**SUBJECT CODE: EE 1003**
**SUBJECT NAME: HIGH VOLTAGE ENGINEERING**

## UNIT-I OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS

**PART-A (1 MARK)**

**1. The electric field developed within clouds before a lighting strokes occurs can be of the order of**
a) .1KV/cm b)1KV/cm c)100KV/cm d)10KV/cm
**2. The maximum voltage gradient at the ground level due to a charged cloud before lighting strikes can be as high as**
a) 1V/cm b)30V/cm c)30V/m d)300V/cm
**3.The velocity of wind currents required for charge separation inside the moving clouds is of the order**
a)1 to 5 m/sec b)5 to m/sec c)10 to 20m/sec d)50 to 100m/sec
**4. Velocity of leader strokes in lighting discharges is about**
a)1.5×10^5 b)1.5×10^6 cm/sec c)1.5×10^7m/sec d)1.5×10^8m/sec
**5.The velocity of return or main stroke may be of the order of (C =velocity of light)**
a)0.01C b)0.001C c)0.1C d)0.8C
**6.The peak value of lighting stroke currents are of the order**
a)100A b)1000A c)10 to 100Ka d)10^6
**7.The cumulative probability of a 10KA lights 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 lighting strokes is**
a)1KA/μs b)100KA/μs c)100A/μs d)1000KA/μs
**9.The ground flash over density(Ng)in any region due to lighting activity is about(TD=thunderstorm days)**
a)0.1 to 0.2 TD/km2-year b)1 to 2 TD/km2-year c)30 to 50TD/km2-year d)5to15TD/km2-year
**10.Surge impedance of loss less transmission line is (if L=inductance/m, C=capacitance/m)**
a)√c/l b)√L/c c)1√LC d)√LC
**11.The attenuation constant of a transmission line in terms all the parameters R,L,G and C is**
a)R/L+G/C b)[R/L+G/C]1/2 c)1/2[R/L+G/C] d)R/L-G/C
**12.The reflection coefficient for a traveling voltage wave at a junction of two impedances z1andz2 is**
a)(z1+z2/z1-z2) b)(z2-z1/z2+z1) c)2z1/(z1+z2) d)2z2/(z1+z2)
**13.A400Ω overhead line is connected to be cable having a surge impedance of 50Ω,thetransmission coefficient into the cable is**
a)2/9 b)1/4 c)-16/9 d)1/9
**14.For surge voltage computation a transformer is a represented by an equivalent circuit of**
a)R-L parallel network b)R-C parallel network c)R-L series network d)R-L-C series network
**15.Switching over voltage in power system network are of the order of**
a)1.5pu b)2.5 to 3.5 pu c)10pu or more d)10pu or more

**16.Overhead transmission lines are protected from lighting over voltage by**

a)counter poise wires b)protector tubes c)ground or shields wires above the main conductors d)shunt reactors

**17.In order to limit the over voltage developed on ground wires due to lighting strokes ,the tower footing resistance should be less than**

a)1000Ω b)100Ω c)25Ω d)1Ω

**18.For a typical heavy duty (10 KA )surge arrester, the discharge voltage at rated current will be of the order of**

a)1pu b)less than 2.0pu c)more than 3.5pu d)2.2 to 3.0 pu

**19.The material used in gap less surge arresters used in H.V power system is**

a)graphite b) aluminum oxide c)zinc oxide d)silicon carbide

**20.Material that is used in surge arresters for EHV and UHV power systems**

a)silicon carbide b)zinc oxide c)aluminum oxide d)metal oxides

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D | C | D | A | D | D | D | A | D | A | D | A | D | A | D | A | C | D | C | B |

**PART-B (2 MARKS)**

**21.Why protection of transmission line important? (AU-NOV/DEC2009)**

It is essential for electrical power engineers to reduce the number of outages and preserve the continuity of service and electric supply.

**22. What are the causes of over voltages in electric system? (AU-NOV/DEC2004,2005,2009,APR/MAY2005,MAY/JUNE2006,2007, NOV/DEC2013)**

- Lightning over voltages
- Switching over voltages

**23.How does switching over voltage originate?**

Switching over voltages originate in the system itself by connection and disconnection of circuit breaker contact or due to initiation or interruption of faults.

**24.What is Iso keraunic level? (AU-APR/MAY2010)**

Isokeraunic level is defined as the number of days in a year when thunder is heard or recorded in particular location.

**25.What are the factors that influence the lightning induced voltage on transmission lines?**

- The ground conductivity
- The leader stroke current
- Corona

**26.How is transmission lines classified?( AU-NOV/DEC2004)**

- Lines with no loss or ideal lines
- Line without distortion or distortion less with small losses
- Lines with infinite and finite length defined by all the four parameters

**27.Define attenuation and distortion.**

The decrease in the magnitude of the wave as it propagates along the line is called attenuation.The elongation or change of wave shape that occurs is called distortion.

**28.How is attenuation and distortion caused? (AU-MAY/JUNE2009)**

Attenuation is caused due to the energy loss in the line an distortion is caused due to to the inductance and capacitance of the line.

**29.What are the causes for the change of induction on transmission line?**

The changes in the inductance are due to the skin effect, the proximity effect and non-uniform distribution effect of the currents and the nearness to steel structures.

**30.What are the causes for the change of capacitance on transmission line?**

The variation in capacitance is due to capacitance change in the insulation nearest to the ground structures, etc.

**31.What is the effect of corona on transmission lines? (AU-NOV/DEC2010)**

The effect of corona is to reduce the crest of the voltage wave under propagation, limiting the peak value to the critical corona voltage. Hence, the excess voltage above the critical voltage will cause power loss by ionizing the surrounding air.

**32.What are the principles observed in the lattice diagram?( AU-MAY/JUNE2008)**

All waves travel down hill, i.e, into the positive time. The position of the wave at any instant is given by means of the time scale at the left of the lattice diagram. The total potential at any instant of time is the super position of all the waves which arrive at that point until that instant of time, displaced in position from each other by time intervals equal to the time difference of their arrival/Attenuation is included so that the amount by which a wave is reduced is taken care. The previous history of the wave, if desired can be easily traced. If the computation is to be carried out at a point where the operations cannot be directly placed on the lattice diagram, the arms can be numbered and the quantity can be tabulated and computed.

**33.Define corona. (AU- APR/MAY2005)**

The traveling wave is divided into a number of sections corresponding to different voltage levels, each voltage level corresponding to a different velocity of propagation since each lamination ionizes a different capacitance. Hence, a distortion is caused in the wave shape.

**34.What are the components of switching surges?**

Switching surges may include high natural frequencies of the system, damped normal frequency voltage component or the restriking and recovery voltage of the system with successive reflected waves from terminations.

**35.How does switching surges cause damage to circuit breaker?**

In circuit breaking operation, switching surges with a high rate of rise of voltage may cause repeated restriking of the arc between the contact of a circuit breaker, thereby causing destruction of the circuit breaker contacts.

**36.What are the factors of origin of switching surges?**

- De-energizing of transmission lines, cables, shunt capacitor banks
- Disconnection of unloaded transformer, reactors
- Energization or reclosing of lines and reactive loads
- Sudden switching off of loads
- Short circuit and fault clearance
- Resonance phenomenon

**37.Give the factor for over voltages generation in EHV system. (AU-NOV/DEC2004)**

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

**38.Give the situation that give rise to switching over voltages of short duration and lower magnitude. (AU-MAY/JUNE2006)**

- Single pole closing of circuit breaker
- Interruption of fault current when the L-G or L-L fault is cleared
- Resistance switching used in circuit breakers
- Switching lines terminated by transformer
- Series capacitor compensated lines
- Sparking of the surge diverter located at the receiving end of the line to limit the lightning over voltages.

**39.What are the different method by which switching over voltages of short duration and long magnitude be calculated?**

- Mathematical modeling of a system using digital computer
- Scale modeling using transient network analyzers
- By conducting field tests to determine the expected maximum amplitude of the over voltages and their duration at different points on the line.

