

QUESTION BANK

SUBJECT : EE6701 HIGH VOLTAGE ENGINEERING

SEM / YEAR: VII/IV

UNIT I - INTRODUCTION			
SYLLABUS			
Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over voltages, Corona and its effects – Reflection and Refraction of Travelling waves- Protection against overvoltage.			
PART - A			
Q.NO	Questions	BT Level	Competence
1.	Discuss different kinds of over voltages and its causes.	1	Remember
2.	Define corona critical Disruptive voltage	1	Remember
3.	Define lightning phenomenon	1	Remember
4.	Define Isokeraunic level and back flash over	2	Understand
5.	List out various schemes of protection against over voltages	2	Apply
6.	Define Shielding angle.	2	Understand
7.	List the techniques to be adopted for controlling switching over voltages?	2	Evaluate
8.	Infer the concept of switching surge? Mention its approximate magnitude and frequency.	1	Apply
9.	What are the methods employed for protection of over head lines against lightning	1	Apply
10.	Draw the mathematical model of lightning.	1	Remember
11.	State the specifications of a travelling wave?	3	Analyze
12.	Define surge impedance of a line?	3	Remember
13.	Outline the concept you understand from the word “travelling waves?	3	Analyze
14.	Define attenuation? How they are caused	4	Analyze
15.	List the origin of switching surges?	4	Evaluate
16.	List the causes of power frequency over voltages in power system?	4	Understand
17.	Mention the specifications of the standard impulse voltage?	6	Create
18.	Express the equations for reflection coefficient and refraction co- efficient	5	Understand

19.	Draw the typical wave shape of switching surges.	5	Create
20.	What is the use of protective devices?	6	Remember
PART - B			
1.	Explore the mechanism of lightning and mathematical model of lightning.	2	Evaluate
2.	Explain the different theories of charge formation in the cloud.	3	Apply
3.	Explain the various protection of transmission line against different over voltages.	1	Evaluate
4.	Explain various causes of power frequency over voltages in power systems and its control techniques.	1	Remember
5.	Derive the expression for velocity of travelling waves on transmission line	3	Remember
6.	Discuss elaborately on reflection and refraction of travelling waves	2	Understand
7.	Explain the control measures for over voltage due to Switching surge and lightning over voltages.	2	Analyze
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	4	Understand
9.	What are the causes for switching and power frequency over voltages? How are they Controlled in power systems?	4	Apply
10.	Write short notes on: (a) Rod gaps used as protective devices (b) Ground wires for protection of overhead lines	1	Create
11.	Discuss elaborately various sources of Temporary over voltages.	1	Remember
12.	Briefly explain about Corona loss and its effects related to Transmission system	6	Analyze
13.	Develop wave equation of travelling waves in transmission line and also discuss the behaviour of travelling waves in open circuited transmission	4	Analyze
14.	i) Draw the cross sectional view of a valve type Lightning arrester and explain its Operation with V-I characteristics ii) Give the requirements of ground wire for protecting power conductors against Lightning stroke. Explain how they are achieved in practice	5	Analyze

Part-C

1.	An underground cable of inductance 0.150 mH/km and of capacitance 0.2 μ F/km is connected to an overhead line having an inductance of 1.2 mH/km and capacitance of 0.006 μ F/km. Calculate the transmitted and reflected voltage and current waves at the junction, if a surge of 200kv travels to the junction, (a) Along the cable (b) Along the overhead line. (15)	5	Analyze
2.	(i) Cloud discharge 14 coulombs within 2ms on to a transmission line during lightning. 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 0.009 μ F/km. Calculate the voltage developed when lightning strikes transmission line injecting a current of 15kA (7)	4	Evaluate
3.	Show and explain the charge distribution patters in the cloud following Wilson's and Simpson's theory. (15)	5	Create
4.	(i) Cloud discharge 15 coulombs within 1.5ms on to a transmission line during lightning. 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) How lightning is modelled mathematically. (7)	4	Evaluate

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UNIT II - II DIELECTRIC BREAKDOWN

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.

