SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

VII SEMESTER

1905701 HIGH VOLTAGE ENGINEERING

Regulation – 2019

Academic Year 2022–23 (odd)

Prepared by

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SUBJECT: 1905701- HIGH VOLTAGE ENGINEERING

SEM / YEAR: VII / IV

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UNIT I - OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS				
SYLLABUS: Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over voltages, Corona and its effects – Bewley lattice diagram- Protection against over voltages.				
PART-A				
Q.No	**Questions**	**BT Level**	**Competence**	**COs**
1.	Why high voltage is preferred for transmission of long distance?	**1**	**Remember**	CO1
2.	List the sources of switching over voltages in power system	**1**	**Remember**	CO1
3.	Define lightning phenomenon	**1**	**Remember**	CO1
4.	Define Isokeraunic level and back flash over	**2**	**Understand**	CO1
5.	List out various schemes of protection against over voltages	**2**	**Apply**	CO1
6.	Define Shielding angle.	**2**	**Understand**	CO1
7.	List the techniques to be adopted for controlling switching over voltages?	**2**	**Evaluate**	CO1
8.	Infer the concept of switching surge? Mention its approximate magnitude and frequency.	**1**	**Apply**	CO1
9.	What is the use of valve type lightening arrester?	**1**	**Apply**	CO1
10.	Draw the mathematical model of lightning.	**1**	**Remember**	CO1
11.	State the specifications of a travelling wave?	**3**	**Analyze**	CO1
12.	Define surge impedance of a line?	**3**	**Remember**	CO1
13.	Define corona inception voltage.	**3**	**Analyze**	CO1
14.	Define attenuation? How they are caused?	**4**	**Analyze**	CO1
15.	List the origin of switching surges?	**4**	**Evaluate**	CO1
16.	List the causes of power frequency over voltages in power system?	**4**	**Understand**	CO1
17.	Mention the specifications of the standard impulse voltage?	**6**	**Create**	CO1
18.	Express the equations for reflection coefficient	**5**	**Understand**	CO1

	and refraction co- efficient of voltage and current waves.			
19.	Draw the typical wave shape of switching surges.	**5**	**Create**	CO1
20.	Explain are the use of protective devices.	**6**	**Remember**	CO1
21.	Mention the breakdown strength of air at STP Condition, and also the STP Value.	**1**	**Remember**	CO1
22.	What is Pilot Steamer and stepped leader? Mention its Specifications.	**1**	**Remember**	CO1
23.	List the causes of power frequency over voltages in power system.	**3**	**Analyze**	CO1
24.	Define effectively or solidly grounded system.	**2**	**Understand**	CO1
	PART-B			
1.	(i) Explain the technique of modeling the lightning. (7) (ii)Discuss in detail the characteristics of switching surges with necessary waveforms. (6)	**2**	**Evaluate**	CO1
2.	Explain the different theories of charge formation in the cloud.(13)	**3**	**Apply**	CO1
3.	Explain in detail the protection of power system equipment's using protective devices. (13)	**1**	**Evaluate**	CO1
4.	Explain various causes of power frequency over voltages in power systems and its control techniques. (13)	**1**	**Remember**	CO1
5.	Derive the expression for velocity of travelling waves on transmission line. (13)	**3**	**Remember**	CO1
6.	Draw & Explain the Bewley Lattice Diagram for a two substations system. (13)	**2**	**Understand**	CO1
7.	Explain the control measures for over voltage due to Switching surge and lightning over voltages. (13)	**2**	**Analyze**	CO1
8.	Give the origin and characteristics of switching surges and explain the causes of over voltage due to switching surges in EHV and UHV system.(13)	**4**	**Understand**	CO1
9.	What are the causes for switching and power frequency over voltages? How are they Controlled in power systems? .(13)	**4**	**Apply**	CO1
10.	Write short notes on: (a) Rod gaps used as protective devices (b) Ground wires for protection of overhead lines.(13)	**1**	**Remember**	CO1
11.	Discuss elaborately various sources of Temporary over voltages. (13)	**1**	**Remember**	CO1
12.	Briefly explain about Corona loss and its effects related to Transmission system. (13)	**4**	**Analyze**	CO1
13.	Develop wave equation of travelling waves in transmission line and also discuss the behavior of travelling waves in open circuited transmission. (13)	**4**	**Analyze**	CO1

