High Voltage Engineering (2160904)

Multiple Choice Questions

Chapter 1 : Electrostatic fields and field stress control

1. **Average electrical field is the magnitude of electrical field**
   (a) at midpoint between conductors
   (b) ratio of potential difference to the distance between the conductors
   (c) at surface of the lower potential electrode
   (d) ratio of potential difference to half the distance between the conductors.

2. **An experimental method for computing the field distribution is**
   (a) solution of Laplace equation
   (a) electrolytic tank method
   (c) digital simulation (d) field intensity method.

3. **Field enhancement factor is the ratio of**
   (a) maximum field to average field
   (b) rms value of electric field to average value
   (c) potential difference to radius of the conductor
   (d) electric field at surface of the hv conductor to electric field at ground conductor.

4. **A numerical method to determine electric field in a multi-conductor geometry is**
   (a) electrolytic tank method
   (b) resistance analog method
   (c) finite element method
   (d) Laplace equation method

5. **Most suitable numerical method to solve electrostatic field problems is**
   (a) Laplace equation method
   (b) charge simulation method
   (c) finite difference method
   (d) resistance analog method

6. **Open geometry does not pose any problem with**
   (a) boundary element method
   (b) charge simulation method
(c) finite difference method
(d) resistance analog method

7. A unique feature of the Boundary Element Method is that
(a) it can be used for electric fields which are uniform only
(b) it can be used only with bounded fields
(c) electric field are proportional to the charge densities on an enclosed electrode which is simulated by real charges
(d) none of the above.

8. Finite Element Method can be used only with
(a) fields which are bounded
(b) fields which are unbounded
(c) fields which are both bounded and unbounded
(d) when high accuracy is not required.

9. A comparison of the accuracies of various computational methods shows a good agreement between the results of
(a) FEM and FDM
(b) CSM and BEM
(c) FEM and CSM
(d) BEM and FEM.

10. The accuracies obtained with the numerical computation of electric fields is usually
(a) < 1%
(b) 2 to 5%
(c) 5 to 10%
(d) can be very high.

1. Electrical conduction in gases was first studied in 1905 by
(a) Loeb
(b) Maxwell
2. According to Townsend current growth process the current \((I)\) in a uniform electric field gap is
   (a) \(I_0e^{-\alpha d}\)
   (b) \(I_0e^{\alpha d}\)
   (c) \(I_0e^{\gamma d}\)
   (d) \(I_0e^{-\gamma d}\)

3. The breakdown criterion in a uniform field electrode gap is
   (a) \(\alpha - \gamma d = 1\)
   (b) \(\alpha = \frac{\eta}{(1 - \gamma)}\)
   (c) \(\gamma e\alpha d = 1\)
   (d) \(\gamma e - \alpha d = 1\)

4. An electronegative gas is one in which
   (a) positive ions are formed along with electrons
   (b) the gas has inherent negative charge
   (c) gas is ionized due to electron bombardment
   (d) the gases in which electron gets attached to form negative ion

5. SF6 is a
   (a) neutral gas
   (b) electronegative gas
   (c) ionizes easily to form ions
   (d) non-attaching gas

6. Ionization coefficients \(\alpha, \gamma\) are functions of
   (a) applied voltage
   (b) pressure and temperature
   (c) electric field
   (d) ratio of electric field to pressure

7. Time lag for breakdown is
   (a) time difference between instant of applied voltage and occurrence of breakdown
   (b) time taken for the voltage to rise before breakdown occurs
(c) time required for gas to breakdown under pulse application
(d) none of the above.

8. Streamer mechanism of breakdown explains the phenomena of electrical breakdown of
(a) very short spark gaps
(b) when $pd$ is less than 1000 torr-cm
(c) very long gaps where field is non-uniform
(d) spark gaps subjected to impulse voltages.

9. Paschen’s law states that
(a) breakdown voltage is a function of electric field
(b) breakdown voltage is a function of $pd$
(c) $\alpha$ and $\gamma$ depends on $E/p$
(d) electronegative gases have high breakdown voltage.

10. Minimum sparking potential of air is about
(a) 100 V
(b) 4.4kV
(c) 40 V
(d) 325 V

11. At standard temperature and pressure the electric field at which breakdown occur in air with a small gap $d$ (cm) is given by
(a) $30 + 6.08/d$
(b) $24.2 + 6.08/d$
(c) $24.2 + 6.08/d$
(d) $30d\left[1 + \frac{0.301}{\sqrt{d}}\right]$

12. For a 1 cm gap in air at 760 mm pressure and 20°C temperature, the breakdown voltage is
(a) 24kV
(b) 30.3kV
(c) 22.92 kV
(d) 40kV
13. Corona occurs before the breakdown in a sphere to ground air gap when ratio of
gap distance to the radius of sphere is
(a) > 1.0
(b) > 3.0
(c) > 10
(d) < 1.0

14. The requirement of gases for insulation purpose is
(a) high dielectric strength and thermal stability
(b) high dielectric strength only
(c) high thermal stability
(d) high thermal stability and low temperature condensation.

