JEPPIAAR ENGINEERING COLLEGE
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION OF INSTITUTION

To build Jeppiaar Engineering College as an institution of academic excellence in technology and management education, leading to become a world class University.

MISSION OF INSTITUTION

- To excel in teaching and **learning, research and innovation** by promoting the principles of scientific analysis and creative thinking.
- To participate in the production, **development, dissemination of knowledge** and interact with **national and international communities.**
- To equip students with ethical **values, and life skills** that would enrich their lives and enable them to meaningfully contribute to the **progress of the society.**
- To prepare students for **higher studies and lifelong learning,** enrich them with the **practical and entrepreneurial skills** necessary to excel as future professionals and contribute to **Nation's economy.**

PROGRAM OUTCOMES (POs)

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

VISION OF THE DEPARTMENT

The Department of Electrical and Electronics Engineering strives to be a Centre of Excellence in education and technical research, in the endeavour of which the Department will continually update the teaching methodologies, progress in the emerging technologies and continue to play a vital role in the development of the society.

MISSION OF THE DEPARTMENT

M1	To develop the ability to **learn** and work creatively that would enhance the ability of both students and faculty to do **innovative research**.
M2	To **create** and maintain state-of-the art facilities which provide students and faculty with opportunities to analyse, apply and **disseminate knowledge globally**.
M3	To impart the knowledge in essential interdisciplinary fields which will enhance the **interpersonal skills**, team work, professional **ethics** and make them work effectively for their own benefit and the **betterment of the society**.
M4	Prepare students for **lifelong learning** of theoretical and **practical concepts** to face intellectual, **economical** and career challenges.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 01	Strengthen the knowledge in Electrical and Electronics Engineering to enable them **work** for modern industries by promoting energy conservation and sustainability.
PEO 02	Enrich analytical, creative and critical **logical reasoning** skills to solve problems faced by emerging domains of electrical and electronics engineering industries worldwide.
PEO 03	Develop effective communication and inter-personal skills to work with enhanced team spirit in multidisciplinary projects with a broader **ethical**, professional, economical and **social** perspective.
PEO 04	Prepare the students either to establish **start ups** or to pursue **higher education** at reputed institutions.

PROGRAM SPECIFIC OUTCOME (PSOs)

PSO 1	**Professional Skills:** Apply the knowledge of Mathematics, Science and Engineering to solve real time problems in the field of **Power Electronics, Electrical Drives, Power Systems, Control Systems and Instrumentation**.
PSO 2	**Research and Innovation:** Analyze and synthesize circuits by solving complex engineering problems to obtain the **optimal solution** using effective software tools and hardware prototypes in the field of robotics and renewable energy systems.
PSO 3	**Product development:** Develop concepts and **products** by applying ideas of electrical domain into other diversified engineering domains.

EE6701 HIGH VOLTAGE ENGINEERING

SYLLABUS

UNIT I OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS

Causes of over voltages and its effects on power system – Lightning, switching surges and temporary overvoltages, Corona and its effects – Reflection and Refraction of Travelling waves- Protection against overvoltages.

UNIT 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.

UNIT III GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS

Generation of High DC, AC, impulse voltages and currents - Triggering and control of impulse generators.

UNIT IV MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS

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.

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.

L: 45, T: 0, Total = 45Periods

Books Referred:

TEXT BOOKS:

1. S.Naidu and V. Kamaraju, ‘High Voltage Engineering’, Tata McGraw Hill, Fifth Edition, 2013.
2. E. Kuffel and W.S. Zaengl, J.Kuffel, ‘High voltage Engineering fundamentals’, Newnes Second Edition Elsevier , New Delhi, 2005.
3. Subir Ray,’ An Introduction to High Voltage Engineering’ PHI Learning Private Limited, New Delhi, Second Edition, 2013.

REFERENCES:

1. L.L. Alston, ‘High Voltage Technology’, Oxford University Press, First Indian Edition, 2011.
2. C.L. Wadhwa, ‘High voltage Engineering’, New Age International Publishers, Third Edition, 2010.