PART – A

Q.No	Questions	BT Level	Competence
1.	Outline the concept of electronegative gases? Give example	2	Remember
2.	Discuss about ionization by collision	2	Remember
3.	Define Paschen's law	2	Remember
4.	Define gas law	1	Remember
5.	Outline the concept of corona discharge	1	Remember
6.	Define intrinsic strength?	1	Understand
7.	Give the criterion for breakdown in non-uniform fields?	2	Apply
8.	Discuss about composite dielectric? List its properties?	1	Analyze
9.	Define Townsends first ionization coefficient	1	Understand
10.	What are pure liquid di-electrics?	1	Understand
11.	Electron attaching gases useful for practical use as insulants when compared to non-attaching gases-justify?	3	Remember
12.	Define uniform and non-uniform fields.	3	Understand
13.	Give the usual range of vacuum used in high voltage apparatus?	3	Remember
14.	Commercial liquid dielectrics are different from pure liquid dielectrics? Justify	4	Create
15.	List the factors that influence conduction in pure liquid dielectrics and in commercial liquid dielectrics?	4	Evaluate
16.	Outline concept of "stressed oil volume theory"?	4	Evaluate
17.	Give the Concept of time lag in breakdown of dielectrics?	6	Analyze
18.	List out various quantities of transformer oil.	5	Analyze

19.	State the factors which affect breakdown of gaseous dielectrics	5	Understand
20.	Explore the concept of penning effect	6	Create
PART-B			
1.	(i) Explain the Townsend's first and second ionization processes. (ii) Explain briefly various theories of breakdown in commercial liquid dielectrics.	1	Remember
2.	(i) Explain clearly various processes which explain electric breakdown in vacuum.(8) (ii) Discuss the properties of composite dielectrics.(8)	3	Remember
3.	Explain the phenomenon of corona discharge and breakdown Mechanism in non-uniform fields.	2	Remember
4.	Explain the following (i) Breakdown mechanism in solid dielectrics (8) ii) Composite dielectrics and how the breakdown occurs in it. (8)	1	Apply
5.	Explain the various theories that explain breakdown in pure and commercial liquid dielectrics.	3	Remember
6.	Explain the phenomena of electrical conduction in liquids. How does it differ from that in gases?	2	Understand
7.	Explore "stressed oil volume theory", and how does it explain breakdown in large volumes of commercial liquid dielectrics	2	Understand
8.	Explain the difference between photo-ionization and photo-electric emission.	2	Analyze
9.	(i) Derive the criterion for breakdown in electronegative gases. (ii) Explain the Streamer theory of breakdown in air at atmospheric pressure.	4	Analyze
10.	i) Outline concept of anode and the cathode streamers? Explain the mechanism of their formation and development leading to breakdown(8) ii) Describe the current growth phenomenon in a gas subjected to uniform electric fields. (8)	4	Analyze
11.	(i) Discuss streamer theory of breakdown in gases (8) (ii) Explain various mechanisms of Vacuum breakdown (8)	1	Analyze
12.	Explain thermal breakdown mechanisms in solid dielectrics. Derive an expression for critical thermal breakdown voltage (V_c) and critical electric field (E_c) for the same. State clearly the assumptions made	1	Apply
13.	Briefly explain breakdown mechanisms in solid dielectrics and composite dielectrics	5	Create
14.	Explain the dielectrics characteristics of liquid dielectrics and also explain the liquid purification system	4	Evaluate

Part-C

1.	(i).List out the problems caused by corona discharge.(7) (ii)describe the mechanism of short term breakdown composite insulation.(8)	5	Analyze
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
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
4.	(i).A steady state current of 5.5×10^{-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 5.5×10^{-9} A. Calculate Townsend's primary ionization coefficient α .(8) (ii).Derive and expression for the growth of current due to Townsend's primary ionization. Assume necessary data.(7)	4	Evaluate

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UNIT III - GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS			
Generation of High DC, AC, impulse voltages and currents - Triggering and control of impulse generators.			
PART – A			
Q.No	Questions	BT Level	Competence
1	List the merits and demerits of Van de Graaff generator?	1	Create
2	Explain the superiority of cascaded transformer over two winding transformer used for generation of high ac voltages	1	Arrange
3	Write the different forms of high voltages required for the testing of electrical apparatus	3	Analyze
4	Comment- surge impedance of the transmission line is higher than cable	3	Remember
5	Draw the voltage multiplier circuit.	3	Apply
6	What is the principle of operation of a resonant transformer and deltatron circuit?	4	Remember
7	What is tesla coil?	1	Remember
8	Give the basic principle for electrostatic generator?	1	Understand
9	Draw the circuit for producing impulse voltage.	4	Understand
10	Draw Schematic diagram of Marx circuit arrangement for multistage impulse generator	4	Remember
11	State the components of multistage impulse generator?	5	Apply
12	Draw a typical impulse current wave form	2	Remember
13	Define the front and tail times of an impulse wave. What are the tolerances allowed as per the specifications	5	Remember
14	Differentiate between spark over, flash over and puncture?	2	Analyze
15	How is the wave front and wave tail times controlled in impulse generator circuits?	6	Understand
16	Trigatron gap- Explain its functions and operation.	6	Understand
17	Mention the different methods of producing switching impulses in test laboratories.	1	Evaluate