15. The mechanism of breakdown in vacuum is due to
(a) particle exchange
(b) field emission
(c) clump formation
(d) all of the above.

16. SF6 has the following property which is not favourable for use in electrical
apparatus:
(a) High dielectric strength
(b) High are quenching ability
(c) It is not environmental friendly and causes global warming
(d) None of the above

17. The breakdown voltage of gas or air with increase in pressure under uniform field
Has relation with pressure
(a) almost linear
(b) square
(c) non-linear
(d) reciprocal

18. The breakdown voltage of a spark gap for impulse voltage is compared to the
breakdown voltage of power frequency ac
(a) same
(b) larger
19. Among the common gases that are used for electrical insulation, which gas has the highest breakdown strength at atmospheric pressure?
(a) Air
(b) Nitrogen
(c) SF6
(d) Oxygen

20. Which of the following gases is an electronegative gas?
(a) Air
(b) O2
(c) SF6
(d) Both O2 and SF6

Chapter : 3-A Breakdown in liquid dielectrics

1. Transformer oil is
(a) askeral
(b) silicone oil
(c) polyester
(d) mineral oil

2. The breakdown strength of mineral oil is about
(a) 20 kV/mm
(b) 50 kV/mm
(c) 3 to 5 kV/mm
(d) 30 to 40 kV/mm

3. tan δ for liquid insulants at 50 Hz should be less than
(a) 0.1
(b) 0.01
(c) 0.001
4. Dielectric constant of mineral oils is about

(a) 1.5 to 2.0
(b) 2.2 to 2.4
(c) 3.0 to 3.5
(d) 1.008

5. DC conductivity of liquid dielectrics at low electric fields is about in Siemens

(a) $10^{-6}$
(b) $10^{-12}$
(c) $10^{-18}$
(d) $10^{-30}$

6. Maximum dielectric strength obtained with pure liquids is about

(a) 100 kV/mm
(b) 10 kV/mm
(c) 1 MV/mm
(d) 50 kV/mm

7. Conduction and breakdown in commercial liquids is affected by

(a) solid particles
(b) vapour or air bubbles
(c) electrode material
(d) all the above three factors a, b and c

8. The relation between breakdown strength and gap distance in liquid dielectrics is $V_b$

(a) $K/d$
(b) $Kdn$
(c) $Kd - n$
(d) $(K_1d + K_2)$

9. Stressed oil volume theory is applicable when

(a) small volume of liquid is involved
(b) large volume of liquid is involved
(c) large gap distance is involved
(d) pure liquids are involved

10. The parameters that affect the breakdown strength of liquids is
11. Which of the following liquids has highest breakdown strength?
(a) Mineral oils
(b) Silicone oils
(c) Chlorinated hydrocarbon oils
(d) Polyolefins or esters

12. Which of the following property is important for a liquid to be used both for electrical insulation and cooling purposes?
(a) Thermal conductivity
(b) Viscosity
(c) Viscosity temperature characteristic
(d) Breakdown strength

13. For good insulating oil, the power factor or tan ‘δ’ at the given frequency of application should be
(a) 0.1
(b) less than 10⁻³
(c) 10⁻² to 10⁻³
(d) 10⁻¹ to 10⁻²

14. The maximum breakdown strength that can be obtained with pure liquids like hexane is about
(a) 1 MV/cm
(b) 100 kV/cm
(c) 250 to 300 kV/cm
(d) 10 MV/cm

15. In a pure liquid dielectric, with the increase in hydrostatic pressure, the breakdown stress
(a) increases linearly up to some extent and does not change afterwards
(b) increases exponentially
(c) decreases
1. The intrinsic breakdown strength of solid dielectrics is about
   (a) 50 to 100 kV/mm
   (b) 500 to 1000 kV/mm
   (c) 5 to 10 kV/mm
   (d) 1 to 5 kV/mm

2. The usual mechanism of breakdown in solid dielectrics is
   (a) intrinsic breakdown
   (b) electromechanical breakdown
   (c) thermal breakdown
   (d) chemical breakdown

3. Long-term deterioration and breakdown occurs in solid dielectrics due to
   (a) thermal phenomenon
   (b) surface discharges
   (c) internal discharges
   (d) treeing phenomenon

4. Paper insulation is mainly used in
   (a) cables and capacitors
   (b) transformers
   (c) rotating machines
   (d) circuit breakers

5. Thermal classification of insulating materials is done for
   (a) gases
   (b) liquids
   (c) solids
   (d) composite insulation

6. Breakdown is permanent in
7. The material used for insulation that is exposed to atmosphere is
(a) ceramics and glass
(b) polyesters
(c) inorganic insulation
(d) rubber and plastics

8. For high frequency applications the following plastic is preferred
(a) polyethylene
(b) polyvinyl chloride (PVC)
(c) polyester
(d) polystyrene