**40.What are the different measures to control or reduce over voltages? (AU-MAY/JUNE2006)**

- One step or multi step energisation of lines by pre insertion or resistors
- Phase controlled closing or circuit breakers with proper sensors
- Drainage or trapped charges on long lines before the reclosing of the lines
- Limiting the over voltages by using surge diverter.

**41.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
- Saturation in transformers

**42.How are the over voltage of power frequency harmonics and voltage with frequency measure the operating frequency caused? (AU-NOV/DEC 2010)**

These are caused during tap changing operations, by magnetic or Ferro resonance phenomena in large power transformers and by resonating over voltages due to series capacitors with shunt reactors or transformers.

**43.What are the methods to control over voltages due to switching? (AU-NOV/DEC 2009)**

- Energisation of transmission lines in one or more steps by inserting resistance and withdrawing then afterwards
- Phase controlled closing of circuit breakers
- Drainage of trapped charges before reclosing
- Use of shunt reactors
- Limiting switching surges by suitable surge diverters.

**44.Give the factor by which over voltages due to lightning strokes can be minimized or avoided in practice.(AU- APR/MAY2007 )**

- Shielding the over head lines by using ground wires above the phase wires
- Using the ground rods and counter poise wires
- Including protective devices like expulsion gaps, protector tubes on the lines and surge diverters at the line terminations and substations.

**45.Where is surge arrester placed in sub station?**

Surge arresters are devices used at substations and at line terminations to discharge the lightning over voltages and short duration switching surges. These are usually mounted at the line end at the nearest point to be substation. They have a flash over voltage lower than that of any other insulation or apparatus at the substation.

**46.Define Masons theorem? (AU-MAY/JUNE 2012)**

The ice splinters should carry only positive charge upwards. Water being ionic in nature. The ion density depends on the temperature. Thus in an ice slab with upper and lower surfaces at temperature there will be a higher concentration of ions in the lower region.

**47.Write the characteristics of swithching surges? (AU-MAY/JUNE 2012)**

- De-energizing of transmission lines,cables& shunt capacitors.
- Disconnection of unloaded transformers
- Sudden switching off loads
- Short circuit and fault clearances

**48.What are the causes of over voltage in a power system in few words?(AU-NOV/DEC 2010)**

- Lightning
- Switching surges

**49.What is known as Isokeraunic Level? (AU-MAY/JUNE 2012)**

Number of hearing sounds located at a particular level is called isokerunic level.

**50.Define lightning? (AU-MAY/JUNE 2013)**

It is a natural phenomenon .Lightning performance tends to improve with increasing insulation level .The magnitude does not depend on line design.

**51.What are the sources causing switching surges? (AU-MAY/JUNE 2013)**

- Phase controlled closing of circuit breakers
- Drainage of trapped charges
- Use of shunt reactors

**PART-C** **(16 MARKS)**

**52.Explain the different theories of charge formation in clouds. (AU-NOV/DEC2007)**

**53.What are the mechanisms by which lightning strokes develop and induce over voltages on over head power lines? (AU-NOV/DEC2005)**

**54.Give the mathematical models for lightning discharges and explain them.( AU-NOV/DEC2004)**

**55.What are the causes for switching and power frequency over voltages? How are they controlled in power system?**

**56.Explain the different methods employed for lightning protection of over head lines.**

**57.Explain with suitable figures the principles and functioning of (a) Expulsion gaps (b) Protector tubes. (AU-NOV/DEC 2009 )**

**58.What is a surge arrester? Explain its function as a shunt protective device?( AU-NOV/DEC 2010)**

**59.What is meant by insulation co-ordination? How are the protective devices chosen for optimal insulation level in a power system? (AU-NOV/DEC2010)**

**60.Write short notes on: (a) Rod gaps used as protective devices (b) Ground wires for protection of over head lines. (AU- MAY/JUNE2009)**

**61.Derive the expression for the voltage and current waves on the long transmission lines and obtain the surge impedance of the line. (AU- MAY/JUNE2007)**

**62.Explain the different aspects of insulation design and insulation co-ordination adopted for EHV systems. (AU-NOV/DEC 2008 )**

**63.A three phase single circuit transmission line is 400 km long . If the line is rated for 220 kV and has the parameter, R=0.1 ohms/km, L= 1.26 mH/km, C=0.009μF/km and G=0 . Find (a) Surge impedance and (b) the velocity of propagation neglecting the resistance of the line. If the surge of 150 kV and infinitely long tail strikes at one end of the line, what is the time taken for the surge to travel to the other end of the line?( AU-MAY/JUNE2006)**

**64.An infinite rectangular wave on a line having a surge impedance of 500Ω strikes a transmission line terminated with a capacitance of 0.004μF, Calculate the extent to which the wave front is retarded? (AU-NOV/DEC 2008)**

**65.An under ground cable of inductance 0.189 mH/km and of capacitance 0.3μF/km is connected to an over head line having an inductance of 1.26mH/km and capacitance of 0.009μF/km. Calculate the transmitted and reflected voltage and current waves at the junction, if the surge of 200kV travels to the junction (i) along the cable (ii) along the over head line.**

**66.A transmission line has the following line constants R=0.1 Ω/km, L= 1.26 mH/km and C= .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. (AU-NOV/DEC 2010)**

**67.Explain the various methods employed for overvoltage protection in electrical power system.**

**68.Discuss the mechanism of lightning stroke with diagrams.**

**69.What are the causes for switching and power frequency over voltage? How they are controlled in power system? (AU-NOV/DEC 2010), (AU-N0V/DEC2013)**

**70. Explain lightning phenomena. (AU-NOV/DEC 2010)**

**71.What are the different methods employed for lightning protection of over head lines? Discuss in detail. (AU-NOV/DEC 2010)**

**72. Describe about various types of shunt protected devices used for overhead lines against lightning stroke. (AU-APR/MAY 2011)**

**73. Discuss about the various control techniques for switching and power frequency over voltages. (AU-APR/MAY 2011)**

**(ii) Explain the different theories of charge formation in clouds. (AU-APR/MAY 2011)**

**74.Describe the power frequency over voltages in power system? (AU-MAY/JUNE 2012)**

**75.Describe the simpsons theory in charge formation of clouds? (AU-MAY/JUNE 2012)**

**76.Explain the mathematical model of lightning? (AU-MAY/JUNE 2013)**

**77.Explain the power frequency over voltages in power system? (AU-MAY/JUNE 2013)**

**78.Explain the protection of transmission lines against lightning? (AU-MAY/JUNE 2013)**

**79.What are the causes for switching and power frequency over voltage ?How they are controlled on power systems,(AU-NOV/DEC2013)**

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

**PART-A** **(1 MARK)**

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

**81.In a voltages double circuits peak to peak ripple is {if C:capacitance, I:load current, and f=frequency}**
a) =(3If/c) b) =2If/fc c) =3I/fc d) =I/fc

**82.Optimum number of stages for cock croft Walton voltage multiplier circuit are (if v max=supply voltage, f=frequency, I=load current ,c=stage capacitance)**
a)√V/Ifc b)√Ifc/V c√Vf/Ic d)√Vfc/I

**83.A van de graaff generator has a belt speed of 2.5 m/sec ,charge density of 10μc/m2 and a belt width 2m .The maximum charging current is**
a) 50μA b)5μA c)2μA d)12.5μA

**84.The nominal rating of a testing transformer in KVA is given by (if ω=supply frequency , C=capacitance loading and V=output voltage )**
a) 0.5 v2ωC b)V2ωC c) 1.5V2ωC d) 10V2ωC

**85.In testing with a resonant transformer , the output voltage is**
a) rectangular wave b) triangular wave c)trapezoidal wave d)pure sine wave

**86.Parallel resonant transformer, test system is used when**
a)large test voltages are needed
b)stable output voltage with high rate of rise of voltages is needed
c)large current is needed
d)when high frequency test voltage is needed

**87.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 a.c voltages

**88.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

**89.The approximate value of time to front in an impulse voltage generators is**
a)3R1C1 b)2.3R1c! c)3.0R1(C1C2)/C1+C2 d)(0.7)(R1+R2)(C1+C2)

**90.An impulse voltage generator has a generator capacitance of 0.01μF,load capacitance of 1 μF, front resistance of R1=110Ω and tail resistance of R2=400Ω.The tail time is**
a)40μs b)55μs c)50μs d)10μs

**91.The value of charging voltage used in a medium size impulse generator is**
a)10 to 50 KV b)50 to 100 KV c)500KV d)any value

**92.The voltage efficiency of a normal impulse generator for generation of switching impulse is**

a)less than 30 % b)80 to 90 % c)40 to 60 % d)10 to 90 %

**93.A16 stage impulse voltage generator has stage capacitance of 0.125 μF and a charging voltageof 200 KV .The energy rating in KJ is**

a)40 b)50 c)80 d)640

**94.In an impulse current generator the capacitance re connected in**

a)series b)parallel c)connected in parallel while charging and in series while discharging d) connected in series –parallel while discharging

**95.Multi test kits used in high voltage laboratories consist of**

a) a.c.,d.c. and impulse voltage test units

b)a.c.andd.c test units

c)d.c and impulse test units

d)a.c.,d.c impulse voltage and test units

**96.Impluse current generator output wave form is**

a)damped oscillatory wave b)overhead wave c)critically damped wave d)can be damped waved or damped oscillatory wave.