14.	(i) Draw the cross sectional view of a valve type Lightning arrester and explain its Operation with V-I characteristics(8) (ii) Give the requirements of ground wire for protecting power conductors against Lightning stroke. Explain how they are achieved in practice(5)	**5**	**Analyze**	CO1
15.	Discuss the behavior of traveling waves in open circuited and short circuited transmission line.	**4**	**Apply**	CO1
16.	A surge of 15 kV magnitude travels along a cable towards its junction with an overhead line. The inductance and capacitance of the cable and overhead line are respectively 0.3 mH, 0.4 μF and 1.5 mH, 0.012 μF per km. Evaluate the voltage rise at the junction due to the surge.	**5**	**Evaluating**	CO1
17.	Develope the expression for reflection and refraction coefficients for voltage and current waves when the transmission line of surge impedance Z terminated with a resistance of R ohm.	**6**	**Creating**	CO1
	PART-C			
1.	Explain in detail the origin and characteristics of switching surges and explain the causes of over voltage due to switching surges in EHV and UHV system with a suitable example. (15)	**5**	**Analyze**	CO1
2.	(i) Cloud discharge 14 coulombs within 2ms on to a transmission line during lightening. Estimate the voltage produced at the point of stroke on the transmission line. Assume the surge impedance of the line is 350 ohm.(8) (ii) An overhead line has inductance of 1.26 mH/km and capacitance of 0.009μF/km. Calculate the voltage developed when lightning strikes transmission line injecting a current of 15kA (7)	**4**	**Evaluate**	CO1
3.	Show and explain the charge distribution patters in the cloud following Wilson's and Simpson's theory. (15)	**5**	**Create**	CO1
4.	A long transmission line is energized by a unit step voltage 1.0V at the sending end and is open circuited at the receiving end. Construct the Bewley lattice diagram and obtain the value of the voltage at the receiving end after a long time. Take the attenuation factor $\alpha = 0.9$. (15)	**4**	**Evaluate**	CO1
5.	Explain the Attenuation of traveling waves in long transmission line.	**5**	**Analyze**	CO1

UNIT II – DIELECTRIC BREAKDOWN

SYLLABUS: Properties of Dielectric materials - Gaseous breakdown in uniform and non-uniform fields – Corona discharges – Vacuum breakdown – Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics- Applications of insulating materials in electrical equipment's.

PART-A

Q.No	Questions	BT Level	Competence	Cos
1.	List the properties of dielectric materials.	2	**Remember**	CO2
2.	Discuss about ionization by collision	2	**Remember**	CO2
3.	Write the Paschen's law	2	**Remember**	CO2
4.	What are electronegative gases?	1	**Remember**	CO2
5.	Outline the concept of corona discharge	1	**Remember**	CO2
6.	Define intrinsic strength?	1	**Understand**	CO2
7.	Give the criterion for breakdown in non-uniform fields?	2	**Apply**	CO2
8.	Discuss about composite dielectric? List its properties?	1	**Analyze**	CO2
9.	Define Townsends first ionization coefficient	1	**Understand**	CO2
10.	Define uniform and non-uniform fields.	1	**Understand**	CO2
11.	Electron attaching gases useful for practical use as insulants when Compared to non-attaching gases-justify?	3	**Remember**	CO2
12.	What are pure liquid di-electrics?	3	**Understand**	CO2
13.	Give the usual range of vacuum used in high voltage apparatus?	3	**Remember**	CO2
14.	Commercial liquid dielectrics are different from pure liquid Dielectrics? Justify	4	**Create**	CO2
15.	List the factors that influence conduction in pure liquid dielectrics	4	**Evaluate**	CO2
16.	Outline concept of "stressed oil volume theory"?	4	**Evaluate**	CO2
17.	Give the Concept of time lag in breakdown of dielectrics?	6	**Analyze**	CO2
18.	List out various quantities of transformer oil.	5	**Analyze**	CO2
19.	State the factors which affect breakdown of gaseous dielectrics	5	**Understand**	CO2
20.	Explore the concept of penning effect	6	**Create**	CO2
21.	List the various dielectric materials used in power system.	1	**Remember**	CO2
22.	Write down the properties of gas insulators	1	**Remember**	CO2
23.	Draw the breakdown characteristics of SF_6 and N_2 as a function of pressure.	2	**Apply**	CO2