9. The operating temperatures of polyethylene insulation is
(a) −30° to 50°
(b) −60° to 150°
(c) −50° to 80°
(d) 0° to 100°

10. Epoxy resins are used as insulation when
(a) composite insulation is required
(b) when cast in insulation mould is required
(c) for very high temperature applications are needed
(d) filler materials are required

11. Electromechanical breakdown occurs when the thickness due to electrical stress is compressed or reduced to about
(a) 0.9
(b) 0.8
(c) 0.7
(d) 0.6

12. Thermal breakdown occurs when the heat generated inside the insulating material is
(a) equal to or greater than the heat dissipated
(b) less than that the heat generated from the surface  
(c) only under ac voltage application  
(d) none of the above  

13. Breakdown due to internal discharges develops  
(a) in milliseconds  
(b) in few seconds  
(c) over a long duration of several days  
(d) all the above  

14. Electrochemical breakdown and deterioration of insulating material is due to  
(a) temperature rise  
(b) oxidation, hydrolysis or some other chemical action  
(c) only due to hydrolysis and moisture effects  
(d) none of the above  

15. Aging in electrical insulating materials under an electrical field means  
(a) gradual reduction in dielectric strength which may lead to breakdown  
(b) decrease in insulation resistance of the materials  
(c) progressive building up of disruptive discharges inside the material  
(d) all the above  
(e) none of the above  

1. Peak to peak ripple is defined as  
(a) the difference between average dc voltage and peak value  
(b) the difference between maximum and minimum dc voltage  
(c) the difference between maximum ac and average dc voltages  
(d) the difference between ac (rms) and average dc voltages  

2. In a voltage doubler circuit peak to peak ripple is if \( C \): capacitance, \( I \): load current, and \( f \)=frequency  
(a) \( = \frac{3If}{C} \)  

Chapter : 4 Generation of high voltages  

1. Peak to peak ripple is defined as  
(a) the difference between average dc voltage and peak value  
(b) the difference between maximum and minimum dc voltage  
(c) the difference between maximum ac and average dc voltages  
(d) the difference between ac (rms) and average dc voltages  

2. In a voltage doubler circuit peak to peak ripple is if \( C \): capacitance, \( I \): load current, and \( f \)=frequency  
(a) \( = \frac{3If}{C} \)
(b) \( = 2I/\sqrt{fC} \)
(c) \( = 3I/\sqrt{fC} \)
(d) \( = I/\sqrt{fC} \)

3. Optimum number of stages for Cockcroft Walton voltage multiplier circuit are (if \( V_{\text{max}} = \) supply voltage, \( f = \) frequency, \( I = \) load current, \( C = \) stage capacitance)

(a) \( \sqrt{V/IfC} \)
(b) \( \sqrt{IfC/V} \)
(c) \( \sqrt{Vf/IC} \)
(d) \( \sqrt{VfC/I} \)

4. A Van de Graaff generator has a belt speed of 2.5 m/s, charge density of 10 μc/m² and a belt width 2 m. The maximum charging current is

(a) 50 μA
(b) 5 μA
(c) 2 μA
(d) 12.5 μA

5. The nominal rating of a testing transformer in kVA is given by (if \( \omega = \) supply frequency, \( C = \) capacitance loading and \( V = \) output voltage)

(a) \( 0.5 V^2 \omega C \)
(b) \( V^2 \omega C \)
(c) \( 1.5 V^2 \omega C \)
(d) \( 10 V^2 \omega C \)

6. In testing with a resonant transformer, the output voltage is

(a) rectangular wave
(b) triangular wave
(c) trapezoidal wave
(d) pure sine wave

7. Parallel resonant transformer test system is used when

(a) large test voltages are needed
(b) stable output voltage with high rate of rise of voltage is needed
(c) large current is needed
(d) when high frequency test voltage is needed
8. Tesla coil is used for
   (a) generation of sinusoidal output voltages
   (b) generation of very high voltages
   (c) generation of rectangular voltages
   (d) generation of high frequency ac voltages

9. Time to front of a impulse voltage wave-form is defined as
   (a) 1.25 times the interval between 0.1 to 0.9 of peak value
   (b) time interval between 0.1 to 0.9 of peak value
   (c) 1.67 times the interval between 0.1 to 0.9 of peak value
   (d) 1.25 times the interval between 0.3 to 0.9 of peak value.