Course code& Name: **EE6701 & HIGH VOLTAGE ENGINEERING**
Degree/Programme: **B.E/EEE** Semester: **VII** Section: **A, B**
Duration: **DEC – APRIL 2018** Regulation: **2013/AUC**
Name of the Staff:

AIM:

To understand the different overvoltages in power system. To understand the overvoltage generating and measuring techniques used for testing electrical apparatus.

Course Objectives:

- To understand the various types of over voltages in power system and protection methods
- Learn the nature of breakdown mechanism in solid, liquid and gaseous dielectrics
- Learn the various methods for generating over voltages in laboratories.
- Learn the various methods form measuring over voltages in laboratories.
- To know the various testing procedures conducted on power apparatus and insulation coordination

Course Outcomes

C7 01.1	Understand the various types of over voltages in power system and protection methods.
C7 01.2	Understand the Nature of Breakdown mechanism in solid, liquid, gaseous and composite dielectrics.
C7 01.3	Design circuits for generating high voltages and high currents
C7 01.4	Measure high voltages and high currents using appropriate method
C7 01.5	Test the transformer ,insulator , circuit breakers, surge diverters and cables

Mapping of Course Outcomes(COs), Course(C),ProgramSpecificOutcomes (PSOs)with Program Outcomes. (POs)– [Levels of correlation:3 (High),2 (Medium), 1(Low)]

EE6701	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
C4 1.1	3	3	3	3	3	3	2	-	-	-	-	1
C4 1.2	3	3	3	3	3	3	1	-	-	-	-	1
C4 1.3	3	3	3	3	3	3	2	-	-	-	-	1
C4 1.4	3	3	3	3	3	3	2	-	-	-	-	1
C4 1.5	3	2	3	3	3	3	2	-	-	-	-	1

LESSON PLAN

UNIT I OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS

Course delivery details:

Sl. No	Course Content	Knowledge level	Delivery method	No. of Hrs to be handled
1	Causes of over voltages and its effects on power system	R, U	chalk and board / PPT	1 h 30 m
2	Lightning	R, U	chalk and board / PPT	45m
3	switching surges	R, U	chalk and board / PPT	45m
4	Temporary overvoltages	R, U	chalk and board / PPT	45m
5	Corona and its effects	R, U	chalk and board / PPT	45m
6	Reflection and Refraction of Travelling waves	R, U	chalk and board / PPT	1 h 30 m
7	Protection against overvoltages	R, U	chalk and board / PPT	45m

UNIT II DIELECTRIC BREAKDOWN

Course delivery details :

Sl. No.	Course Content	Knowledge level	Delivery method	No. of Hrs to be handled
8	Gaseous breakdown in uniform and non-uniform fields	R, U	chalk and board / PPT	1 h 30 m
9	Corona discharges	R, U	chalk and board	45m
10	Vacuum breakdown time	R, U	chalk and board	45m
11	Conduction and breakdown in pure liquids	R, U	chalk and board / PPT	45m
12	Conduction and breakdown in commercial liquids	R, U	chalk and board / PPT	45m

13	Maintenance of oil Quality	R, U	chalk and board / PPT	45m
14	Breakdown mechanisms in solid dielectrics	R, U	chalk and board / PPT	45m
15	Breakdown mechanisms in composite dielectrics	R, U	chalk and board / PPT	45m

UNIT III GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS
Course delivery details :

Sl. No.	Course Content	Knowledge level	Delivery method	No. of Hrs to be handled
16	Generation of High DC voltage	R, U, An	chalk and board / PPT	45m
17	Generation of High AC voltage	R, U, An	chalk and board / PPT	45m
18	Generation of High impulse voltage	R, U, An	chalk and board / PPT	45m
19	Generation of High DC current	R, U, An	chalk and board / PPT	45m
20	Generation of High AC current	R, U, An	chalk and board / PPT	45m
21	Generation of High impulse current	R, U, An	chalk and board / PPT	1 h 30 m
22	Triggering and control of impulse generators.	R, U, An	chalk and board / PPT	1 h 30 m

UNIT IV MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS
Course delivery details :