**97.To minimize the inductance in impulse current generator circuits**

a)capacitor connected in parallel b)capacitor sub divided into smaller units

c)air core inductors used in series d)discharge path into a rectangular path.

**98.A trigetron gap is used with**

a)cascade transformer units b)impulse current generator c)impulse voltage generator

d)dc voltage double units.

**99.A oscillatory impulse waveform is represented by**

a) e-at cosbt b) eat cosbt c) e-at cos e-bt d) eat-ebt.

| 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B | A | C | C | D | A | C | C | C | B | D | C | C | D | D | A | A | D | B | D |

**PART-B (2 MARKS)**

**100.What are the different gases that are used as insulating medium?**

Air, Nitrogen, carbon dioxide, Freon and sulphur hexa fluoride.

**101.What are the various phenomena that occur inn gaseous dielectric?( AU-NOV/DEC2010)**

When the applied voltage is low, small currents flow between the electrodes and the insulation retains its electrical properties. On the other hand, if the applied voltages are large, the current flowing through the insulation increases very sharply and an electrical breakdown occurs.

**102.What is break down voltage?**

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

**103.Give the types of electrical discharge in gases. (AU-NOV/DEC 2005)**

- Non sustaining discharges
- Self sustaining discharges

**104.Define spark breakdown and ionization. (AU-MAY/JUNE2006)**

The break down in a gas, called spark breakdown is the transition of a non-sustaining discharge into self sustaining discharge. The build-up of high current s in a breakdown is due to the process known as ionization in which electrons and ions are created from neutral atoms or molecules and their migration to the anode and cathode respectively leads to high currents.

**105.Give the theories that explain the mechanism for breakdown. (AU-MAY/JUNE2009)**

- Townsend theory
- Streamer theory

**106.What are the conditions in the gases that govern the ionization process?**

- Pressure
- Temperature
- Electrode field configuration
- Nature of electrode surfaces
- Availability of initial conducting particles

**107.Define the elastic collision & inelastic collision. (AU-NOV/DEC2004)**

Elastic collision are collisions which when occur, no change takes place in the internal energy of the particles but only their kinetic energy gets redistributed. Inelastic collision are those in which internal changes in energy take place within an atom or a molecule at the expense of the kinetic energy of the colliding particles.

**108.Define electron drift velocity.**

The electron drift velocity which has been defined as the average velocity, with which the centre of mass of the electron swarm moves in the direction of the field.

**109.What is Maxwellian distribution? (AU- MAY/JUNE2007)**

The Maxwellian distribution has been found to apply where there is thermal equilibrium between the electrons and molecules.

$$F(\varepsilon) = C_1 \varepsilon^{0.5} \exp(1.5\ \varepsilon/\ \varepsilon)$$

**110.What is Druyesteynian distribution? (AU-NOV/DEC 2008)**

Druyesteynian distribution applies when the electron or ion energy is much greater then the thermal energy and is therefore expected to be more of application in transcend discharges.

$$F(\varepsilon) = C_2 \varepsilon^{0.5} \exp(-0.55\ \varepsilon^2/\ \varepsilon^{-2})$$

**111.Define collision cross section.**

Collision cross section is defined as the area of contact between two particles during collision. The total area of impact.

**112.What is mean free path?**

The mean free path is defined as the average distance between collisions. When the discharge occurs large number of collisions occurs between the electrons and the gas molecules.

**113.What are the different processes by which radiation can be absorbed by atom?**

(i)Excitation of the atom to a higher energy state

(ii) Continuous absorption by direct excitation of the atom or dissociation of diatomic molecule or direct ionization

**114.Define the secondary ionization process. ( AU-NOV/DEC 2010)**

The secondary ionization processes by which secondary electrons are produced are the one which sustain a discharge after it is established due to ionization by collision and photo ionization.

**115.What is an electron attachment collision? (AU-MAY/JUNE2006)**

The types of collisions in which electrons may become attached to atoms or molecules to form negative ions are called attachment collisions. Electron attachment process depends on the energy of the electron and the nature of the gas.

**116. Define time lag.**

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

**117.On what factors does time lag depend?**

Statistical time lag- Pre ionization , size of the gap and quantity of radiation
Formative time lag – Mechanism of the avalanche growth in the gap, transit time.

**118.What is Paschen's Law?**

V=f(pd)

**119.What are the effects of corona?**

- Loss of power
- Deterioration of insulation
- Rise to radio interference.

**120.Define corona. (AU-NOV/DEC 2009, NOV/DEC2013)**

If the field is non-uniform an increase in voltage will first cause a discharge in the gas to appear at points with highest electric filed intensity namely at sharp points or where the electrodes are curved or on transmission lines. This form of discharge is called a corona discharge.

**121.What are the properties of good gaseous dielectric for the HV application?**

- High dielectric strength
- Thermal stability and chemical inactivity towards materials of construction.
- Non-flammability and physiological inertness and environmentally non-hazardous.
- Low temperature of condensation
- Good heat transfer
- Ready availability at moderate cost.

**122.What is vacuum?**

A vacuum system which is used to create vacuum is a system in which the pressure is maintained at a value much below the atmospheric pressure.

**123.Define vacuum discharge. (AU-NOV/DEC 2010)**

Electrons get multiplied due to the various ionization processes and an electron avalanche is formed. In high vacuum, even if the electrodes are separated by a few centimeters, an electron crosses the gap without encountering any collisions.

**124.What are the different mechanisms of breakdown in vacuum?**

- Particle exchange mechanism
- Field emission mechanism
- Clump theory

**125.On what factors does liquid dielectric is selected?**

- Chemical stability
- Space
- Cost
- Previous usage
- Susceptibility to the environmental influences.

**126.Give different properties of liquid electric.**

- Electrical properties
- Its capacitance per unit volume or its relative permittivity

- Its resistivity
- Its loss tangent or its power factor
- Its ability to with stand high electric stresses.
- Heat transfer characteristics
- Chemical stability.

**127.What are the factors that influence conduction in pure liquid dielectric and in commercial liquid dielectric?**

- The nature and condition of the electrodes
- The physical properties of the liquid
- The impurities and gases present in the liquid

**128.What are the various theories that explain breakdown in commercial liquid dielectric? (AU-NOV/DEC2013)**

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

**129.What are the properties of good solid dielectric?( AU-NOV/DEC 2009)**

- Low dielectric loss
- High mechanical strength
- Should be free from gaseous inclusions and moisture
- Resistant to thermal and chemical deterioration

**130.Give different solid dielectric material.**

- Organic material
- Paper
- Wood
- rubber
- In organic material

**131.Give different breakdown mechanism in solid dielectrics.**

- Intrinsic or ionic breakdown
- Electromechanical breakdown
- Failure due to treeing and tracking
- Thermal breakdown
- Electrochemical breakdown
- Breakdown due to internal charges.

**132.What are the properties of composite dielectric? (AU-NOV/DEC 2009)**

- Effect of multiple layers
- Effect of layers thickness
- Effect of interfaces.