10. The approximate value of time to front in an impulse voltage generator is
    (a) $3 R_1 C_1$
    (b) $2.3 R_1 C_1$
    (d) $(0.7)(R_1+R_2)(C_1 + C_2)$

11. An impulse voltage generator has a generator capacitance of 0.01 μF, load capacitance of 1 nF, front resistance of $R_1 = 110 \, \Omega$ and tail resistance of $R_2 = 400 \, \Omega$.
    The tail time is
    (a) 40 μs
    (b) 55 μs
    (c) 50 μs
    (d) 10 μs

12. The value of charging voltage used in a medium-size impulse generator is
    (a) 10 to 50 kV
    (b) 50 to 100 kV
    (c) 500 kV
    (d) any value

13. The voltage efficiency of a normal impulse generator for generation of switching impulses is
    (a) less than 30%
    (b) 80 to 90%
    (c) 40 to 60%
    (d) 10 to 90%
14. A 16-stage impulse voltage generator has stage capacitance of 0.125 \( \mu F \) and a charging voltage of 200 kV. The energy rating in kJ is
(a) 40
(b) 50
(c) 80
(d) 640

15. In an impulse current generator the capacitors are connected in
(a) series
(b) parallel
(c) connected in parallel while charging and in series while discharging
(d) connected in series while charging and parallel while discharging

16. Multi test kits used in high-voltage laboratories consist of
(a) ac, dc and impulse voltage test units
(b) ac and dc test units
(c) dc and impulse test units
(d) ac, dc impulse voltage and current test units

17. Impulse current generator output wave-form is
(a) damped oscillatory wave
(b) overdamped wave
(c) critically damped wave
(d) can be damped waved or damped oscillatory wave

18. To minimise the inductance in impulse current generator circuits
(a) capacitor are connected in parallel
(b) capacitors are subdivided into smaller units
(c) air core inductors are used in series
(d) discharge path is made into a rectangular path

19. A trigetron gap is used with
(a) cascade transformer units
(b) impulse current generator
(c) impulse voltage generator
(d) dc voltage double units

20. A oscillatory impulse waveform is represented by
(a) $e^{-at} \cos bt$
(b) $e^{+at} \cos bt$
(c) $e^{-at} - e^{-bt}$
(d) $e^{at} - e^{-bt}$

21. With in the limits of regulation and ripple, the maximum voltage and current rating to which a ‘dc’ voltage multiplier can be built in
(a) 1 MV, 10 ma
(b) 2 MV, 20 ma
(c) 1 MV, 100 ma
(d) no limitation

22. The energy rating of different resistors in impulse generators of medium and large size is
(a) less than 1 kJ
(b) 10 to 20 kJ
(c) 1 to 2 kJ
(d) 2 to 5 kJ

23. Impulse generators needed to test gas-insulated systems are required to produce impulse voltages waves of
(a) 0.1/1 or 0.3/3 μ second
(b) $\frac{1}{10}$ and $\frac{1}{50}$ μ second
(c) 1.2/50 and 25/250 μ second
(d) 4/20 and 8/20 μ second

24. Voltage stabilizers used for regulating high dc voltages are
(a) series type
(b) shunt type
(c) both series and shunt type
(d) shunt or series or degenerative

25. Typical capacitive loading on a testing transformers rated for 100 kVA, 250 kV will be about
(a) less than 1 nF
(b) 3 to 5 nF
Chapter : 5 Measurement of high voltages

1. A generating voltmeter is used to measure
(a) impulse voltages
(b) ac voltages
(c) dc voltages
(d) high-frequency ac voltages

2. A series capacitance voltmeter can measure
(a) dc voltages
(b) ac voltage (rms value)
(c) ac voltage (peak value)
(d) impulse voltages

3. CVT when tuned does not have
(a) ratio error
(b) phase angle error
(c) both ratio and phase angle errors
(d) temperature error

4. Electrostatic voltmeters can measure
(a) only dc voltage
(b) both dc and ac voltages up to high frequency
(c) impulse voltages
(d) ac, dc and impulse voltages

5. Sphere gaps are used to measure
(a) dc voltages
(b) ac peak voltages
(c) dc, ac peak and impulse voltages
(d) only dc and ac peak voltages.

6. Sphere gap measurement is linear and valid for gap spacing less than or equal to
   (a) radius of the sphere
   (b) diameter of the sphere
   (c) half the radius of sphere
   (d) two times diameter of the sphere

7. The main factors that affect the sparkover voltage of sphere gap are
   (a) humidity and waveform
   (b) nearby earthed objects and atmospheric conditions
   (c) diameter of the sphere
   (d) gap spacing, diameter and waveform

8. For an RC divider to be compensated, the condition is
   (a) \( R_1C_1 = R_2C_2 \)
   (b) \( R_1C_2 = R_2C_1 \)
   (c) \( R_1C_1 = R_2C_g \)
   (d) \( (R_1 + R_2)(C_1 + C_2) \mu s. \)

9. Compensated capacitance divider for high voltages (1 MV) generally has a bandwidth of
   (a) 10 MHz
   (b) 1 MHz
   (c) 100 MHz
   (d) 1000 MHz.

10. In a pure capacitive divider, the ground capacitance \( C_g \) is represented by adding additional capacitance from central point of hv capacitor to the ground and is equal to
    (a) \( C_g \)
    (b) \( C_g/3 \)
    (c) \( 2C_g/3 \)
    (d) \( C_g/2 \).