Sl. No.	Course Content	Knowledge level	Delivery method	No. of Hrs to be handled
23	High Resistance with series	R, U, An	chalk and board	45m
24	Dividers, Resistance, Capacitance and Mixed dividers	R, U, An	chalk and board	45m

25	Peak voltmeter	R, U, An	chalk and board	45m
26	Generating Voltmeters	R, U, An	chalk and board	45m
27	Capacitance Voltage Transformers	R, U, An	chalk and board	45m
28	Electrostatic Voltmeters	R, U, An	chalk and board	45m
29	Sphere Gaps	R, U, An	chalk and board	45m
30	High current shunts	R, U, An	chalk and board	45m
31	Digital techniques in high voltage measurement	R, U, An	chalk and board	45m

UNIT V HIGH VOLTAGE TESTING & INSULATION COORDINATION
Course Delivery Details :

Sl. No.	Course Content	Knowledge level	Delivery method	No. of Hrs to be handled
32	High voltage testing of electrical power apparatus as per International and Indian standards	R, U, An, E	chalk and board	45m
33	Power frequency	R, U, An, E	chalk and board	45m
34	Impulse voltage	R, U, An, E	chalk and board	45m
35	Impulse voltage	R, U, An, E	chalk and board	45m
36	DC testing of Insulators	R, U, An, E	chalk and board	45m
37	Circuit breakers	R, U, An, E	chalk and board	45m
38	Bushing, isolators	R, U, An, E	chalk and board	45m
39	Transformers	R, U, An, E	chalk and board	45m
40	Insulation Coordination	R, U, An, E	chalk and board	45m

R- Remember, U- Understand, A- Apply, An- Analyze, E- Evaluate & C- Create.

Books:Text/Reference:

TEXT BOOKS:

1. S.Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, Fifth Edition, 2013.
2. E. Kuffel and W.S. Zaengl, J.Kuffel, 'High voltage Engineering fundamentals', Newnes Second Edition Elsevier , New Delhi, 2005.
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2. C.L. Wadhwa, 'High voltage Engineering', New Age International Publishers, Third Edition, 2010.

Comments Given by the Scrutinizing Committee Members	
Signature of the Scrutinizing	
Signature of the HOD	

EE 6701- HIGH VOLTAGE ENGINEERING

UNIT I
OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS
PART – A

1. What are the different types of over voltages? (May 2013)(May 2015)
Lightning over voltages, Switching over voltages, and power frequency over voltages (temporary over voltage).

2. Explain the various regions of the cloud.
The upper regions of the cloud are positively charged, whereas the lower region and the base are predominantly negative except the local region near the base and the head which is possible.

3. What is back flashover?
When a direct lightning stroke occurs on a tower, the tower has to carry huge impulse currents. If the tower footing resistance is considerable, the potential of the tower rises to a large value, steeply with respect to the line and consequently a flashover may take place along the insulator strings. This is known as back flashover

4. State the parameters and the characteristics of the lightning strokes. (May 2015)
Amplitude of the current, the rate of rise, the probability distribution of them and the wave shapes of the lightning voltages and currents.

5. How is attenuation and distortion caused?
Attenuation is caused due to the energy loss in the line and distortion is caused due to the inductance and capacitance of the line.

6. State the factors influence the lightning induced voltages on transmission lines.(Nov 2015)
The ground conductivity, the leader strokes current and the corona.

7. State the attenuation and distortion of traveling waves.
The decrease in the magnitude of the wave as it propagates along the line is called attenuation. The elongation or change of wave shapes that occur is called distortion.

8**. When over voltages are generated in EHV system?**
Over voltages are generated in EHV systems when there is a sudden release of internal energy stored either in the electrostatic form or in the electromagnetic form.

9. What are the uses of shunt reactors?
Shunt reactors are (i) Used to limit the voltage rise due to ferranti effect (ii)Used to reduce surges caused due to sudden energizing.

10. What is ground wire?

Ground wire is a conductor run parallel to the main conductor of the transmission line supported on the same tower and earthed at every equally and regularly spaced towers. It is run above the main conductor of the line.

