Department of Electrical and Electronics Engineering

High Voltage Engineering 2

mark Question with answers

Unit I

Overvoltage's in Electrical Power System

1. Write some applications of high voltage?

   Cathode ray tubes, particle accelerators, Xerography, Electrostatic precipitators, Nuclear Research

2. What are the causes of over voltages in a power system?

   Lightning and Switching surges are the causes of overvoltages.

3. What are the theories associated with the formation of charges in clouds?

   - Simpson's theory
   - Reynold's and mason's theory

4. What are the types of lightning strokes

   - Direct stroke
   - Indirect stroke

5. What are the sources of switching surges?

   - De-energizing of the lines, cables and shunt capacitors
   - Disconnection of unloaded transformers and reactors
   - Opening and closing of the protective devices
   - Arcing ground

6. What are the factors to be considered for switching over voltages in EHV and UHV system?

   - Interruption of low inductive currents by high speed circuit breakers
   - Ferro resonance condition
   - Interruption of fault current when the fault is cleared

- Single pole closing of Circuit breakers.
- Resistance switching used in circuit breakers.
- Sparking of the lightning arrestors located in the receiving end of the line.

7. What are the methods to control overvoltage due to switching and power frequency?
    - One or multi-step energization of lines by inserting resistors.
    - Phase controlled closing of Circuit breakers with proper sensors.
    - Drain the trapped charges before reclosing the lines
    - Using shunt reactors
    - By using lightning arrestors or surge arrestors.
8. Write the causes of power frequency overvoltages.
    - Sudden load rejection
    - Disconnection of inductive and capacitive loads
    - Ferranti effect
    - Saturation in transformers
    - Tap changing operation
9. What are the various methods of protecting the power system from lightning?
    - Using Ground wires
    - Using ground rods
    - Using counter poise wires
    - Using protective devices like rod gap, expulsion and valve type surge arrestors.
10. What are the uses of ground wires?

    It is used for direct stroke protection of lines for voltages of 110 kv and above and from attenuation of travelling waves in the line.

11. What are the methods to vary the tower footing resistance?
    - Varying the spacing of the rod.
    - Varying the number of rods
    - Varying the depth to which they are driven

12. What are the requirements of the lightning arrestor?

- Should not pass any current to the system component which to be protected abnormal condition.
- Should discharges the surge current without any damage.
- Should interrupt the power frequency follow current after the surge is discharged.

13. What are the advantages of rod gaps?

It is simple in construction and Cheap

14. What are the disadvantages of rod gaps?

It does not interrupt the power frequency follow current. Every operation of the ground rod results in a line to ground fault and the breaker must operate to isolate the faulty section.

15. What are the disadvantages of expulsion type lightning

arrestor? It has poor volt ampere characteristics.

Unit II

Electrical Breakdown in Gases, Solids and Liquids

1. Define breakdown voltage.

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

2. What are the electrical discharges in gases?

Non sustaining type and self sustaining type discharge

3. What are the theories associated with the breakdown in gases?

Townsend's theory

Streamer's theory

4. What are the types of collision?

- Elastic collision
- Inelastic collision

5. Define collision cross section.

It is defined as the area of contact between two particles during a collision.

6. Define mean free path.

It is the average distance between collision.

7. Define Ionization.

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

8. Define electron attachment process.

   The type of collisions in which electrons may become attached to atoms or molecules to form negative ions are called attachment collisions.

9. Define Townsend's first ionization co-efficient.

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

10. Define Townsend's ionization co-effiecient.

    The net number of secondary electrons produced per incident positive ions, photons, excited particle or meta stable particle and the total value of all is called Townsend's Second ionization coefficient.

11. What is a streamer?

    When a positive voltage pulse is applied to a point electrode, a filamentary branch is formed by ionization. This discharge is called streamer.

12. Write the Townsend's criterion for breakdown.

$$\Gamma[\exp(\alpha d)]=1$$

13. State Paschen's law.

    V=f(Nd) where N is the density of the gas molecules.

14. What are the properties of vacuum?

    - No conduction
    - Act as a perfect insulating medium

15. What are the uses of vacuum insulator?

    Particle accelerators, X-ray tubes, Field emission tubes, Electron microscope, circuit breakers.

16. What are the mechanisms in vacuum breakdown?

    - Particle exchange mechanism
    - Field emission mechanism

- Clump theory

17. Write the several theories proposed to explain the breakdown in liquids.

- Suspended particle mechanism
- Cavitation and bubble mechanism
- Stressed oil volume mechanism

18. What are the various types of breakdown?

- Chemical and Electromechanical detoriation and breakdown
- Breakdown due to treeing and tracking
- Breakdown due to internal discharge
- Intrinsic breakdown
- Electromechanical breakdown

19. What is tracking?

When voltage is applied, a formation of continuous conducting paths across the surface of the insulation due to surface erosion is called tracking.