24.	Give the Applications of vacuum insulators.	**2**	**Apply**	CO2
	PART-B			
1.	Explain the Townsend's first and second ionization processes.(13)	**1**	**Remember**	CO2
2.	Explain in detail the breakdown mechanism in non-uniform fields and phenomenon of corona (13)	**1**	**Remember**	CO2
3.	Explain the phenomenon of corona discharge and breakdown Mechanism in non-uniform fields. (13)	**1**	**Remember**	CO2
4.	(i) Briefly explain about Corona loss and its effects related to Transmission system. (7) (ii) Explain various mechanisms of Vacuum breakdown (6)	**2**	**Apply**	CO2
5.	Explain the various theories that explain breakdown in pure and Commercial liquid dielectrics. (13)	**3**	**Remember**	CO2
6.	Explain the phenomena of electrical conduction in liquids. How does it differ from that in gases? (13)	**2**	**Understand**	CO2
7.	Explore "stressed oil volume theory", and how does it explain breakdown in large volumes of commercial liquid dielectrics(13)	**2**	**Understand**	CO2
8.	Explain the difference between photo-ionization and photo- electric emission. (13)	**2**	**Analyze**	CO2
9.	(i) Derive the criterion for breakdown in electronegative gases. (7) (ii) Explain the Streamer theory of breakdown in air at atmospheric pressure. (6)	**4**	**Analyze**	CO2
10.	(i) Outline concept of anode and the cathode streamers? Explain the mechanism of their formation and development leading to breakdown(7) (ii) Describe the current growth phenomenon in a gas subjected to uniform electric fields. (6)	**1**	**Analyze**	CO2
11.	Explain about the breakdown mechanisms in solid dielectrics with neat sketches (13)	**1**	**Analyze**	CO2
12.	Explain thermal breakdown mechanisms in solid dielectrics. Derive an expression for critical thermal breakdown voltage (Vc) and critical electric field (Ec) for the same. State clearly the assumptions made(13)	**1**	**Apply**	CO2

13.	Explain the dielectrics characteristics of liquid dielectrics and also explain the liquid purification system(13)	**5**	**Create**	CO2
14.	Give short notes on the application of dielectric materials for (i) Cables. (7) (ii) Circuit Breakers.(6)	**4**	**Evaluate**	CO2
15.	Explain the following breakdown mechanism in vacuum. (i) Particle Exchange Mechanism. (6) (ii) Anode and cathode heating Field emission. (7)	**2**	**Analyze**	CO2
16.	Explain the various processes followed for the maintenance of transformer oil quality. (13)	**4**	**Evaluate**	CO2
17.	Give a short note on the electromechanical and thermal breakdown mechanism in solid dielectric. (13)	**5**	**Analyze**	CO2
	PART-C			
1.	(i) List out the problems caused by corona discharge. (7) (ii)A steady state current of $5.5x10^{-8}$ A was noted during experiments in certain gas at 8kV at a distance of 0.4cm between plane electrodes. Keeping the field constant and reducing the distance to 0.1cm resulted in a current of $5.5x10^{-9}$ A. Calculate Townsend's primary ionization coefficient alpha. (8)	**5**	**Analyze**	CO2
2.	(i)Name the primary ionization processes in gaseous dielectrics and explain in detail. (8) (ii)How vacuum breakdown occurs according to particle exchange mechanism. (7)	**4**	**Evaluate**	CO2
3.	State why the very high intrinsic strength of solid dielectric is not fully realized in practice. Explain in detail any one mechanism of breakdown in solid dielectrics.(15)	**5**	**Create**	CO2
4.	Describe the mechanism of breakdown in composite insulation in detail.(15)	**4**	**Evaluate**	CO2
5.	Infer how does the "internal discharge" phenomena lead to breakdown in solid dielectrics.	**5**	**Create**	CO2