18	How are rectangular current pulses generated for testing purposes? How is their time duration controlled?	2	Evaluate
19	List the advantages of series resonant circuit	2	Apply
20	Mention the necessity of generating High DC voltage	1	Create
PART-B			
1	Explain the resonant transformers used for generation of high ac voltages. What are its advantages?	1	Analyze
2	Explain simple voltage doubler and cascaded voltage doubler used for generation of high DC voltages.	2	Apply
3	Mention the necessity of generating High DC voltage and also with a neat sketch explain the working of a Van de Graaff generator.	1	Analyze
4	With a neat sketch explain the Cockroft – Walton voltage multiplier circuit for generation of high DC voltages.	1	Remember
5	Explain with diagrams, different types of rectifier circuits for producing high D.C. voltages.	1	Understand
6	Discuss elaborately the principle and operation of Cascaded transformers for generating high AC voltages.	2	Understand
7	Discuss elaborately the principle and operation of impulse current generator	2	Understand
8	Give different circuits that produce impulse waves explaining clearly their relative merits and demerits.	3	Analyze
9	Give the Marx circuit arrangement for multistage impulse generators. How is the basic arrangement modified to accommodate the wave time control resistances?	3	Understand
10	Explain the different methods of producing switching impulses in test laboratories.	6	Evaluate
11	Trigatron gap-Explain its functions and operation.	4	Remember
12	Give the expression for ripple and regulation in voltage multiplier circuits. How are the ripple and regulation minimized?	5	Remember
13	Explain the working of Cockroft-Walton voltage multiplier circuit under unloaded and Loaded conditions	4	Analyze
14	A Cockroft Walton type voltage multiplier has eight stages with capacitances ,all equal to $0.05\mu\text{F}$.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	4	Remember

Part-C

1.	What is Tesla coil? How is damped high frequency oscillations obtained from a Tesla coil?(15)	5	Analyze
2.	Calculate the peak current and wave shape of the output current of the following generator. Total capacitance of the generator is $53\mu\text{F}$.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
3	An impulse generator has 10 stages with capacitor of $0.18\mu\text{F}$ 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 $1.2/50\mu\text{s}$.(15)	5	Create
4	A ten stage Cockraft-Walton circuit has all capacitor of $0.04\mu\text{F}$ 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	4	Evaluate

UNIT IV - MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS**PART – A**

Q.No	Questions	BT Level	Competence
1.	Discuss the advantages and limitations of generating volt meters?	2	Remember
2.	Enumerate the reason of using sphere type electrodes in measurement of high voltage.	2	Understand
3.	Write the advantages and disadvantages of CVT.	6	Evaluate
4.	How the stray effect is reduced in resistive shunt type of measurements	1	Apply
5.	List the drawbacks of resistance potential divider?	2	Remember
6.	Give the basic principle of generating and electrostatic voltmeter?	1	Evaluate
7.	How stray effect is reduced in shunt type of measurement?	3	Remember
8.	List the effect of nearby earthed objects on the measurements using sphere gaps?	1	Remember
9	List some advantages of Faraday generator.	5	Understand
10	List the general methods used for measurement of high frequency and impulse currents	1	Understand
11	List out various techniques for high voltage DC measurement	1	Understand
12	State the type of measuring devices preferred for measurement of high frequency impulse current.	2	Remember
13	Explain the basic principle of hall generator.	3	Apply
14	List the factors that are influencing the peak voltage measurement using sphere gap.	2	Analyze
15	Outline the limitations of generating voltmeter?	6	Analyze
16	State the demerits of CVT measurement of HVAC measurements?	1	Analyze
17	Give the principle of mixed potential divider? How is it used for impulse voltage measurements?	3	Apply
18	Outline requirements of an oscillograph for impulse and high frequency measurements in high voltage test circuits?	4	Understand