11. For an optimally damped R-C divider, the damping resistance \( R_1 \) connected in hv arm is equal to \( (L = \) high voltage lead inductance, and \( C_g = \) equivalent ground capacitance)
12. The surge impedance of a measuring cable with its resistance neglected, $C_g$ is (if $L$ and $C$ are inductance and capacitance of cable per unit lamp

(a) $\sqrt{L/C}$  
(b) $2\sqrt{L/C}$  
(c) $\sqrt{L/C_g}$  
(d) $\frac{1}{2}\sqrt{L/C_g}$

13. Hall generators are normally used to measure

(a) impulse voltages  
(b) unidirectional impulse currents  
(c) any type of impulse currents  
(d) large ac currents

14. For measuring high impulse currents, the best type of shunt is

(a) squirrel cage  
(b) bifilar strip  
(c) disc  
(d) coaxial tubular (Park type)

15. The skin depth for resistance material used for impulse shunts is given by

(a) $\frac{\sqrt{\pi\mu\sigma}}{\sqrt{LC}}$  
(b) $\frac{\sqrt{\pi\mu\sigma}}{2\sqrt{LC}}$  
(c) $\frac{\sqrt{\pi\mu\sigma}}{2\sqrt{LC}}$  
(d) $\frac{\sqrt{\pi\mu\sigma}}{2\sqrt{LC}}$

16. Rogowski coils and high frequency current transformers have bandwidth of about

(a) 100 KHz  
(b) 10 MHz  
(c) 1.0 MHz  
(d) 1100 Hz

17. An $R$-$C$ voltage divider has a capacitance, $C_1 = 600 \text{ pF}$, resistance $R = 400 \Omega$ and equivalent ground capacitance $C_g = 240 \text{ pF}$. The effective time constant of the divider in nanoseconds is

(a) 108  
(b) 90  
(c) 69
18. Shunts used for measuring impulse currents, in the range 10 kA-50 kA will have a resistance of the order of
(a) 10 to 25 mΩ
(b) 0.1 to 1 mΩ
(c) 100 to 500 mΩ
(d) 0.1 to 1.0Ω.

19. The type of measuring device preferred for measurement of impulse currents of short duration is
(a) Park’s tubular shunt
(b) current transformer
(c) Hall generator
(d) Faraday ammeter.

20. Secondary arm of a resistance impulse voltage divider consists of
(a) a few resistors connected in series
(b) a few resistors connected in parallel
(c) a single wire wound resistor of very high power rating
(d) a linear resistor in parallel with a non-linear resistor of high power rating

21. The resistivity of the materials used as shunts for high currents will be in the range (Ω - cm)
(a) 1 to 5 × 10⁻⁵
(b) ≈10⁻³
(c) 0.5 × 10⁻⁶ to 0.5 X 10⁻⁷
(d) 0.2 × 10⁻⁶ to 1.5 X 10⁻⁶

22. In high frequency and RF current transformers, the secondary winding is terminated with a resistance of
(a) 1 Ω
(b) 10 Ω
(c) 1 kW
(d) 50 Ω or 75 Ω

23. To measure a high-voltage of peak value about 150 kV, the suitable sphere gap would be (diameter in cm)
24. With a series capacitor voltmeter, a large error will result in when the
(a) capacitance is larger
(b) meter used is an electromechanical meter
(c) voltage to be measured is non-sinusoidal and contains harmonics
(d) none above

25. Sphere-gap measurement of peak voltage has an error of
(a) <±1%
(b) 5 to 10%
(c) 3 to 5%
(d) <3%

Chapter : 6 Over voltages, testing procedures and insulation coordination

1. The electrical field developed within clouds before a lightning stroke occurs can be of
the order of
(a) 0.1 kV/cm
(b) 1.0 kV/cm
(c) 100 kV/cm
(d) 10 kV/cm

2. The maximum voltage gradient at the ground level due to a charged cloud before
lightning strikes, can be as high as
(a) 1 V/cm
(b) 30 V/cm
(c) 30 V/m
(d) 300 V/cm

3. The velocity of wind currents required for charge separation inside the moving clouds is of the order
(a) 1 to 5m/s
(b) 5 to 10m/s
(c) 10 to 20m/s
(d) 50 to 200m/s

4. Velocity of leader strokes in lightning discharges is about
(a) 1.5x105cm/s
(b) 1.5x106cm/s
(c) 1.5 x 107 m/s
(d) 1.5 x 108 m/s

5. The velocity of return or main stroke may be of the order of (C = velocity of light)
(a) 0.01 C
(b) 0.001 C
(c) 0.1 C
(d) 0.8 C

6. The peak value of lightning stroke currents are of the order
(a) 100 A
(b) 1000 A
(c) 10 to 100 kA
(d) 106A

7. The cumulative probability of a 10 kA lightning stroke current (peak) is about
(a) 0.6
(b) 0.2
(c) 0.1
(d) 0.98

8. The rate of rise of current \((dI/dt)\) in lightning strokes is
(a) 1 kA/ßs
(b) 100 kA/ßs
(c) 100 A/ms
(d) 1000 kA/ms
9. The ground flashover density \((Ng)\) in any region due to lightning activity is about \((TD = \text{thunderstorm days})\)
(a) 0.1 to 0.2TD/km2-year
(b) 1 to 2TD/km2-year
(c) 30 to 50TD/km2-year
(d) 5 to 15TD/km2-year