**133.What are the different breakdown mechanisms in composite dielectric?**

- Short term breakdown
- Long term breakdown

**134.What is ionization by collision? (AU-APR/MAY 2011)**

The process of liberating an electron from a gas molecule with the simultaneous production of a positive ion. A free electron collides with a neutral gas molecule and give rise to a new electron and a positive ion.

**135.Define Gas law. (AU-APR/MAY 2011)**

High pressure gas provides a flexible and reliable medium for high voltage insulation using gases at high pressure field gradients have been realized.

**136.State and explain Paschen's law. (AU-MAY/JUNE 2012)**

It is generally stated as f(Nd) The pressure of the gas changes with temperature according to the gas law. It is probably due to the transition from the breakdown mechanism.

**137. What do you mean by 'Intrinsic strength' of a solid dielectric? (AU-MAY/JUNE 2012)**

When voltages applied only for short duration the dielectric strength increases very rapidly to an upper limit called the intrinsic dielectric strength.

**138.Define treeing and tracking? (AU-MAY/JUNE 2013)**

The spreading of spark channels during tracking in the form of the branches of a tree is called treeing. Tracking is the formation of a continuous conducting paths across the surfaces of the insulation due to surface erosion under voltage application.

**PART-C (16 MARKS)**

**139.Describe the current growth phenomenon in a gas subjected to uniform electric fields.**

**140.Define Townsend's first and second ionization coefficients. How is the condition for breakdown obtained in a Townsend discharge?( AU-MAY/JUNE2006)**

**141.Derive the criterion for breakdown in electronegative gases. (AU-NOV/DEC 2009)**

**142.What are the anode and the cathode streamers? Explain the mechanism of their formation and development leading to breakdown. (AU-MAY/JUNE2009)**

**143.What is Paschen's law? How do you account for the minimum voltage for breakdown under a given 'p x d' condition? (AU-MAY/JUNE2007)**

**144.Explain the various theories that explain breakdown in commercial liquid dielectrics.**

**145.What is stressed oil volume theory, how does it explain breakdown in large volumes of commercial liquid dielectrics? (AU-NOV/DEC2004)**

**146.What do you understand by "intrinsic strength" of a solid dielectric? How does breakdown occur due to electrons in a solid dielectric?( AU-NOV/DEC2010)**

**147.Explain the different mechanisms by which breakdown occurs in solid dielectrics in practice.**
**148.Describe the mechanism of short term breakdown of composite insulation. (AU-NOV/DEC2013)**
**149.Discuss the breakdown in non uniform fields and corona discharge with diagram. (AU-MAY/JUNE 2012, AU-NOV/DEC2013)**
**150.Discuss the field emission theory in vaccum breakdown? (AU-MAY/JUNE 2012)**
**151. Explain the primary and secondary breakdown mechanism of gaseous dielectrics.**
**152.Explain the various breakdown theories involved in commercial liquid dielectrics.**
**153.(i)Explain clearly various processes which explain electric breakdown in vacuum. (8)**
**(ii) Discuss about the properties of composite dielectrics. (8) (AU-MAY/JUNE 2012)**
**154.Explain briefly various theories of breakdown in liquid dielectrics. (AU-MAY/JUNE 2012)**
**(ii) Explain the Townsends criterion for a spark.**
**155.Explain the liquid dielectrics with illustration. (AU-MAY/JUNE 2012)**
**ii)Describe corona discharges?**
**156.Explian composite dielectric with an example (AU-MAY/JUNE 2013)**
**157.Explain the operation and breakdown in commercial liquids? (AU-MAY/JUNE 2013)**

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

**PART-A (1 MARK)**

**158.A generating voltmeter is used to measure**
a)impulse voltages b)AC voltages c)DC voltages d)high frequency AC voltages.
**159.A series capacitance voltmeter can measure**
a)DC voltages b)AC voltages c)AC peak voltages d)impulse voltages
**160.CVT when tuned does not have**
a)ratio error b)phase angle error c)both errors d)temperature error.
**161.Electrostatic voltmeter can measure**
a)only DC voltages b)both AC and DC c)impulse voltages d)AC,DC and impulse.
**162.Sphere gaps are used to measure**
a)DC voltages b)AC peak voltages c)DC,AC and impulse d)only AC and DC peak voltages.
**163.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 d)two times diameter of sphere.
**164.The main factors that affect the spark over voltage of sphere gap are**
a)humidity and waveform b)nearby earthed objects c)diameter of th sphere d)gap spacing,diameter and waveform.
**165.For an RC divider to be compensated, the condition is**
a)R1C1=R2C2 b)R1C2=R2=C1 c)R1C1=R2Cg d)(R1+R2)(C1+C2)<1s
**166.Compensated capacitance divider for high voltages has a bandwidth of**
a)10MHZ b)1MHZ c)100MHZ d)1000MHZ.
**167.In a pure capacitance divider, the ground capacitance is represented by adding additional capacitance from central point of HV to the ground and is equal to**
a)Cg b)Cg/3 c)2Cg/3 d)Cg/2.

**168.For an optimally damped RC divider, the damping resistance R1 connected in HV arm is equal to**

a)4√L/Cg b)2√L/Cg c) √L/Cg d)1/2√L/Cg

**169.The surge impended of a measuring cable with its resistance neglected, Cg is**

a) √L/C b)2√L/C c)2√LC d) √C/L.

**170.Hall generators are normally used to measure**

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

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

a)squirrel cage b)bifilar strip c)disc d)coaxial tubular.

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

a)(πfμσ)1/2 b) )(πfμσ)-1/2 c)2√ πfμσ d)0.5(πfμσ)-1/2.

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

a)100KHZ b)10MHZ c)1.0 MHZ d)1100Hz.

**174.An RC voltage divider has HV an arm capacitance C1=600Pf,R=400 and Cg=240Pf.The** effective time constant of the divider is

a)108 b)90 c)69 d)32.

**175.Shunts used for measuring impulse currents in the rang of 10KA-50KA will have a resistance of the order of**

a)10-25 mΩ b)0.1-1mΩ c)100-500mΩ d)0.1-1Ω.

**176.Th type of measuring device preferred for measurement of impulse current of short duration is**

a)park tubular shunt b)current transformer c)Hall generator d)Faraday ammeter.

**177.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 high power rating d)a linear resistor in parallel with a non linear resistor of high power rating.

| 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B | A | C | C | D | A | C | C | C | B | D | C | C | D | D | A | A | D | B | D |

**PART-B (2 MARKS)**

**178.Give the different forms of high voltages. (AU-MAY/JUNE2006)**

- High ac voltages of power frequency
- High ac voltages of high frequency
- High transient or impulse voltages of very short duration
- Transient voltages of longer duration.

**179.Give the circuits that produce high dc voltages.( AU-NOV/DEC 2009 )**

- Half wave and full wave rectifier circuit
- Voltage doubler circuit
- Voltage multiplier circuit
- Van de Graaff generators

**180.On what factors does ripple δV depend?**

- The supply voltage frequency ,f
- The time constant $CR_L$
- The reactance of the supply transformer, $X_L$

**181.Give the circuits that produce high dc voltages.**

- Cascade transformers
- Resonant transformers

**182.How is ripple voltage kept low?( AU-NOV/DEC 2010)**

The ripple voltage is kept as low as possible with the proper choice of the filter capacitor and the transformer reactance for a given load $R_L$.

**183.What is the use of regulator circuit?**

The Dc voltage regulator consists of detecting elements actuated by the detector in such a manner as to correct the changes.

**184.What are the types of regulator?**

- Series type
- Shunt or parallel type

**185.What are the chief advantages of resonant transformers? (AU-NOV/DEC2010)**

- It gives an output of pure sine wave.
- Power requirement are less
- No high power arcing and heavy current surges occur if the test object fails, as resonance ceases at the failure of the test object
- Cascading is also possible for very high voltages.
- Simple and compact test arrangement
- No repeated flashovers occur in case of partial failures of the test object and insulation recovery.

**186.Give the advantages of high frequency transformers. (AU-NOV/DEC2004)**

- The absence of iron core in cost and size
- Pure sine wave output
- Slow build-up of voltage over a few cycles and hence no damage due to switching surges.
- Uniform distribution of voltage across the winding coils due to subdivision of coil stack into a number of units.