20. What is treeing?

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

21. What is called a composite dielectric?

Different dielectric materials can be in parallel with each other or in series with one another.

22. Name the various mechanisms in composite dielectric.

- Short term breakdown and
- long term breakdown

Unit III

Generation of High Voltages and High Currents

1. What are the different forms of high voltages?

- High DC voltages
- High ac voltages of power frequency

- High ac voltages of high frequency
- High transient or impulse voltage of very short duration
- Transient voltages of longer duration such as switching surges.

2. What are the applications of high voltages?
    - Electron microscopes and x-ray units in the order of 100KV or more.
    - Electrostatic precipitators
    - Testing purposes to simulate over voltages due to lighning and switching.
3. Name the methods used to generate High voltage DC.
    - Half and full wave rectifier
    - Voltage doubler circuit
    - Voltage multiplier circuit
    - Van de Graff generator
4. Write the equation for optimum number of stages in Cockcroft Walton Voltage multiplier circuit.

$$n_{optimum} = \sqrt{\frac{V_{max}}{fC\,I}}$$

5. Write the basic principle of Electrostatic machines.

    In electrostatic machines, current carrying conductors are moved in a magnetic field, so that the mechanical energy is converted into electrical energy.

6. What are the advantages of Van de graff generator?
    - Very high DC voltage
    - Ripple free output
    - Precision and flexible of control
7. What are the limitations of Van de graff generator?
    - Low current output.
    - Limitations on belt velocity due to vibration.
    - It is difficult to have an accurate grading of electric fields

8. What are the methods to generate High alternating voltages?

- Cascaded Transformers
- Resonant Transformers

9. What are the advantages of using cascade transformer with isolating transformer?
    - Natural cooling is sufficient.
    - Transformer are compact in size
    - Constructional is identical
    - Three phase connection in star or delta is possible
10. What are the advantages of resonant transformers?
    - It gives an output of pure sine wave.
    - Power requirement is less.
    - No high power arcing and heavy current surges occur.
    - Cascading is also possible for very high voltages.
    - Simple and compact test arrangement.
11. What are the advantages of High frequency ac transformers?
    - The absence of iron core in transformers and hence saving in cost and size.
    - Pure sine wave output.
    - Slow build up of voltage over a few cycles and hence no damage due to switching surge.
12. Define the standard impulse wave . 1.2/50μs
13. Define front time.

    It is the time required for the response to raise from 10% to 90% or o to 100% of the final value at the very first instant.

14. What is peak value?

    The maximum positive deviation of the output with respect to its desired value is known as peak value.

15. What are the components of multi-stage impulse generator?
    - DC charging set
    - Charging resistor

- Generator capacitor or spark gap
- Wave shaping resistors and capacitors
- Trigerring system
- Voltage dividers
- Gas insulated impulse generators

Unit IV

Measurement of High Voltages and High Currents

1. What are the methods to measure DC voltages?
    - Series resistance micrometer
    - Resistance potential divider method
    - Generating voltmeter
    - Sphere and other gaps
2. What are the methods to measure ac voltages(power frequency) ?
    - Series impedance ammeters
    - Potential dividers
    - Potential transformers
    - Electrostatic voltmeters
    - Spher gap
3. What are the methods to measure high frequency ac voltages and impulse voltages?
    - Potential divider with a CRO.
    - Peak voltmeters
    - Sphere gaps
4. What are the methods to measure direct currents?
    - Resistive shunt with milli-ammeters
    - Hall effect generator
    - Magnetic links

5. What are the methods to measure alternating currents?
    - Resistive shunts
    - Electromagnetic current transformers
6. What are the methods to measure high frequency ac, impulse and rapidly changing currents?
    - Magnetic potentiometer or Rogowski coils
    - Magnetic Links
    - Hall effect generator
7. What are the limitations in the series resistance design?
    - Power dissipation and source loading
    - Temperature effects and long time stability
    - Voltage dependence of resistive elements
    - Sensitivity to mechanical stresses
8. Define Generating voltmeter.

    A generating voltmeter is a variable capacitor electrostatic voltage generator which generates current proportional to the applied external voltage.
9. What are the advantages of Generating voltmeters?
    - No source loading in the meter
    - No direct connection to high voltage electrode
    - Scale is linear and extension of range is easy.
10. What are the limitation of Generating Voltmeters?
    - They require calibration
    - Careful construction is needed and is cumbersome instrument requiring an auxillary drive
    - Disturbance in position and mounting of the electrodes make the calibration invalid.
11. What do you mean by CVT?

Capacitance voltage transformer is a device used to measure voltages. It consists of a capacitance divider with a suitable matching or isolating potential transformer tuned for resonance condition.

