gases used as the insulating medium in electrical apparatus?

Most of the electrical apparatus use air as the insulating medium, and in a few cases other gases such as nitrogen, carbon dioxide, Freon and sulphurhexafluoride

27. What is breakdown voltage?

The maximum voltage applied to the insulation at the moment of breakdown is called the breakdown voltage.

28. What are the two types of electrical discharges in gases?

Non-sustaining discharges, self-sustaining discharges.

29. What is spark breakdown?

Spark breakdown is the transition of a non-sustaining discharge into a self-sustaining discharge.

30. State the two types of theories, which explain the mechanism for breakdown.

Townsend theory and streamer theory

31. What is collision process?

Collision process is mainly gas process, which occurs due to the collision between the charged particles and gas atoms or molecules.

32. What are the two types of collision?

Elastic collision and Inelastic collision

33. What are elastic collisions?

They are collisions which when occur, no change takes place in the internal energy of the particles but only their kinetic energy gets redistributed.

34. What are inelastic collisions?

They are those in which internal changes in energy takes place within an atom or a molecule at the expense of the total kinetic energy of the colliding particle. The collision often results in a change in the structure of the atom.

35. Give examples of inelastic collisions.

Ionization, attachment, excitation and recombination.

36. What is diffusion?

When particles possessing energy, which is exhibited as a random motion, are distributed unevenly throughout a space, then they tend to redistribute themselves uniformly throughout the space. This process is known as diffusion.

37. Define collision cross section.

It is defined as the area of contact between two particles during a collision. In other words the total area of impact.

38. Define the mean free path.

It is defined as the average distance between collisions. The mean free path is expressed as k/p cm, where k is a constant and p is the gas pressure in microns.

39. What is ionization?

The process of liberating an electron from a gas molecule with a simultaneous production of a positive ion is called ionization.

40. What is Townsend's first ionization coefficient?

Townsend's first ionization coefficient is the average number of ionizing collisions made by an electron per centimeter travel in the direction of the field.

41. What is Townsend's secondary ionization coefficient?

The Townsend's secondary ionization coefficient is defined as the net number of secondary electrons produced per incident positive ion, photon, excited particle or meta stable particle.

42. What is an electronegative gas?

An electronegative gas is one in which the electrons get attached to form negative ion.

43. Define an attachment coefficient.

An attachment co-efficient is defined as the number of attaching collisions made by one electron drifting one centimeter in the direction of the field.

44. What is meant by time lag?

The time difference between the application of a voltage sufficient to cause breakdown and the occurrence of breakdown itself is called as time lag.

45. What is a statistical time lag of the gap?

The time which lapses between the application of the voltage sufficient to cause breakdown and the appearance of the initiating electron is called a statistical time lag of the gap.

46. Mention the different mechanisms for the breakdown in vacuum.

Partial exchange mechanism, Field emission mechanism and Clump theory.

47. Write the two mechanisms used in field emission theory?

Anode heating and cathode heating mechanisms.

48. What are the classifications of vacuum?

High vacuum, Very high vacuum and Ultra high vacuum

49. What are liquid dielectrics?

Liquid dielectrics are normally mixtures of hydrocarbons and are weakly polarized.

50. Mention some of the applications of liquid dielectrics.

They are used as impregnants in high voltage cables and capacitors, and for filling up of transformers, circuit breakers. They are also used as heat transfer agents in transformers and as arc quenching media in circuit breakers.

51. Name some examples of liquid dielectrics.

Petroleum oils, Synthetic hydrocarbons, halogenated hydrocarbons, silicone oils and fluorinated hydrocarbons.

52. What are pure liquids? Give examples.

They are chemically pure and do not contain any other impurity even in traces of 1 in 10^9 and are structurally simple. Examples are n-hexane, n-heptane and other paraffin hydrocarbons.

53. Mention the impurities added in liquid dielectrics.

Dust, moisture, dissolved gases and ionic impurities.

54. What are the different types of solid insulating materials?

Organic materials: paper, wood and rubber

Inorganic materials: Mica, glass and porcelain

Synthetic polymers: Persplex, PVC, epoxy resins

55. State the properties of good dielectrics

Low dielectric loss, high mechanical strength, should be free from gaseous inclusions and moisture and be resistant to thermal and chemical deterioration.

56. Name the two types of intrinsic breakdown mechanisms.

Electronic breakdown. Avalanche or streamer breakdown.

UNIT IV

57. Mention the techniques used in impulse current measurements.

Hall generators, Faraday generators and current transformers.