**187.What are the components of multistage impulse generator?**

- DC charging set
- Charging resistors
- Generator capacitors and spark gaps
- Wave shaping resistors and capacitors
- Triggering system.
- Voltage dividers
- Gas insulated impulse generator.

**188.What are the different circuits that are used for producing switching impulse voltage?**

Impulse generator circuit modified to give longer duration wave shapes
Power transformers or testing transformers excited by dc voltages giving oscillatory waves and these include tesla coil.

**189.Define standard switching impulse voltage. (AU-NOV/DEC 2010)**

Standard switching impulse voltage is defined both by the Indian standards and the IEC, as 250/2500 μs wave, with the same tolerance for time to front and time to tail as those for the lightning impulse voltage wave and time to half value of (2500±500 ) μs

**190.Define duration of wave.**

The duration of the wave is defined as the total time of the wave during which the current is at least 10% of its peak value.

**191.What are the essential parts of impulse current generator?( AU-MAY/JUNE2006)**

- DC charging unit giving a variable voltage to the capacitor bank.
- Capacitors of high value each with very low self inductance, capable of giving high short circuit currents.
- An additional air cored inductor of high current value

- Proper shunts and oscillograph for measurement purposes
- A triggering unit and spark gap for the initiation of the current generator.

**192.Define peak to peak ripple. (AU-NOV/DEC2010)**

Peak to peak ripple is defined as the difference between maximum and minimum dc voltages.

**193.Define time to front if a impulse voltage waveform. (AU- MAY/JUNE2007)**

Time to front of an impulse voltage waveform is defined as 1.25 times the interval between 0.1 to 0.9 of peak value

**194.What is the use of tesla coil?**

Tesla coil is used for generation of high frequency ac voltages.

**195.What is trigatron gap? (AU-MAY/JUNE2009, AU-NOV/DEC2013)**

A trigatron gap 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.

**196.What is tesla coil? (AU-MAY/JUNE 2012)**

The absence of iron core in transformer and it has sine wave output. It slow build up of voltages and hence no damages due to switching surges. It has uniform distribution of voltages across the winding coils.

**197. What is a cascaded transformer? (AU-MAY/JUNE 2012)**

Test transformers are build to withstand transients during the flashover of the test object.

**198.What are the merits of Van de graff generator? (AU-MAY/JUNE 2013)**

High voltage and low current applications. The output voltage is controlled by controlling the corona source voltages and the rate of charging. The voltage can be stabilized 0.01.These are extremely flexible and precise machine for voltage control.

**199.Define the principle of Hall generator? (AU-MAY/JUNE 2013)**

If an electric current flow normal to the of both the current flows through a metal plate located in a magnetic field perpendicular to it ,Lorentz force will deflect the electrons in the metal structure in a direction normal to the direction of both the current and the magnetic field.

**200. Give the expression for ripple and regulation in voltage multiplier circuits? (AU-NOV/DEC2013)**

Ripple voltage =I1/fc2,
Let f=supply frequency
Q= chare transferred in each cycle
I1= load current from the rectifier
T1=conduction period of rectifier

**PART-C (16 MARKS)**

**201.Explain with diagram, different types of rectifier circuits for producing high d.c voltages.**

**202.Why is Cockcroft Walton circuit preferred for voltage multiplier circuits? Explain its working with a schematic diagram. (AU-NOV/DEC 2009)**

**203.Give the expression for ripple and regulation in voltage multiplier circuits. How are the ripple and regulation minimized?**

**204.Describe with a neat sketch the working of a Van de Graaff generator. What are the factors that limit the maximum voltage obtained? (AU-NOV/DEC 2010 2006,MAY/JUNE2009,2008)**

**205.Explain the different schemes for cascade connection of transformers for producing very high a.c. voltages. (AU-N0V/DEC2013)**
**206.What is the principle of operation of a resonant transformer? How is it advantageous over the cascade connected transformer?**
**207.What is Tesla coil? How is damped high frequency oscillations obtained from a Tesla coil? (AU-NOV/DEC2004)**
**208.Give the Marx circuit arrangement for multistage impulse generators. How is the basin arrangement modified to accommodate the wave time control resistance? (AU-MAY/JUNE2009)**
**209.Describe the circuit arrangement for producing lightning current waveforms in lab.**
**210. What is trigatron gap? Explain its functions and operations (MAY/JUNE2006)**
**211.Describe the high DC voltage are generated by rectifier circuit? (AU-MAY/JUNE 2012).**
**212.Explain the principle and operation of Vande Graff generators. (AU-MAY/JUNE 2012).**
**213.Draw and explain the circuits for producing impulse waves. (16) (AU-APR/MAY 2011)**
**214.Explain any one method of generating HV AC at power frequency and discuss its limitation/feature.**
**215.Explain the Marx circuit arrangement for multistage impulse generators. How is the basic arrangements modified to accommodate the wave time control resistances? (AU-MAY/JUNE 2012)**
**216.(i) Explain the basic principle of operation of an electrostatic generator. (6)**
**(ii) Draw a typical impulse current generator circuit and explain its operation and application. (10) (AU-MAY/JUNE 2012)**
**217.Explain the operation of Electrostatic generator? (AU-MAY/JUNE 2013)**
**218.Explain the techniques used in cascaded transformer? (AU-MAY/JUNE 2013)**
**219.Explain the operation of Van de graff generator with neat diagram? (AU-MAY/JUNE 2013)**
**220.A Cockcroft-walton type voltae multiplier has eight stages with capacitances all equal to 0.05microF.the supply transformer secondary voltage is 125KVat a frequency of 50HZ. If the load current to be supplied is 5mA,find(i)the percentage ripple,(ii)the reulation and the optimum number of stages for minimum regulation or voltage drop,(AU-NOV/DEC2013)**

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

**PART-A (1MARK)**

**221.Electrical conduction in gases was studied in 1905 by**
a)Loeb b)Maxwell c)Townsend d) Hertz.
**222.According to Townsend current growth process the current in a uniform lectric field gap is**
a)Io e-αd b)Io e αd c)Io eγd d) Io e- γd.
**223.The breakdown criterion in a uniform field electrode gap is**
a) α- γd. b) α=η/(1-γ) c) γe αd=1 d) ) γe -αd=1
**224.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 electrons gets attached to form negative ions.

**225.SF6 is a**

a)neutral gas b)electronegative gas c)ionizes easily to form ions d)non attaching gas.

**226.Ionising coefficients $\alpha, \gamma$ are functions of**

a)applied voltage b)pressure and temperature c)electric field d)ratio of electric field and pressure.

**227.Time lag for breakdown is**

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

**228.Streamer mechanism of breakdown explains the phenomena of electrical breakdown of**

a)very short spark gaps b)when pd is less than 1000 c)very long gaps where field is uniform d)spark gaps subjected to impulse voltages.

**229.Paschens 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.

**230.Minimum sparking potential of air is about**

a)100V b)4.4KV c)40V d)325V.

**231.Transformer oil is**

a) askeral b)silicone oil c)polyester d)mineral oil

**232.The breakdown strength of mineral oil is about**

a)20KV/mm b)50KV/mm c)3-5KV/mm d)30-40KV/mm

**233.Tan value for liquid insulants at 50 HZ should be less than**

a)0.1 b)0.01 c)0.001 d)10^-6

**234.Dielectric constant of mineral oils is about**

a)1.5 to2.0 b)2.2 to 2.4 c)3.0 to 3.5 d)1.008

**235.D.C conductivity of liquid dielectrics at low electric fields is about in siemens**

a)106^-6 b)10^-12 c)10^-18 d)10^-30

**236.Maximum dielectric strength obtained with pure liquids is about**

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

**237.Conduction and break down in commercial liquids is affected by**

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

**238.The relation between breakdown strength and gap distance in liquid dielectric is Vb**

a)K/d b)Kd^n c)Kd^-n d)(K1d+K2)

**239. 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 liquid are involved

**240.The parameters that affect the breakdown strength of liquid is**

a)hydrostatic pressure and pressure
b)dissolved impurities
c)dielectric constant
d)pressure,temperature,dissolved impurities and suspended particles

| 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | A | B | C | A | D | B | C | B | D | D | A | C | C | D | B | A | C | D | D |

**PART-B** **(2 MARKS)**

**241.Why is measurement of high voltages and high current necessary?**

In industrial testing and research laboratories, it is essential to measure the voltages and currents accurately, ensuring perfect safety to the personnel and equipment.