12. What are the advantages of CVT?

- Simple design and easy design
- Can be used both as a voltage measuring device for meter and relaying purpose and also as a coupling condenser for power line carrier communication.
- Provides isolation between the high voltage terminal and low voltage metering.

13. What are the disadvantages of CVT?

- Voltage ratio is susceptible to temperature variations.
- In the presence of capacitance and choke, the problem of ferro-resonance occurs in power system.

14. What is the principle used in electrostatic voltmeter?

If the electric field is produced by the voltage between a pair of parallel plate disc electrodes, the Force F on an area A of the electrode, for which the field gradient E is the same across the area and perpendicular to the surface.

15. What are the advantages of electrostatic voltmeter?

- Low loading effect
- High pressure or vacuum between electrodes provide very high resistivity.
- Voltage upto 600 KV can be measured.

16. What are the types of potential dividers?

- Resistive
- Capacitive
- Mixed

17. What are the types of peak reading AC voltmeters?

- Series capacitor peak voltmeter
- Digital peak voltmeter
- Peak voltmeter with potential dividers

18. What are the factors which influence the peak voltage measurement using sphere gap?

- Nearby earthed objects
- Atmospheric conditions
- Influence of humidity
- Irradiation
- Polarity and rise time of voltage waveform
- Switching surge

19. Define Hall effect.

    Whenever an electric current flows through a metal plate in a magnetic field perpendicular to it, Lorenz force will detect the electrons in the metal plate in a direction perpendicular to both the magnetic field and the flow of current. The change in displacement generates an emf called the Hall effect.

20. How is the resistance shunt designed?

    - Bifilar flat strip design
    - Coaxial tube or Park's shunt design
    - Coaxial squirrel cage design

21. Define Faraday effect.

    When a linearly polarized light beam passes through a transparent crystal in the presence of a magnetic field, the plane of polarization of the light beam undergoes rotation. These rotations of polarization are proportional to the current.

22. What are the advantages of using Faraday's generator?

    - No connection between the source and the device
    - No thermal problem even for large currents of several KA.
    - No insulation problem arises for EHV system because the signal transmission is through optical system.

Unit V

High Voltage Testing and Insulation Coordination

1. What are the classifications of

   testing? Power frequency voltage tests

   Impulse voltage tests

2. Define critical disruptive voltage.

   It is the voltage which produces the loss of dielectric strength of an insulation.

3. Define withstand voltage.

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

4. Define Fifty Percent Flashover voltage.

   It is the voltage which has a probability of 50% flashover when applied to the test object.

5. Define Hundred Percent Flashover voltage.

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

6. Define Creepage distance.

   It is the shortest distance on the contour of the external surface of the insulator unit or between two metal fittings on the insulator.

7. Write the reference atmospheric condition according to Indian

   standard. Temperature: 27^0C

   Pressure : 760 torr

   Absolute humidity: 19gm/m^3

8. Differentiate between type test and routine test.

   Type test: It is intended to prove or check the design features and the quality. It is done on samples.

   Routine test: It is intended to check the quality of the individual test piece. It is done to ensure the reliability of the individual test objects and quality and consistency of the materials used in their manufacture.

9. What are the impulse tests?

   - Impulse withstand voltage test
   - 50% dry impulse flash over test
   - Pollution test

10. What are the test conducted on an isolators and circuit breakers?

    - Dielectric test or overvoltage test

- Temperature rise and mechanical test
- Short circuit test

11. What are the tests conducted on transformers?
    - Induced overvoltage test
    - Partial discharge test
    - Impulse testing
12. What are the uses of induced overvoltage test on transformer?
    - Reduce core saturation
    - Limit the charging current
    - Check the insulation withstand strength
13. What are the tests conducted on surge arrestors?
    - Power frequency spark over test.
    - 100% standard impulse spark over test
    - Front of wave spark over test
    - Residual voltage test
    - High impulse current test
14. What are the test conducted on cables?
    - Mechanical Test
    - Thermal duty test
    - Dielectric power factor test
    - Power frequency withstand voltage test.
    - Impulse withstand voltage test
    - Partial discharge test
    - Life expectancy test
15. What are the tests conducted on bushings?
    - Power Frequency tests

- Impulse voltage tests
- Thermal tests

16. Define thermal coordination.

    The selection of suitable values for the insulation levels of the various components in any electrical system and their arrangement in a rational manner is called insulation coordination.

17. What is insulation level of an apparatus?

    It is defined as that combination of voltage values which characteristics its insulation with regards to its capability of withstanding the dielectric stresses.

18. Why is insulation coordination needed?

    - To ensure the reliability and continuity to the utility concerns
    - To minimize the number of failures of lines and substations due to over voltages.
    - To minimize the cost involved in the design, installation and operation of protective devices.