58. Mention the problems associated with bifilar strip design.

The shunt suffers from stray inductance associated with resistance element and its potential leads are linked to a small part of the magnetic flux generated by the current that is measured.

59. Mention the different ways in which the stray effect is reduced in resistance shunt?

Bifilar flat strip design, Co-axial tube or park's shunt design and Co-axial squirrel cage design.

60. Specify the 2 types of arrangements in sphere gaps.

Vertically with lower sphere grounded and Horizontally with both spheres connected to the source voltage or one sphere grounded.

61. State the advantages of Sphere gaps?

They are used for voltage measurements. They are suitable for all types of waveforms from d.c to impulse voltages of short times. They are used for radio frequency a.c voltage peak measurements upto 1 MHz.

62. State the advantages of magnetic potential transformers.

They are simple in construction and designed for any voltage. For very high voltages cascading of the transformers are possible.

63. How is an electric field is measured?

It is measured by introducing a small fixed capacitance probe into the field area and measuring the induced charge on it.

64. Mention the devices used to measure the d.c electric field strength.

Variable capacitor probe and a vibrating plate capacitor.

65. Give the advantages of generating voltmeters

No source loading by the meter. No direct connection to high voltage electrode .Scale is linear and extension of range is easy.

66. Define type test.

They are intended to prove or check the design features and the quality. They are done on samples when new designs or design changes are introduced.

67. Define routine test.

They are intended to check the quality of an individual test piece. They are done to ensure the reliability of an individual test object and quality and consistency of materials used in their manufacture.

68. Define withstand test voltage.

The voltage which has to be applied to a test object under specified conditions in a withstand test is called withstand voltage.

69. Define flashover voltage.

The voltage that causes a flashover at each of its applications under specified conditions when applied to test objects as specified is called flashover voltage.

70. Name the tests conducted on surge diverters.

Power frequency spark over test, Hundred percent impulse spark over test, Front of wave spark over test and residual voltage test.

71. Give any two classification of test on cables.

Partial discharge test and impulse withstand voltage test.

72. Explain the porosity test on insulators.

The insulator is broken and immersed in a 0.5 % alcohol solution under a pressure of 13800 KN/sq.m for 24 hours. The broken insulator is taken out and further broken. It should not show any sign of impregnation.

73. Why is the cable meant for a.c system to be tested with dc supply?

Cables are tested for power frequency ac and dc voltages. During manufacture the entire cable is passed through a higher voltage test and the rated voltage to check the continuity of cable. High voltage dc of 1.8 times the rated dc voltage of negative polarity for 30 minutes is applied and cable is set to have no failure.

UNIT V

74. What is a surge diverter?

It is a non-linear resistor in series with a spark gap kept at line terminals in the substations.

75. Define creeping distance.

It is the shortest distance on the contour of the external surface of the insulator unit.

76. What is the importance of radio interference voltage measurements for extra high voltage power apparatus?

In the power apparatus it produces unwanted electrical signals in radio and high frequency ranges. It is important to see that the noise generated should be reduced. For this purpose this measurement is important.

77. Name the test conducted on bushings.

Power frequency test, impulse voltage test and thermal test.

78. Mention the applications of HVDC in high voltage testing.

In cables during manufacture entire cable is passed through a high voltage test to check its continuity. In insulators to check the design features and quality it is used.

79. Define partial discharge.

An electrical discharge that only partially bridges the dielectric between the conductors. Examples are surface discharge, internal discharge

80. What is treeing?

The spreading of spark channels during tracking in the form of branches of a tree is called treeing.

81. What is the function of surge arrester?

They are capable of discharging 10 to 20 KA of long duration surges and 100 to 250 KA of short duration surge currents.

82. State the consequences of RIV.

When the noise meter measurements are stated the information regarding the specification of meters used in the band pass characteristics and the open circuit the detector characteristics has to be mentioned.

83. What do you mean by radio interference?

The power apparatus produces unwanted signals in the radio and high frequency ranges. These are called radio interference.

84. Define an isolator.

It is a disconnecter or a mechanical switching device, which provides in the open position an isolating distance in accordance with special requirements.

85. Define a circuit breaker.

It is a switch, which automatically interrupts the circuit when a critical current or voltage rating is exceeded.

86. Define 50% flashover.

It is the voltage, which has the 50 % flashover when applied to test object.

87. Define 100 % flash over.

The voltage that causes a flashover at each of its application under specified conditions when applied to test objects as specified.