**242.What are the methods available for measuring dc voltages? (AU-MAY/JUNE2010)**

- Series resistance micro ammeter
- Resistance potential divider
- Generating voltmeter
- Sphere and other spark gaps

**243.What are the methods available for measuring ac voltages of high frequency?**

- Potential dividers with a cathode ray oscillograph
- Peak voltmeters
- Sphere gaps

**244.What are the methods available for measuring ac voltages of power frequency? (AU-NOV/DEC 2009)**

- Series impedance ammeters
- Potential dividers
- Potential transformers
- Electrostatic voltmeters

**245.What are the methods available for measuring dc current? (AU-NOV/DEC2004)**

- Resistive shunts with milli ammeter
- Hall effect generators
- Magnetic links

**246.What are the methods available for measuring ac current of high frequency?( AU-MAY/JUNE2006)**

- Resistive shunts
- Magnetic potentiometers
- Magnetic links
- Hall effect generators

**247.What are the methods available for measuring ac current of power frequency?**

- Resistive shunts
- Electromagnetic current transformers

**248.What are limitations in the series resistance design? (AU-MAY/JUNE2009 )**

- Power dissipation and source loading
- Temperature effects and long time stability
- Voltage dependence or resistive elements
- Sensitivity to mechanical stresses.

**249.What is generating voltmeter? ( AU-MAY/JUNE2010)**

A generating voltmeter is a variable capacitor electrostatic voltage generator which generates current proportional to the applied external voltage. The device is driven by an external synchronous or constant speed motor and does not absorb power or energy from the voltage measuring source.

**250.What are the advantages and limitations of generating voltmeter? (AU- MAY/JUNE2007)**

Advantages:

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

- A very convenient instrument for electrostatic devices

Limitations:

- They require calibration
- Careful construction is needed and is cumbersome instrument requiring an auxiliary drive
- Disturbance in position and mounting of the electrodes make the calibration invalid.

**251.Give the different methods of measuring dc electric field strength.**

- Variable capacitor field meter
- Vibrating plate field meter
- A.C field strength meter: capacitor probe

**252.How series capacitance is formed in voltmeter for measurement?**

The series capacitance is formed as a parallel plate capacitor between the high voltage terminal of the transformer and a ground plate suspended above it.

**253.What are the advantages of capacitance voltage transformers (CVT)? (AU-MAY/JUNE2006)**

- Simple design and easy installation
- Can be used both as a voltage measuring device for meter and relaying purposes and also as a coupling condenser for power line carrier communication and relaying.
- Frequency independent voltage distribution along elements as against conventional magnetic potential transformers which require additional insulation design against surges.
- Provides isolation between the high voltage terminal and low voltage metering.

**254.What are the sources that contribute to the error?**

- The effective value of the capacitance being different from the measured value of C.
- Imperfect rectifiers which allows small reverse currents
- Non-sinusoidal voltage waveforms with more than one peak or maxima per half cycle.
- Deviation of the frequency from that of the value used for calibration.

**255.What are the different ways by which sphere gap can be arranged?**

Sphere gaps can be arranged either (i) Vertically with lower sphere grounded or (ii) horizontally with both sphere connected to the source voltage or one sphere grounded. In horizontally configurations, it is generally arranged such that both spheres are symmetrically at high voltage above the ground. The two shapes used are identical in size and shape.

**256.Why is series resistance connected between the source and sphere gap?( AU-MAY/JUNE2005)**

A series resistance is usually connected between the source and the sphere gap to (i) limit the breakdown current and (ii) to suppress unwanted oscillations in the source voltage when breakdown occurs.

**257.Give the factors that affect the spark over voltage of sphere gap.**

- Nearby earthed objects
- Atmospheric conditions and humidity
- Irradiation
- Polarity and rise time of voltage waveform.

**258.For what rod gaps are used.**

A rod gaps are used for approximate measurement of peak values of power frequency voltages and impulse voltage. IEEE recognizes that this method gives an accuracy within 8%.

**259.What are the elements that cause different error in the potential divider for impulse voltage measurement?( AU-NOV/DEC 2010 )**

- Residual inductance in the elements.
- Stray capacitance occurring
- between the elements
- From sections and terminals of the elements to ground.

**260.How resistance shunt is usually designed? (AU-MAY/JUNE2009)**

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

**261.Define skin depth.**

Skin depth, d , is defined as the distance or depth from the surface at which the magnetic field intensity is reduced to 1/e of the surface value for a given frequency f. Materials of low conductivity have large skin depth and hence exhibit less skin effect.

$$D = 1 / ( \sqrt{} \pi f \mu \sigma)$$

**262.What are the different techniques for impulse current measurement?**

- Rogowski coil
- Magnetic links
- Hall generators
- Faraday generator
- Current transformer

**263.How is delay obtained in cathode ray oscillo graph for impulse measurement? (AU-NOV/DEC 2009)**

A long interconnecting coaxial cable 20 to 50 m long. The required triggering is obtained from an antenna whose induced voltage is applied to the external trigger terminal. The measuring signal is transmitted to the CRO by a normal coaxial cable. The delay is obtained by an externally connected coaxial long cable to give the necessary delay.
The impulse generator and the time base of the CRO are triggered from an electronic tripping device. A first pulse from the device starts the CRO time base and after a predetermined times a second pulse triggers the impulse generator.

**264.What is hall voltage and hall coefficient? (AU-NOV/DEC2013)**

If electric current flows through a metal plate located in a magnetic field perpendi9cular to it, Lorenz forces will deflect the electrons in the metal structure in a direction normal to the direction of both the current and the magnetic field. The charge displacement generates an emf in the normal direction, called the "Hall voltage". The Hall voltage is proportional to the current I a, the magnetic flux density B and the reciprocal; of the plate thickness, the proportionality constant R is called the "Hall coefficient"

$$V_H = R (Bi / d)$$

**265.What are the different power frequency tests done on bushings? (AU-MAY/JUNE 2012**).

- Power factor voltage test
- Internal test
- Momentry withstand test
- Visible discharge test

**266.What is the significance of impulse test? (AU-MAY/JUNE 2012).**

This test is done by applying standard impulse voltages of specified value under dry conditions with positive and negative polarities of the wave. If the test object has withstood subsequent applications ,it is to have passed the test.

**267.What are the advantages of CVT? (AU-APR/MAY 2011)**

- Simple design and easy installation
- Voltage measuring device
- Frequent voltage distribution
- Provide isolation between high voltage and low voltage metering

**268.What are the merits of series resistance micro ammeter method? (AU-MAY/JUNE 2013)**

- Voltage measuring device
- Frequent voltage distribution

**269.What is the effect of nearby earthed objects on the measurements using sphere gaps? (AU-MAY/JUNE 2013)**

By enclosing the earthed sphere inside an earthed cylinder the spark over voltages is reduced. The breakdown voltages varied with the limits.