UNIT III - GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS				
SYLLABUS: Generation of High DC voltage: Rectifiers, voltage multipliers, vandegraff generator: generation of high impulse voltage: single and multistage Marx circuits –generation of high AC voltages: cascaded transformers, resonant transformer and tesla coil- generation of switching surges – generation of impulse currents - Triggering and control of impulse generators.				
PART-A				
Q.No	**Questions**	**BT Level**	**Competence**	**COs**
1	Give the expression for effective inductance of distributed inductors in impulse current generator	**1**	**Create**	CO3
2	What are the specifications for standard impulse voltage	**1**	**Arrange**	CO3
3	Write the different forms of high voltages required for the testing of electrical apparatus	**3**	**Analyze**	CO3
4	List the merits and demerits of Van de Graff generator?	**3**	**Remember**	CO3
5	Draw the voltage multiplier circuit.	**3**	**Apply**	CO3
6	Define the standard switching impulse voltage.	**4**	**Remember**	CO3
7	What is tesla coil?	**1**	**Remember**	CO3
8	Give the basic principle of electrostatic generator?	**1**	**Understand**	CO3
9	Draw the circuit for producing impulse voltage.	**4**	**Understand**	CO3
10	Draw Schematic diagram of Marx circuit arrangement for multistage impulse generator.	**4**	**Remember**	CO3
11	State the components of multistage impulse generator?	**5**	**Apply**	CO3
12	Draw a typical impulse current wave form.	**2**	**Remember**	CO3
13	Define the front and tail times of an impulse wave. What are the tolerances allowed as per the specifications	**5**	**Remember**	CO3
14	Differentiate between spark over, flash over and puncture?	**2**	**Analyze**	CO3
15	How is the wave front and wave tail times controlled in impulse generator circuits?	**6**	**Understand**	CO3
16	Trigatron gap- Explain its functions and operation.	**6**	**Understand**	CO3
17	Mention the different methods of producing switching impulses in test laboratories.	**1**	**Evaluate**	CO3
18	How are rectangular current pulses generated for testing purposes? How is their time duration controlled?	**2**	**Evaluate**	CO3
19	List the advantages of series resonant circuit.	**2**	**Apply**	CO3
20	Mention the necessity of generating High DC voltage.	**1**	**Create**	CO3
21	Mention the different circuits used to generate HVDC for high voltage testing.	**2**	**Apply**	CO3
22	State the necessity for generating high DC	**1**	**Understand**	CO3