11. What is an expulsion gap?

Expulsion gap is a device, which consists of a spark gap together with an arc quenching device, which extinguishes the current arc when the gap breaks over due to over voltage.

12. What is a protector tube?

It is a device, which consists of a rod or spark gap in air formed by the line conductor and its high voltage terminal. It is mounted underneath the line conductor on a tower.

13. How are the insulation level and the protective safety margin arrived?

Selecting the risk of failure, the statistical safety factor and by firing the withstand level of any equipment or apparatus corresponding to 90% or 95% of the withstand voltage.

14. Mention the various insulation levels in a substation?

The bus bar insulation is the highest to ensure the continuity of supply in a substation. The circuit breakers, isolators, instrument and relay transformers are given the next lower limiting level. The power transformers are the costliest and sensitive devices and the insulation level for it is the lowest.

15. What are the various types of surge arresters used for EHV and UHV systems?

Silicon carbide arresters with spark gaps, Silicon carbide arresters with current limiting gaps and the gapless metal oxide arresters.

16. Write the equation of surge admittance and surge impedance of the transmission line.

$$Y(S) = C/L\ ((S+\alpha - \beta)(S+\alpha + \beta))^{1/2}$$

$$Z(S) = L/C\ ((S+\alpha-\beta)(S+\alpha-\beta))^{1/2}$$

where α is the attenuation constant and β is the wavelength constant.

17. Define Isokeraunic level or thunderstorm days. (May 2011).

It is defined as the number of days in a year when the thunder is heard or recorded in a particular location. Often it does not distinguish between the ground strokes and the cloud-to-cloud strokes.

18. A transmission line surge impedance 250 ohms is connected to a cable of surge impedance of 50 ohms at the other end, if the surge of 400 kV travels along the line to the junction point, find the voltage build at the junction. (May 2011).

V"=V(2*Z2/Z1+Z2), where V=400 kV , Z1=250 ohms, Z2=50 ohms

V"=400,000*(2(50)/(250+50)), V"=133.33kV.

19. Define Lightning phenomenon. (Dec 2012)

Lightning phenomenon is a peak discharge in which charge accumulated in the clouds discharges into a neighboring cloud or to the ground.

20. List some sources causing switching surges. (Dec 2012)

Sudden switching off of loads, short circuits and fault clearances, disconnection of unloaded transformers, reactors.

21. What is stepped leader stroke? (May 2013)

Due to insufficient build of charge at the head of leader stroke comes to a halt after progressing about 50 meter and again after short interval the streamer starts out repeating its performance with different branches by a series of jumps. It is called as stepped leader.

22. State the sources which determine the wave shape of switching surges. (Nov 2013)

- De-energizing of transmission lines, cables, shunt capacitor, banks,etc.
- Disconnection of unloaded transformers, reactors, etc.
- Energization or reclosing of lines and reactive loads,
- Sudden switching off of loads.
- Short circuits and fault clearances.
- Resonance phenomenon like ferro-resonance, arcing grounds, etc.

23. Write down the causes of power frequency over voltages. (Nov 2013)

The main causes for power frequency and its harmonic over voltages are,

- Sudden loss of loads,
- Disconnection of inductive loads or connection of capacitive loads,
- Ferranti effect, unsymmetrical faults, and
- Saturation in transformer

24. Classify the lightning strokes. (May 2014)

- Cloud to cloud lightning
- Cloud to air lightning
- Intra cloud lightning
- Cloud to ground lightning
- Bolt from the blue
- Ribbon lightning

25. Why a simple spark gap cannot offer full protection against overvoltages? (Nov 2015)

The sparkover voltage of a rod gap depends on the atmospheric conditions. There is no current limiting device provided so as to limit the current after sparkover, and hence a series resistance is often used. Without a series resistance, the sparking current may be very high and the applied impulse voltage suddenly collapses to zero thus creating a steep step voltage, which sometimes proves to be very dangerous to the apparatus to be protected, such as transformer or the machine windings.