88. State 2 standard tests to be conducted on HV Transformers.

Induced over voltage test and partial discharge test

UNIT III

89. What does the selection of BIL level for lines depend?

Atmospheric conditions, lightning activity, insulation pollution and acceptable outage of the line.

90. Specify the rectifier circuits for producing high dc voltages from ac sources.

Half wave and full wave rectifiers.

91. What are the classifications of high voltages?
High dc, high ac of power frequency, high ac of high frequency and impulse voltages.
92. What is regulation?
The change of average voltage across the load from the no load theoretical value expressed as a percentage of no load is called regulation.
93. What is a tesla coil?
The high frequency resonant transformer is called as a tesla coil.
94. What are the uses of high frequency high voltages?
They are required for rectifier dc power supplies. Also for testing electrical apparatus for switching surges it is used.
95. Mention the advantages of high frequency transformers.
Saving in cost and size, pure sine wave output, uniform distribution of voltage across the winding coils due to subdivision of coil stack into number of units.
96. How are impulse waves specified?
By defining the rise of front time, fall times to 50% peak value and the value of the peak voltage.
97. Mention the circuits to produce impulse waves.
In the laboratory with a combination of a series R-L-C circuit under over damped conditions or by the combination of 2 R-C circuits.
98. Name the multi test sets used for high voltage testing.
Ac testing transformers, dc units, impulse voltage units.
99. What is transient voltage?
It is an oscillatory wave or a damped oscillatory wave of frequency ranging for few Hundred hertz to few kilohertz.
100. What are the components of a multistage impulse generator?
Dc charging unit, charging resistors, generator capacitors and spark gaps, wave shaping resistors and capacitors, triggering system, voltage dividers and gas insulated impulse generators.
101. Define the duration of the wave.
It is defined as the total time of the wave during which the current is at least 10% of its peak value.
102. How are impulse currents of large value produced?
A bank of capacitors connected in parallel are charged to a specified value and are discharged through a series R-L circuit.
103. How will you generate rectangular current pulses with high magnitudes?
They are generated by discharging a pulse network.

104. Mention the advantage of trigatron gap?

It requires much smaller voltage for operation compared to the three-electrode gap.

105. What are the components of a trigatron gap?

It consists of a high voltage spherical electrode of suitable size, an earthed main electrode of spherical shape and a trigger electrode through the main electrode.

16 Marks questions

- 1.Explain the various mechanisms of breakdown in Solid dielectric.
- 2.Explain the various mechanisms of breakdown in liquid dielectric.
- 3.Explain the various mechanisms of breakdown in Gaseous dielectric.
- 4.Define Townsend's first and second ionization Co-efficient and Explain the Townsend's Criterion for breakdown.
- 5.Explain the various mechanisms of breakdown in Vacuum di-electric
- 6.How and are determined experimentally.
- 7.Explain the natural causes of over voltage and how if induce over voltage on overhead power lines,
- 8.What are the various causes of over voltage due to switching surges and how it can be Prevented.
- 9.What are the various causes of over voltage due to power frequency and how it can be Prevented.
- 10.Define the mathematical model of lighting over voltage.
- 11.Explain the various tests to be carried out on Insulator
- 12.Explain the various tests to be carried out on circuit breaker.
- 13.Explain the various tests to be carried out on Power transformer.
- 14.Explain the various high voltage tests to be carried out on cables.
- 15.Explain the various high voltage tests to be carried out on Isolator
- 16.Explain the various high voltage tests to be carried out on surge diverter
17. Discuss the different methods of measuring high voltage dc.
- 18.Explain the principle and construction of an electrostatic voltmeter for very high voltages. Also mention its merits and demerits for high voltage ac measurement.
19. Explain how a sphere gap can be used to measure the peak voltages? What are the parameters and factors that influence such voltage measurement?

20. Give the schematic arrangement of an impulse potential divider with an oscilloscope connected for measuring impulse voltage.
21. Explain the various potential divider used for a.c voltage measurements.
22. What is a mixed potential divider? how is it used for the measurement of Impulse voltage
23. What are the various methods for measuring impulse current
24. Explain the construction and working of multistage impulse generator
25. Explain the construction and working of Van de graff generator
26. Explain the construction and working of cascaded voltage doubler circuit
27. Explain the construction and working of generating voltmeter
28. Explain the construction and working of cascaded transformer for high a.c voltage measurement
29. Explain the construction and working of Tesla coil
30. Explain the various methods of generating switching surge voltage
31. Explain the construction and working of Electrostatic voltmeter

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Two marks questions

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