	Voltages.			
23	Draw the Cascaded Voltage Doubler circuit.	**2**	**Analyze**	CO3
24	Describe why the energy in switching surges more than the energy in lightning?	**5**	**Analyze**	CO3
	PART-B			
1	(i)Write a brief note on resonant transformer (8) (ii) How is impulse current generated using capacitor bank? Explain it in detail.(5)	**1**	**Analyze**	CO3
2	Explain simple voltage doubler and cascaded voltage doubler used for generation of high DC voltages.(13)	**2**	**Apply**	CO3
3	What is the principle behind the electrostatic energy conversion methods? Explain the construction and operation of Van de Graaff generator.(13)	**1**	**Analyze**	CO3
4	With a neat sketch explain the Cockcroft – Walton voltage multiplier circuit for generation of high DC voltages. (13)	**1**	**Remember**	CO3
5	Explain with diagrams, different types of rectifier circuits for producing high D.C. voltages. (13)	**2**	**Understand**	CO3
6	Discuss elaborately the principle and operation of Cascaded transformers for generating high AC voltages. (13)	**2**	**Understand**	CO3
7	Discuss elaborately the principle and operation of impulse current generator(13)	**2**	**Understand**	CO3
8	Give different circuits that produce impulse waves explaining clearly their relative merits and demerits. (13)	**3**	**Analyze**	CO3
9	Give the Marx circuit arrangement for multistage impulse generators. How is the basic arrangement modified to accommodate the wave time control resistances? (13)	**2**	**Understand**	CO3
10	Explain the different methods of producing switching impulse voltages in test laboratories. (13)	**6**	**Evaluate**	CO3
11	Explain the Trigatron gap & its functions and operation. (13)	**4**	**Remember**	CO3
12	Give the expression for ripple and regulation in voltage multiplier circuits. How are the ripple and regulation minimized? (13)	**5**	**Remember**	CO3
13	Explain the working of Cockroft-Walton voltage multiplier circuit under unloaded and	**4**	**Analyze**	CO3

	Loaded conditions(13)			
14	A Cockroft Walton type voltage multiplier has eight stages with capacitances ,all equal to 0.05μF.The supply transformer secondary voltage is 125Kv at a frequency of 125Hz.If the load current to be supplied is 4.5mA.Find (1) the % ripple(2) the regulation(13)	**4**	**Remember**	CO3
15	Explain Deltatron or Engetron Circtit. Also State its advantages and disadvantages. (13)	**2**	**Understand**	CO3
16	Analyze the construction and working principle of Electrostatic Generators. (13)	**4**	**Analyze**	CO3
17	Analyze the triggering and control of Impulse Generators. (13)	**4**	**Analyze**	CO3
PART-C				
1.	What is Tesla coil? How is damped high frequency oscillations obtained from a Tesla coil?(15)	**5**	**Analyze**	CO3
2.	Calculate the peak current and wave shape of the output current of the following generator. Total capacitance of the generator is 53μF.the charging voltage is 240 Kv. the circuit inductance is 1.54mH and the dynamic resistance of the test object is 0.05 ohms.(15)	**4**	**Evaluate**	CO3
3	An impulse generator has 10 stages with capacitor of 0.18μF rated at 150kV per stage. The load capacitor is 200PF. Estimate values of series and parallel resistance needed to produce an impulse of wave shape 1.2/50μs.(15)	**5**	**Create**	CO3
4	A ten stage Cockraft-Walton circuit has all capacitor of 0.04μF the secondary voltage of the supply transformer is 120Kv at a frequency of 150HZ.if the load current is 1.2 milliamps, determine (i)voltage regulation (ii) the ripple(iii)the optimum number of stages for maximum output voltage(iv) the maximum output voltage. (15)	**4**	**Evaluate**	CO3
5	Explain the different methods of producing switching impulse currents in test laboratories. (15)	**5**	**Analyze**	CO3