10. Surge impedance of loss less transmission line is \((\text{if } L — \text{ inductance/m}, C — \text{capacitance/m})\)
(a) \(\sqrt{C/L}\)
(b) \(\sqrt{L/C}\)
(c) \(1/\sqrt{LC}\)
(d) \(\sqrt{LC}\)

11. The attenuation constant of a transmission line in terms all the parameters \(R, L, G\) and \(C\) is
(a) \(\frac{R + G}{L + C}\)
(b) \(\sqrt{\frac{R}{L} + \frac{G}{C}}\)
(c) \(\frac{1}{2} \left[ \frac{R + G}{L} \right] \frac{1}{C}\)
(d) \(\frac{R - G}{L} \frac{1}{C}\)

12. The reflection coefficient for a travelling voltage wave at a junction of two impedances \(Z1\) and \(Z2\) is
(a) \(\frac{(Z1 + Z2)}{(Z1 - Z2)}\)
(b) \(\frac{(Z2 + Z1)}{(Z2 - Z1)}\)
(c) \(\frac{2Z1}{Z2}\)
(d) \(\frac{2Z2}{Z1 + Z2}\)

13. A 400 \(\Omega\) overhead line is connected to a cable having a surge impedance of 50 \(\Omega\), the transmission coefficient into the cable is
(a) 2/9
(b) 1/4
14. For surge-voltage computation, a transformer is represented by an equivalent circuit of
(a) $R-L$ parallel network
(b) $L-C$ parallel network
(c) $R-L$ series network
(d) $R-L-C$ series network

15. Switching overvoltage in power system networks are of the order of
(a) 1.5pu
(b) 2.5 to 3.5pu
(c) 10pu or more

16. Overhead transmission lines are protected from lightning overvoltages by
(a) counter poise wires
(b) protector tubes
(c) ground or shield wires above the main conductors
(d) shunt reactors.

17. In order to limit the overvoltages developed on ground wires due to lightning strokes, the tower footing resistance should be less than
(a) 1000 $\Omega$
(b) 100 $\Omega$
(c) 25 $\Omega$
(d) 1 $\Omega$

18. For a typical heavy duty (10 kA rated) surge arrester, the discharge voltage at rated current will be of the order of
(a) 1 pu
(b) less than 2.0 pu
(c) more than 3.5 pu
(d) 2.2 to 3.0 pu

19. The material used in gap less surge arresters used in hv power system is
(a) graphite
(b) aluminium oxide
20. Material that is used in surge arresters for EHV and UHV power systems
(a) silicon carbide
(b) zinc oxide
(c) aluminium oxide
(d) metal oxides.

21. The volt ampere characteristic of a non-linear resistor used in surge arrester is given by
(a) $V=KI^2$
(b) $V=KIn$
(c) $V=KTn$
(d) $V=K1I+K2I−1$.

22. The equivalent circuit of a surge arrester may be represented as:
(a) capacitor
(b) an inductor
(c) non-linear resistor
(d) resistor

23. Basic impulse level (BIL) of a power system is defined as
(a) the minimum Insulation Impulse withstand voltage of any power equipment or apparatus
(b) the maximum power frequency withstand voltage of any power equipment or apparatus
(c) the minimum power frequency withstand voltage of any apparatus or power equipment
(d) the peak value of highest system voltages.

24. The BIL of a power system is usually chosen as
(a) 25% to 30% more than the protective level offered by the protective devices (surge arresters etc.)
(b) 50% more than the protective level offered by the protective devices (surge arresters etc.)
(c) 5 to 10% more than the protective level offered by the protective devices (surge arresters etc.)
(d) highest lightning surge voltage expected.

25. In EHV and UHV system the type of surge diverter used for overvoltage protection is
(a) valve type Si C arrester
(b) gapless ZnO arrester
(c) gapless Si C arrester
(d) rod gap

26. The duration of switching surges in GIS is
(a) ms
(b) microseconds
(c) few nanoseconds and less than a microsecond
(d) few tens of micro seconds

27. Indirect strokes near overhead transmission lines induce overvoltages due to
(a) electrostatic induction
(b) both electrostatic and electromagnetic induction
(c) only electromagnetic induction
(d) conduction currents through line conductors

28. In EHV and UHV system, ratio of BIL to SIL will be usually
(a) less than unity
(b) more than 1.5
(c) 1.5 to 2.0
(d) 1.2 to 1.5

29. The purpose of insulation coordination is to
(a) limit the overvoltages
(b) to protect the electrical apparatus against overvoltages
(c) to grade the insulation of different power apparatus and overhead lines such that the least important and easily replaceable apparatus flashes or fails first and the most important one is protected to the highest level.
(d) None of the above a, b or c.