**PART-C (16 MARKS)**

**270.Discuss the different methods of measuring high dc voltages. What are the limitations in each method?( AU-NOV/DEC 2010)**

**271.Describe the generating voltmeter used for measuring high dc voltages.**

**272.What is capacitance voltage transformer? Explain with phasor diagram how a tuned capacitance voltage transformer can be used for voltage measurements in power systems.**

**273.Explain the principle and construction of an electrostatic voltmeter for high voltages. What are its merits and demerits for high voltage a.c measurement? (AU-MAY/JUNE2009)**

**274.Give the basic circuit for measuring the peak voltage of (i) a.c voltage and (ii) impulse voltage. What is the difference in measurement technique in the above two cases? (AU- MAY/JUNE2007)**

**275.Explain how a sphere gap can be used to measure the peak value of voltages. What are the parameters and factors that influence such voltage measurement?**

**276.Give the schematic arrangement of an impulse potential divider with an oscilloscope connected for measuring impulse voltages. Explain the arrangement used to minimize errors. (AU-NOV/DEC2004)**

**277.Explain the different method of high current measurement with their relative merits and de-merits. (AU-MAY/JUNE2006)**

**278.What are the different types of resistive shunts used for impulse current measurement? Discuss their characteristics and limitations.**

**279.What are the requirements of an oscillograph for impulse and high frequency measurement in high voltage test circuits? (AU- MAY/JUNE2005)**

**280.Explain the necessity of earthing and shielding arrangements in impulse measurements and in high voltage laboratories. Give a sketch of the multiple shielding arrangements used for impulse voltage and current measurement. (AU-NOV/DEC 2009)**

**281.Construct and describe the principle of Electrostatic voltmeter. (AU-MAY/JUNE 2012).**

**282.Mention and explain the various arrangements of Sphere gap measurements with neat sketch. (AU-MAY/JUNE 2012).**

**283. Discuss the various techniques for the measurement of impulse voltage. (16)**

**284.With a neat sketch explain the sphere gap measurements for peak voltage measurement. (16) (AU-MAY/JUNE 2012)**

**285. (i) Explain with neat diagram how rod gaps can be used for measurement of high voltages. Compare its performance with a sphere gap. (8)**

**(ii) Explain with neat diagram the principle of operation of an Electrostatic Voltmeter. Discuss its advantages and limitations for high voltage measurements. (AU-MAY/JUNE 2012, AU-NOV/DEC2013)**

**286.Explain the tripping and control of impulse generator? (AU-MAY/JUNE 2013)**

**287.Explain CVT for high voltage ac measurements? (AU-MAY/JUNE 2013)**

**288.Explain the operation of hall effect generator? (AU-MAY/JUNE 2013)**

**289.What are the factors influencing spark over voltage of sphere gaps? (AU-MAY/JUNE 2013)**

**290.Explain the concept of digital technique in high voltage measurement. (AU-NOV/DEC2013)**

**291.What are the conditions to be satisfied by a potential divider to be used for impulse work. (AU-NOV/DEC2013)**

## UNIT-V
## HIGH VOLTAGE TESTING & INSULATION CO-ORDINATION

**PART-A** **(1 MARK)**

**292.Fifty per cent flash over voltage is defined as**

a)the voltage at which the flash over 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 with stand voltage and flash over voltage

**293.Standard atmospheric condition as Indian standard specification are**

a)temp=27◌̊C,pressure =1013 millibans and humidity =17 gms/m^3
b)temp=20◌̊C,pressure= 1013 millibans and humidity =11 gms/m^3
c)temp=27C, pressure= 1013 millibans and humidity =11 gms/m^3
d)temp=27C, pressure =1000 millibans and humidity =17 gms/m^3

**294.In wet flashover tests,the conductivity of water used is**

a)10±1.5μsiemens b)100±15μsiemens at ambient temperature
c)45±10μsiemens at root temperature d)‹1.0μsiemens at 27 C

**295. Most important tests conducted on isolators and circuits breakers are**

a)voltage withstand tests b)short circuits tests c)high current tests d)temperature rise tests

**296.fault location in an H.V. cable is done by**

a)voltage withstand tests b)partial discharge scanning tests c)life tests d)impulse tests

**297.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

**298.The most important test to assert the proper function of a surge divertor is**

a)100% impulse withstand tests b)front of wave spark over and residual voltage tests
c) impulse current test d)pollution tests

**299.The salt-fog test done on isulators is**

a)impulse tests b)power frequency pollution tests c)impulse current tests d)switching surge tests

**300.C-tanδ test on electric bushing is done using**

a)impulse generators b)high voltage Schering bridge c)power frequency cascade transformer unit d)resonant transformer

**301. In C-tan δ test, a steep increase in tan δ, when the applied voltage increase from 100% to 110%indicates**

a)insulation is failing b)presence of an internal discharge c)increase in permittivity d)decrease in insulation resistance

**302.The intrinsic breakdown strength of solid dielectrics is about**

a)50 to 100 KV/mm b)500 to 1000KV/mm c)5 to 10 KV/mm d)1 to 5 KV/mm

**303. Long –term deterioration and breakdown occurs in solid dielectric due to**

a)thermal phenomenon b) surface discharges c) internal discharge d) tree phenomenon

**304.Paper insulation is mainly used in**

a) cable and capacitors b) transformer c)rotating machines d)circuit breakers

**305.Thermal classification of insulating materials is done for**

a)gases b)liquids c)solids d) composite insulation

**306.Breakdown is permanent in**

a) gases b)liquids c)solids d)in all the three

**307.The material used for insulation that is exposed to atmospheric is**

a)ceramics and glass b) polyester c)inorganic insulation d)rubber and plastic

**308.For high frequency application the following plastic is prepared**

a)poly ethylene b)polyvinyl chloride(PVC) c)polyester d) polystyrene

**309. The operating temperature of poly ethylene insulation is**

a)-30 to 50 b)-60 to 150 c)-50 to 80 d)0 to 100

**310. 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 application are needed d)filler material are required

| 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | A | B | C | A | D | B | C | B | D | D | A | C | C | D | B | A | C | D |

**PART-B ( 2 MARKS)**

**311.What is the necessity of high voltage testing? (AU-MAY/JUNE2009 )**

It is essential to ensure that the electrical equipment is capable of withstanding the over voltages that are met with in service. The over voltages may be either due to natural causes like lightning or system originated ones such as switching or power frequency transient voltages. Hence, testing for over voltages is necessary.

**312.What are the classifications of over voltage test?**

- Power frequency voltage test
- Impulse voltage test.

**313.Define disruptive discharge voltage.**

Disruptive discharge voltage is defined as the voltage which produces the loss of dielectric strength of insulation. It is that voltage at which the electrical stress in the insulation causes a failure which includes the collapse of voltage and passage of current.

**314.Define withstand voltage. (AU-NOV/DEC2004, AU-NOV/DEC2013)**

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

**315.Define fifty percent flashover voltage. (AU- MAY/JUNE2005)**

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

**316.What is hundred percent flashover voltages. (AU-MAY/JUNE2006)**

The voltage that causes a flashover at each of its applications under specified conditions, when applied to test objects as specified , is hundred per cent flash over voltage.

**317.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.

**318.Give the absolute parameters for testing.**

- Temperature : 27 degrees
- Pressure : 1013millibars
- Absolute humidity : 17 gm / $m^3$

**319.What is type test and routine test?**

- Type test are intended to prove or check the design features and the quality.
- The routine tests are intended to check the quality of the individual test piece.

**320.Give the different power frequency test.**

- dry& wet flashover test
- wet & dry flashover test

**321.What is dry& wet flashover test? (AU-MAY/JUNE2006)**

If the test is conducted under normal conditions without any rain or precipitation it is called dry flash over test. If the test is done under conditions of rain it is called wet flash over test.

**322.What is wet & dry flashover test?**

In these test, the voltage specified in the relevant specification is applied under dry or wet conditions for a period of one minute with an insulator mounted as in service conditions.

**323.Give the different impulse test.**

- Impulse withstand voltage test.
- Impulse withstand flash over test.
- Pollution test.

**324.Define the impulse withstand voltage test. (AU-NOV/DEC 2006)**

This is the test done by applying standard impulse voltage of specified value undr dry conditions with both positive and negative polarities of the wave. If five consecutive waves do not cause a flash over or puncture, the insulator is deemed to have passed the test.

**325.What is the various type of pollution?**

- Dust, micro organisms, bird secretions flies
- Industrial pollution
- Coastal pollution
- Desert pollution
- Ice and fog deposits.

**326.What are the different types of power frequency test for bushing? (AU-MAY/JUNE2009)**

- Power factor voltage test
- Internal or partial discharge test
- Momentary withstand test at power frequency.
- One minute wet with stand test at power frequency
- Visible discharge test at power frequency.

**327.What are the different types of impulse voltage test for bushing?**

- Full wave withstand test
- Chopped wave with stand and switching surge test.
- Temperature rise and thermal stability tests.