19	What are the problems associated with measurement of very high impulse voltages	4	Create
20	List out different types of resistive shunts used for impulse current measurements	5	Remember
PART-B			
1.	With a neat circuit and phasor diagram, explain the Capacitance Voltage Transformer.	2	Remember
2.	List the various techniques used for measurement of Dc voltages? Explain (i) Generating Voltmeter. (ii) Resistance potential divider (iii) Series resistance	3	Remember
3.	micrometer Explain series impedance, series capacitance and capacitance potential dividers used for measurement of high ac voltages.	1	Remember
4.	Explain briefly the Electrostatic Voltmeter. Also list the advantages and disadvantages	1	Remember
5.	Explain the peak reading AC voltmeter?	3	Understand
6.	(i) Explain the Hall generator for measuring high dc current. (ii) Explain the measurement of high power frequency alternating current using CT with electro optical signal converter. (iii) Enumerate digital peak voltmeter	2	Understand
7.	Explain Sphere gaps for measurement of high dc, ac and impulse voltages & the factors affecting the measurement.	2	Apply
8.	(i) Explain hall generators for measurement of High currents.(8) (ii) Explain high- power frequency ac current using current transformer with electro optical signal converter.(8)	4	Apply
9.	Explain Electrostatic voltmeter used for measurement of high voltage.	4	Understand
10	With neat circuit diagram explain the capacitance potential transformer. Draw the necessary phasor diagram	1	Evaluate
11	Briefly explain arrangements of Rogowski coil and magneto optic methods for high current measurements	1	Analyze
12	Discuss elaborately about various digital techniques in HV measurement	6	Analyze
13	Describe the construction, principle of operation of a generating voltmeter and give its application and limitations	4	Analyze
14	Discuss and compare the performance of resistance capacitance and mixed R-C potential dividers for measurement of impulse voltages	5	Create

Part-C

1.	Explain any two methods to measure high impulse current(15)	5	Analyze
2.	A Rogowski coil is required to measure impulse current of 8KA having rate of change of current of 10^{10} A/sec .The voltmeter is connected across the integrating circuit which reads 8KV 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.	4	Evaluate
3	(i) Explain the different methods of high current measurements with their relatives merits and demerits. (ii) Explain with neat diagram how rod gaps can used for measurement of high voltages compare its performance with sphere gap.	5	Create
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 the ohmic value and its dimensions.	4	Evaluate

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

19	How is impulse voltage withstand test conducted	5	Understand
20	Distinguish between flashover and puncture	6	Analyze
PART – B			
1.	Explain the following: (i) Flashover voltage (ii) Withstand voltage (iii) Impulse voltage (iv) Creepage distance.	1	Remember
2.	Discuss the different high voltage tests conducted on bushings.	3	Remember
3.	What are the tests conducted on isolators and circuit breakers? Explain in detail.	3	Understand
4.	Explain the different aspects of insulation design and insulation coordination adopted for EHV systems	4	Apply
5.	Explain the methods of impulse testing of high voltage transformers. What is the procedure adopted for locating the failure?	4	Understand
6.	What are the tests conducted on circuit breakers and isolators switches	4	Remember
7.	Explain the following terms used in HV testing as per the standards i) Disruptive discharge voltage (ii) Creepage distance (iii) Impulse voltage (iv) 100% and 50 % flash over voltage	2	Remember
8.	Briefly discuss the various tests carried out the insulator	2	Understand
9.	List the different power frequency tests done on bushing?	2	Apply
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	1	Analyze
11	Discuss elaborately about Insulation coordination.	1	Analyze
12	Briefly explain short circuit plant pertaining to testing of CB	1	Analyze
13	i) Elaborately discuss about various types of standards for HV power apparatus testing of electrical power apparatus(8) ii) write short notes on statistical methods for insulation coordination(8)	5	Create
14	i) Briefly explain about pollution testing of Insulators(8) ii) Draw the layout for synthetic testing and explain the procedure(8)	6	Evaluate

1.	Explain the different high voltage tests done on bushing?	5	Analyze
2.	Explain the direct and synthetic testing of isolators and circuit breakers in detail.	4	Evaluate
3	(i) How are the protective devices chosen for the optimal insulation level in a power system? (ii) Explain the following (a) Withstand voltage (b) Flashover voltage (c) 50% of flashover voltage	5	Create
4	Explain the complete test procedure for conducting impulse voltage withstand test on 33KV post insulator.	4	Evaluate