30. The maximum rate of rise of surge currents that occur in overhead lines is
(a) 2 to 3 kA/ms
(b) less than 1 kA/ms
(c) 5 to 10 kA/ms
(d) greater than 10 kA/ms
Chapter : 7 Non-destructive insulation test techniques

1. For resistivity and dielectric constant measurements the electrode system used is
   (a) two electrode
   (b) three electrode
   (c) four electrode
   (d) none of the above

2. A sensitive dc galvanometer has a maximum sensitivity of
   (a) 10−9A/cm
   (b) 10−8A/cm
   (c) 10−6 A/cm
   (d) 10−12 A/cm

3. The power supply used in resistivity measurements is
   (a) ±110V
   (b) ±250 V
   (c) 500 V
   (d) 500 to 2000 V

4. Loss of Charge Method is used to determine
   (a) insulation resistance
   (b) dielectric constant
   (c) loss factor – (tan δ)
   (d) rate of charging of a capacitor

5. The equivalent circuit of a lossy capacitor or dielectric is
   (a) R-C series circuit
   (b) L-C series circuit
   (c) R-C parallel circuit
   (d) L-C parallel circuit
6. The type of bridge used for low frequency (≈ 50 Hz) dielectric measurement is
(a) Transformer ratio bridge
(b) Mole’s-bridge
(c) shunted Schering-bridge
(d) Wagner’s-bridge

7. Wagner’s earth is used with Schering-bridge for
(a) grounding
(b) divert high current through the bridge when specimen fails
(c) suppress spikes and over voltages
(d) eliminating stray capacitance and coupling

8. In a transformer ratio arm bridge, unknown capacitance $C_x$ is given by (if $C_s =$ standard capacitor, and $N_s, N_x$ are the number of turns used on standard capacitor and test capacitor sides)

(a) $\frac{C_s N_x}{N_y}$
(b) $\frac{C_s N_x}{N_y}$
(c) $\frac{C_s N_s C_x}{N_x N_y}$
(d) $\frac{C_s N_x}{N_y}$

9. Current comparator bridge is used
(a) when test capacitance is large
(b) for high-voltage power frequency measurements
(c) for high-frequency low-voltage measurements
(d) low-voltage high-frequency measurements

10. Corona discharge is
(a) an internal discharge
(b) surface discharge
(c) a spark between conductors
(d) partial discharge around a high-voltage conductor

11. Partial discharge magnitude is
(a) quantity of charge measured at the terminals of the specimen
(b) quantity of charge inside a specimen
(c) voltage across the terminals of a specimen
(d) average current through the terminals of the specimen

12. Partial discharge detector is a device that measures or detects
(a) a partial discharge
(b) corona discharge
(c) leakage current
(d) fault current

13. A simple partial discharge detector circuit consists of a power unit and a
(a) coupling capacitor and test capacitor
(b) coupling capacitor, test capacitor, measuring impedance and detector
(c) test capacitor, measuring impedance and a detector
(d) test capacitor, calibrating unit and detector

14. The discharge energy in a partial discharge in terms of discharge magnitude $q$ and
inception voltage $v$ is

   (a) $q_{vi}$
   (b) $\frac{q_v}{\sqrt{2}}$
   (c) $0.5q_{vi}$
   (d) $\sqrt{2}q_{vi}$

15. Partial discharge inception voltage is defined as
(a) the rms value of supply voltage at which partial discharges occur
(b) the lowest value of the voltage at which discharge disappears when the voltage is reduced
(c) the lowest value of the voltage at which discharge appears when voltage is increased
(d) the voltage at which corona discharge starts.

16. In pd detectors partial discharges are displayed on
(a) any CRO
(b) built in CRO with circular time base
(c) built in CRO with elliptic time base
(d) built in CRO with linear time base.

17. The bridge commonly used for measurement of dielectric constant and loss factor in
the audio frequency range 100 Hz to 10 kHz is
(a) high-voltage Schering-bridge
(b) transformer ratio bridge
(c) Wagner’s Bridge
(d) low-voltage high-frequency Schering-bridge

18. The measuring range of high-voltage Schering-bridge with Std. Capacitors of 50 or 100 pf is
   (a) 10pF to 10nF
   (b) 1pF to 1000pF
   (c) 1 nF to 1 μF
   (d) 1 pf to 100 μF

19. The measuring range of a high-frequency low-voltage Schering-bridge is
   (a) 10pF to 10nF
   (b) 1pF to 1000pF
   (c) 1 nF to 1 μF
   (d) 1 pf to 100 μF

20. The charge associated with partial discharges in electrical apparatus will be
   (a) micro coloumbs
   (b) nano coloumbs
   (c) pico coloumbs
   (d) coloumbs

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Chapter : 8 High voltage testing

1. Fifty per cent flashover voltage is defined as
   (a) the voltage at which the flashover probability is 0.5
   (b) the voltage at which corona discharge appears before flashover
   (c) the voltage at which the flashover occurs alternately when applied several times
   (d) the average value of withstand voltage and flashover voltage.