UNIT IV - MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS				
SYLLABUS: High Resistance with series ammeter – Dividers, Resistance, Capacitance and Mixed dividers - Peak Voltmeter, Generating Voltmeters – Capacitance Voltage Transformers, Electrostatic Voltmeters – Sphere Gaps - High current shunts- Digital techniques in high voltage measurement.				
PART-A				
Q.No	**Questions**	**BT Level**	**Competence**	**COs**
1.	What is Rogowski coil? Give its limitations?	**2**	**Remember**	CO4
2.	Enumerate the reason for using sphere type electrodes in HV measurement	**2**	**Understand**	CO4
3.	Write the advantages and disadvantages of CVT.	**6**	**Evaluate**	CO4
4.	How is stray effect reduced in resistive type of shunt measurements	**1**	**Apply**	CO4
5.	What are the drawbacks of resistance potential divider?	**2**	**Remember**	CO4
6.	Give the basic principle of generating and electrostatic voltmeter?	**1**	**Evaluate**	CO4
7.	List out various digital techniques in high voltage measurement.	**1**	**Remember**	CO4
8.	Give short notes on the effect of nearby earthed objects on the measurements using sphere gaps?	**1**	**Remember**	CO4
9.	Mention some advantages of Faraday generator.	**5**	**Understand**	CO4
10.	List the general methods used for measurement of high frequency and impulse currents	**1**	**Understand**	CO4
11.	Why is peak value instrument needed in high voltage measurement?	**1**	**Understand**	CO4
12.	State the type of measuring devices preferred for measurement of high frequency impulse current.	**2**	**Remember**	CO4
13.	Explain the basic principle of hall generator.	**3**	**Apply**	CO4
14.	List the factors that are influencing the peak voltage measurement using sphere gap.	**2**	**Analyze**	CO4
15.	Outline the limitations of generating voltmeter?	**6**	**Analyze**	CO4
16.	State the demerits of CVT measurement of HVAC measurements?	**1**	**Analyze**	CO4
17.	Give the principle of mixed potential divider? How is it used for impulse voltage measurements?	**3**	**Apply**	CO4
18.	Classify the types of resistive shunts used for impulse current measurements	**4**	**Understand**	CO4
19.	What are the problems associated with measurement of very high impulse voltages	**4**	**Create**	CO4

20.	List the factors that are influencing the peak voltage measurement using sphere gap	**5**	**Remember**	CO4
21.	List the advantages of generating voltmeter.	**3**	**Apply**	CO4
22.	Suggest the different methods to measure the high D.C. Voltages.	**3**	**Apply**	CO4
23.	Draw the vector diagram of CVT.	**1**	**Remember**	CO4
24.	Suggest the different methods to measure the high D.C., A.C., and Impulse Currents.	**3**	**Apply**	CO4
	PART-B			
1.	With a neat circuit and phasor diagram, explain the Capacitance Voltage Transformer.(13)	**2**	**Remember**	CO4
2.	List the various techniques used for measurement of Dc voltages and Explain (i) Generating Voltmeter. (5) (ii) Resistance potential divider (5) (iii) Series resistance (3)	**1**	**Remember**	CO4
3.	Tabulate and explain the methods used for measurement of High Voltages. (13)	**1**	**Remember**	**CO4**
4.	Explain briefly the Electrostatic Voltmeter. Also list the advantages and disadvantages(13)	**1**	**Remember**	CO4
5.	Explain the peak reading AC voltmeter? (13)	**3**	**Understand**	CO4
6.	(i)Explain the Hall generator for measuring high dc current.(7) (ii)Explain the measurement of high power frequency alternating current using CT with electro optical signal converter.(6)	**3**	**Understand**	CO4
7.	With a neat diagram explain the sphere gap arrangement method of high A.C voltage measurement in detail and give the factors influencing the measurements. (13)	**2**	**Apply**	CO4
8.	Describe in detail about the high current shunts in detail. (13)	**2**	**Apply**	CO4
9.	A generating voltmeter has to be designed so that it can have a range from 25 to 250 kV dc. If the indicating meter reads a minimum current of 2.5μA and maximum current of 30μA, what should the capacitance of the generating voltmeter be? (13)	**4**	**Understand**	CO4
10.	Explain the measurement of high power frequency alternating currents using current transformer with electro-optical signal convertor for EHV system. (13)	**1**	**Evaluate**	CO4
11.	Briefly explain arrangements of Rogowski coil and magneto optic methods for high current measurements. (13)	**1**	**Analyze**	CO4
12.	Discuss elaborately about various digital techniques in HV measurement.(13)	**6**	**Analyze**	CO4
13.	Describe the construction, principle of operation of a generating voltmeter and give	**4**	**Analyze**	CO4