**328.Define an isolator. (AU- MAY/JUNE2007)**

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

**329.What does testing of circuit breaker intended to evaluate?**

The constructional and operational characteristics

The electrical characteristics of the circuit which the switch or breaker has to interrupt or make.

**330.Give the different characteristics of circuit breaker. (AU-NOV/DEC 2006)**

The electrical characteristics which determine the arcing voltage , the current chopping characteristics , the residual current, the rate of decrease of conductance of the arc space and the plasma, and the shunting effects in interruption. Other physical characteristic including the media in which the arc is extinguished, the pressure developed or impressed at the point of interruption, the speed of the contact travel, the number of breaks, the size of the arcing chamber and the materials and configuration of the circuit interruption.

The characteristics of the circuit include the degree of electrical loading, the normally generated or applied voltage, the type of fault in the system which the breaker has to clear, the time of interruption, the time constant, the natural frequency and the power factor of the circuit, the rate of rise of recovery voltage, the restriking voltage , the decrease in the a.c. component of the short circuit current and the degree of asymmetry and the dc component of the short circuit current.

**331.What are the various methods of conducting short circuit test?( AU-NOV/DEC2010)**

- Direct test
- Synthetic test

**332.Give the advantage and disadvantages on field test. (AU-MAY/JUNE2008)**

ADVATAGES:

- The circuit breaker is tested under actual conditions
- Special occasions
- To assess the thermal and dynamic effects of short circuit currents, to study applications of safety devices and to revise the performance test procedures.

DISADVANTAGES:

- The circuit breaker can be tested at only a given rated voltage and network capacity.
- The necessity to interrupt the normal service and to test only at light load conditions.
- Extra inconvenience and expenses in installation of controlling and measuring equipment in the field.

**333.What are the different test conducted on circuit breaker and isolator?**

- The dielectric test
- The temperature rise test
- The mechanical test
- The short circuit test.

**334.What are the different tests available for testing cables? (AU- MAY/JUNE2005)**

- Mechanical test
- Thermal duty tests
- Dielectric power factor test
- Power frequency withstand voltage test
- Impulse withstand voltage test
- Partial discharge test
- Life expectancy test.

**335.Give the methods of testing transformers. (AU-NOV/DEC 2010 )**

- Induced over voltage test
- Partial discharge test.

**336.What is the purpose of impulse testing of transformers?**

The purpose of the impulse test is to determine the ability of the insulation of the transformers to withstand the transient voltages due to lightning, etc.

**337.What is the sequence of impulse testing?**

- Applying impulse voltage of magnitude 57% of the Basic impulse Level(BIS) of the transformer under test.
- One full wave voltage of 100% BIL.
- Two chopped waves of 100% BIL
- One full wave of 100% BIL
- One full wave of 75% BIL

**338.What are the different methods by which fault in transformer insulation is located in impulse test?**

- General observations
- Voltage oscillogram method
- Neutral current method.
- Transferred surge current method.

**339.Give the various test methods on surge arresters. (AU- MAY/JUNE2008)**

- Power frequency spark over test
- Hundred percent standard impulse spark over test
- Front of wave spark over test
- Residual voltage test

**340.What are the conditions for surge arrester to pass the test? (AU-NOV/DEC 2009)**

- The power frequency spark over voltage before and after the test does not differ by more than 10%.
- The voltage and current waveforms of the diverter do no differ significantly in the two applications
- The non-linear resistance elements in the diverter do not show any sign of puncture or external flashover.

**341.Give the conditions for diverter to pass the test.**

- The power frequency spark over voltage before and after the application of the current wave does not differ by 10%.
- The voltage across the arrester at the first and the last application does not differ by more than 8%
- There is no sign of puncture or other damage.

**342.What are the conditions for arrester to pass the test? (AU-NOV/DEC2004)**

- The average power frequency spark over voltage before and after the test does not differ by more than 10%
- The residual voltage at the rated current does not vary by more than 10%
- The follow-on power frequency current is interrupted each time

- No significant change signs of flashover or puncture occur to the prorated unit.
- Give the other tests that are conducted on surge arrester.

**343.What are the requirements of a protective device connected in parallel?**

- It should not usually flashover for power frequency over voltages
- The volt-time characteristic of the device must lie below the withstand voltage of the protected apparatus or insulation. The marginal difference between the above two should be adequate to allow for the effects of distance, polarity, atmospheric conditions, changes in the characteristics of the devices due to ageing, etc.
- It should be capable of discharging high energies contained in surges and recover insulation strength quickly.It should not allow power frequency follow-on current to flow.

**344.On what factors does the selection of surge arrester depend on?**

- The rate of rise of voltage
- The type of system to be handle
- Operating characteristics of the arrester.

**345.What are the different types of surge arrester used? (AU-NOV/DEC 2010 )**

- Silicon carbide arresters with spark gaps
- Silicon carbide arresters with current limiting gaps
- The gapless metal oxide arrester.

**346.What are the insulation level and protective safety margin?( AU-NOV/DEC 2009)**

- Selecting the risk of failure
- The statistical safety factor
- Then fixing the withstand voltage and designing the insulation level of any equipment or equipment or apparatus corresponding to 90% or 95% of the withstand voltage thus fixed.

**347.What is the significance of impulse test? (AU-MAY/JUNE 2012).**

It is characterized by polarity , peak value, time to front and time to half the peak value. The deviation is checked by measuring instantaneous value over specified intervals.

**348.Define 50% flash over voltage. (AU-APR/MAY 2011)**

This is the voltage which has a probability of 50 flashover when applied to a test object. This is normally applied in impulse test in which the loss of insulation strength is temporary.

**349.What are the tests conducted on power transformers? (AU-MAY/JUNE 2012)**

- Induced overvoltage test
- Partial discharge test
- Impulse testing of transformer

**350.List out various tests to be carried out on insulator and give a brief account of each test.**

- Power frequency test
- Impulse test

**351. What are the significances of power factor tests? (AU-MAY/JUNE 2013)**

The power factor test is changed with the rated value. The maximum value of power factor and the difference in power factor the rated voltage are specified.

**352. What is insulation co-ordination?**

The process of bringing the insulation strengths of electrical equipment and buses into the proper relationship with expected over voltages and with the characteristics of the insulating media and surge protective devices to obtain an acceptable risk of failure

**PART-C** **(16 MARKS)**

**353.What are the different power frequency tests done on insulators? Mention the procedure for testing.( AU- MAY/JUNE2007 )**
**354.What is the significance of impulse tests? Briefly explain the impulse testing of insulators.**
**355.What are the significance of power factor tests and partial discharge tests on bushing? How are they conducted in the laboratory? (AU-NOV/DEC 2008)**
**356.Mention the different electrical tests done on isolators and circuit breakers.**
**357.Why is synthetic testing advantageous over the other testing methods for short circuit tests? Give the layout for synthetic testing. (AU-NOV/DEC 2009)**
**358.Explain the partial discharge tests on high voltage cables. How is a fault in the insulation located in this test? (AU-NOV/DEC 2010 )**
**359.Explain the method of impulse testing of high voltage transformers. What is the procedure adopted for locating the failure?**
**360.What is an operating duty cycle test on a surge arrester? Why is it more significant than other tests? (AU-NOV/DEC2004)**
**361.Discuss the impulse testing of transformer with neat diagrams. (AU-MAY/JUNE 2012, AU-NOV/DEC2013)**
**362.Describe the non linear element surge arrester with neat sketches. (AU-MAY/JUNE 2012).**
**363. Discuss the various tests carried out in a circuit breaker at HV labs. (16) (AU-APR/MAY 2011)**
**364. What is the significance of impulse tests? Briefly explain the impulse testing of insulators. (16) (AU-APR/MAY 2011)**
**365. Explain the method of impulse testing of high voltage transformers.**
**366.What is the procedure adopted for locating the failure? (16) (AU-MAY/JUNE 2012)**
**367. Explain the different aspects of insulation design and insulation co-ordination adopted for EHV systems. ((AU-MAY/JUNE 2012)**
**368.explain different high voltage testing on bushings?**
**369.Explain the various tests on insulators?( AU-MAY/JUNE 2013)**
**370.Explain the various test on cables? (AU-MAY/JUNE 2013)**

********** **ALL THE BEST** **********