2. Standard atmospheric condition as per Indian Standard Specifications are
   (a) temp = 27°C, pressure = 1013 millibans and humidity = 17 gms/m³
(b) temp = 20°C, pressure = 1013 millibans and humidity = 11 gms/m³
(c) temp = 27°C, pressure = 1013 millibans and humidity = 11 gms/m³
(d) temp = 27°C, pressure = 1000 millibans and humidity = 17 gms/m³.

3. In wet flashover tests, the conductivity of water used is
   (a) 10 ±1.5 μ Siemens
   (b) 100 ±15 μ Siemens at ambient temperature
   (c) 45 ±10 μ Siemens at room temperature
   (d) < 1.0 μ Siemens at 27°C.

4. Most important tests conducted on isolators and circuit breakers are
   (a) voltage withstand tests
   (b) short circuit tests
   (c) high current tests
   (d) temperature rise tests.

5. Fault location in an HV cable is done by
   (a) voltage withstand test
   (b) partial discharge scanning tests
   (c) life tests
   (d) impulse testing

6. In impulse testing of transformers fault location is usually done by
   (a) neutral current oscillogram
   (b) chopped wave oscillogram
   (c) observing for noise or smoke
   (d) scanning method

7. The most important test to assert the proper functions of a surge divertor is
   (a) 100% impulse withstand test
   (b) front of wave spark over and residual voltage tests
   (c) impulse current test
   (d) pollution tests

8. The salt-fog test done on insulators is
   (a) impulse test
   (b) power frequency pollution test
   (c) impulse current test
(d) switching surge test

9. $C$- $\tan \delta$ test on electric bushings is done using
   (a) impulse generator
   (b) high voltage Schering bridge
   (c) power frequency cascade transformer unit
   (d) resonant transformer

10. In $C$- $\tan \delta$ test, a steep increase in $\tan \delta$, when the applied voltage increases from 100% to 110% indicates.
   (a) insulation is failing
   (b) presence of an internal discharge
   (c) increase in relative permittivity
   (d) decrease in insulation resistance

11. Impulse testing of transformers indicates
   (a) winding to ground insulation strength
   (b) winding to winding insulation strength
   (c) dielectric strength, quantity of insulation and processing
   (d) induced voltages in other windings during transients

12. A better method to detect fault during impulse testing is to
   (a) observe the windings after tests
   (b) record more number of test oscillograms of currents and voltages
   (c) use digital recording of waveforms
   (d) analyse the waveforms using waveform analysis techniques such as transfer function techniques

13. Switching impulse tests on UHV and EHV transformers can result in
   (a) failure of transformer windings
   (b) Induce high voltages in other windings
   (c) drive the transformer core the saturation
   (d) both c and b

14. RIV tests on transmission line hardware is done to
   (a) determine the induced noise due to corona
   (b) interfering electric field in the neighborhood of power lines.
   (c) high frequency signals induced in power lines
(d) determine or measure noise generated in radio frequency range due to corona or partial discharges

15. A high-voltage dielectric test done on HVDC valves is
(a) dc corona test
(b) synthetic test
(c) fast transient or steep fronted impulse test
(d) back-to-back test

1. A small high-voltage laboratory usually will have
(a) ac, dc test sources with ratings less than 100 kV, 10 kVA/kW and impulse of voltage 400 kV, 5 kJ
(b) ac, dc test sources of 500 kV, 100 kVA/kW, and impulse of 1 MV, 10 kJ
(c) ac voltage sources of 300 kV, 10 kVA, and impulse voltage of 1 MV, 15 kJ
(d) ac, dc sources only

2. Test sources required for testing power apparatus of 220 kV, 3-phase ac system are
(a) 500 kV ac, 1 MV impulse
(b) 800 kV impulse
(c) 300 kV ac, 500 kV impulse
(d) 250 kVA, 500 kV impulse.

3. The kVA rating of a testing transformer unit intended for test voltage and test object capacitance ‘C’ (pF)
(a) $\omega CV^2$
(b) $\omega CV^2 \times 10^{-9}$
(c) $\omega C^2 V^2 \times 10^9$
(d) $\omega C V^2 \times 10^{-6}$

4. The rating of an impulse voltage generator with generator capacitance $C_g$ and voltage rating $V$ with $n$ stages is (kJ)
(a) 0.5 $C_g V^2$
(b) $(n/2) (C_g V^2) (C_g V^2) (C_g V^2)$
5. The clearances normally adopted in hv laboratories for ac and impulse voltages are

(a) 100 to 200 kV/m for ac and 500 kV/m for impulse
(b) 300 kV/m for ac and 500 kV/m for impulse
(c) 30 kV/m for ac and 50 kV/m for impulse
(d) 10 kV/m for ac and 50 kV/m for impulse

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