	its application and limitations.(13)			
14.	Discuss and compare the performance of resistance capacitance and mixed R-C potential dividers for measurement of impulse voltages(13)	**5**	**Create**	CO4
15.	Tabulate and explain the methods used for measurement of high current (13)	**1**	**Remember**	**CO4**
16.	Calculate the correction factors for atmospheric conditions, if the laboratory temperature is 37°C, the atmospheric pressure is 750 mm Hg and the wet bulb temperature is 27°C. (13)	**5**	**Analyze**	CO4
17.	Explain the different methods of impulse current measurement techniques. (13)	**5**	**Analyze**	CO4
	PART-C			
1.	Explain any two methods to measure high frequency and impulse current. (15)	**5**	**Analyze**	CO4
2.	A Rogowski coil is required to measure impulse current of 8KA having rate of change of current of 1010 A/sec .The voltmeter is connected across the integrating circuit which reads 8V for full scale deflection. The input to integrating circuit is from Rogowski coil. Determine the mutual inductance of coil, R and C for the integrating circuit. (15)	**4**	**Evaluate**	CO4
3	(i) Explain the different methods of high current measurements with their relative merits and demerits. (7) (ii) Explain with neat diagram how rod gaps can used for measurement of high voltages compare its performance with sphere gap. (8)	**5**	**Create**	CO4
4	A coaxial shunt is to designed to measure an impulse current of 50 KA. If the bandwidth of shunt is to be at least 10 MHZ and if the voltage drop across the shunt should not exceed 50V, Find ohmic value & dimension. (15)	**4**	**Evaluate**	CO4
5	With a neat diagram explain the sphere gap arrangement method for high D.C., A.C., and Impulse Voltage measurements in detail and give the factors influencing the measurements. (15)	**5**	**Analyze**	CO4

UNIT V - HIGH VOLTAGE TESTING & INSULATION COORDINATION				
SYLLABUS: High voltage testing of electrical power apparatus as per International and Indian standards – Power frequency, impulse voltage and DC testing of Insulators, circuit breakers, bushing, isolators and transformers- Insulation Coordination & testing of cables.				
PART-A				
Q.No	**Questions**	**BT Level**	**Competence**	**Cos**
1.	What is the difference between type and routine test?	**2**	**Remember**	CO5
2.	State the importance of insulation coordination in Power system	**1**	**Remember**	CO5
3.	Define 50% and 100% flashover voltage?	**1**	**Analyze**	CO5
4.	Define creepage distance?	**1**	**Remember**	CO5
5.	Enumerate the difference between type and routine tests?	**1**	**Understand**	CO5
6.	Define air density correction factor	**2**	**Apply**	CO5
7.	Discuss about BIL in power system insulation coordination?	**2**	**Remember**	CO5
8.	List the tests to be carried out on insulator and give a brief account of each test?	**2**	**Apply**	CO5
9.	Infer the significance of power factor tests?	**3**	**Analyze**	CO5
10	List out the standards for testing bushing, CB, insulators and transformer	**4**	**Understand**	CO5
11	List out tests conducted on power transformer as per standard	**4**	**Create**	CO5
12	State the various test conducted on bushing	**3**	**Understand**	CO5
13	Define impulse voltage and withstand voltage	**3**		CO5
14	List out various tests to be carried out on circuit breaker	**1**	**Understand**	CO5
15	Give the values of reference atmospheric condition as per I.S specifications	**1**	**Apply**	CO5
16	Outline the demerits of synthetic testing of circuit breaker	**4**	**Evaluate**	CO5
17	Explore the concept of insulation coordination	**5**	**Remember**	CO5
18	Examine the concept of one minute dry/wet withstand test	**6**	**Analyze**	CO5
19	How is impulse voltage withstand test conducted	**5**	**Understand**	CO5
20	Distinguish between flashover and puncture	**6**	**Analyze**	CO5
21	Define the disruptive discharge voltage.	**2**	**Apply**	CO5

22	Draw the volt time characteristics for good insulation coordination.	**5**	**Analyze**	CO5
23	Define front and tail time in impulse wave.	**2**	**Apply**	CO5
24	List the tests conducted on surge arresters.	**2**	**Apply**	CO5
	PART-B			
1.	Explain the following: (i) Flashover voltage. (4) (ii) Withstand voltage. (3) (iii) Impulse voltage. (3) (iv) Creepage distance. (3)	**1**	**Remember**	CO5
2.	Discuss the different high voltage tests conducted on bushings. (13)	**3**	**Remember**	CO5
3.	What are the tests conducted on isolators and circuit breakers? Explain in detail. (13)	**3**	**Understand**	CO5
4.	Explain the different aspects of insulation design and insulation coordination adopted for EHV systems. (13)	**4**	**Apply**	CO5
5.	Explain the methods of impulse testing of high voltage transformers. List are the procedure adopted for locating the failure. (13)	**4**	**Understand**	CO5
6.	Explain in detail the power frequency and impulse voltage test need to be conducted on bushings with necessary diagrams (13)	**4**	**Remember**	CO5
7.	Explain the following terms used in HV testing as per the standards (i) Disruptive discharge voltage. (4) (ii) Creepage distance. (3) (iii) Impulse voltage. (3) (iv) 100% and 50 % flash over voltage. (3)	**4**	**Remember**	CO5
8.	Briefly discuss the various tests carried out the insulator. (13)	**2**	**Understand**	CO5
9.	Discuss in detail the dielectric power factor test and partial discharge test procedures for HV cables. (13)	**2**	**Apply**	CO5
10.	Give the necessity of volt-time curves? Explain the procedure for constructing Volt-time curves with neat sketch. Give its significance in power system studies. (13)	**1**	**Analyze**	CO5
11.	Discuss elaborately about Insulation coordination. (13)	**1**	**Analyze**	CO5
12.	Briefly explain short circuit plant pertaining to testing of CB. (13)	**1**	**Analyze**	CO5
13.	(i) Elaborately discuss about various types of	**5**	**Create**	CO5

	standards for HV power apparatus testing of electrical power apparatus. (7) (ii) Write short notes on statistical methods for insulation Coordination. (6)			
14.	(i) Briefly explain about pollution testing of Insulators. (7) (ii) Draw the layout for synthetic testing and explain the procedure. (6)	**6**	**Evaluate**	CO5
15.	List the different test conducted on cables according to standards. Explain any one of them. (13)	**2**	**Apply**	CO5
16.	Discuss the various tests carried out in a circuit breaker at high voltage laboratories. (13)	**6**	**Evaluate**	CO5
17.	Describe the various Indian and international standard specification for high voltage testing of electrical power apparatus. (13)	**6**	**Evaluate**	CO5
PART-C				
1.	Explain the different high voltage tests done on bushing. (15)	**5**	**Analyze**	CO5
2.	Explain the direct and synthetic testing of isolators and circuit breakers in detail. (15)	**4**	**Evaluate**	CO5
3	What are the tests to be conducted on cables as IS10810? Explain them in detail. (15)	**5**	**Create**	CO5
4	Explain the complete test procedure for conducting impulse voltage withstand test on 33KV post insulator. (15)	**4**	**Evaluate**	CO5
5	Infer the significance of impulse tests and briefly explain the impulse testing of insulators. (15)	**6**	**Evaluate**	CO5

Course Outcomes:

COs	Course Outcome
CO1	To understand the various types of over voltages in power system and protection methods.
CO2	To know about nature of Breakdown mechanism in solid, liquid and gaseous dielectrics
CO3	To know about Generation of over voltages in laboratories.
CO4	To understand Measurement of over voltages.
CO5	To understand the testing of power apparatus and insulation coordination.