26. What is ground wire?

Ground wire is a conductor run parallel to the main conductor of the transmission line supported on the same tower and earthed at every equally and regularly spaced towers. It is run above the main conductor of the line.

27. What is the use of ground wire?

It shields the transmission line conductor from induced charges, from clouds as well as from a lightning discharge.

28. Mention the various insulation levels in a substation.?

The bus bar insulation is the highest to ensure the continuity of supply in a substation. The circuit breakers, isolators, instrument and relay transformers are given the next lower limit level. The power transformers are the costliest and sensitive devices and the insulation level for it is the lowest.

29. What are surge arresters?

They are non-linear resistors in series with spark gaps, which act as fast switches.

30. What are the various types of surge arresters used for EHV and UHV systems?

Silicon carbide arresters with spark gaps, Silicon carbide arresters with current limiting gaps and the gapless metal oxide arresters.

PART – B

1. What are the causes for switching and power frequency over voltages? How are they controlled in power system? **(May 2011, 2012, 2013,2014, Nov 2015)(April 2017)**
2. Explain with suitable figure the principles and functioning of (i) Expulsion Gap (ii) Protector Tube. **(April 2017)**
3. Write short a note on (i) Rod gaps as protective devices (ii) Ground wires for protection of overhead lines.**(Nov 2014) (nov-2017)**
4. What are the mechanisms by which lightning strokes develop and induce over voltages on overhead power lines? Give the mathematical models for lightning discharges and explain them. **(May 2013) (nov-2016) (nov-2017)**
5. Explain the different theories of charge formation in clouds. **(May 2011) (Dec 2012)**
6. An underground cable of inductance 0.150 mH/km and of capacitance 0.2 μF/km is connected to an overhead line having an inductance of 1.2 mH/km and capacitance of 0.006 μF/km. Calculate the transmitted and reflected voltage and current waves at the junction, if a surge of 200 kV travels to the junction, (i) along the cable, and (ii)along the overhead line. **(May 2011).**
7. A long transmission line is energized by a unit step voltage 1.0 V 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 $\alpha = 0.8$.Discuss the step by step procedure for constructing Bewley's Lattice diagram with an example. **(May 2014, Nov 2015)**
8. Draw the cross sectional view of valve type lightning arrester and explain its operation with V-I characteristics.**(May 2014)**
9. What are the requirements of a ground wire for protecting power conductors against direct lightning stroke? Explain how they are achieved in practice.**(May 2014) (nov-2016)**
10. Explain the characteristics of switching surges with typical waveforms. Explain why a steep fronted surge waveform are more vulnerable to insulation? **(May 2015)**

UNIT II-DIELECTRIC BREAKDOWN

PART A

1.Mention the gases used as the insulating medium in electrical apparatus?

Most of the electrical apparatus use air as the insulating medium, and in a few cases other gases such as nitrogen, carbon dioxide, Freon and sulphur hexafluoride

2 .What is breakdown voltage?

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

3.What is ionization?

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

4.What is Townsend's first ionization coefficient?

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

5.What is Townsend's secondary ionization coefficient?

The Townsend's secondary ionization coefficient is defined as the net number of secondary electrons produced per incident positive ion, photon, excited particle or metastable particle.

6. What are electronegative gases? (May 2013) (Nov 2015)

The gases which are highest breakdown strength due to attachment of free electrons to neutral atoms or molecules to form negative ions, thus removing free electrons that would otherwise led to breakdown is called as electronegative gases.

7. Define an attachment coefficient.

An attachment co-efficient is defined as the number of attaching collusions made by one electron drifting one centimeter in the direction of the field.

8. What is meant by time lag?

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

9. Mention some of the applications of liquid dielectrics.

They are used as impregnants in high voltage cables and capacitors, and for filling up of transformers, circuit breakers. They are also used as heat transfer agents in transformers and as arc quenching media in circuit breakers.

10.Name some examples of liquid dielectrics.

Petroleum oils, Synthetic hydrocarbons, halogenated hydrocarbons, silicone oils and fluorinated hydrocarbons.

11.What are pure liquids? Give examples.

They are chemically pure and do not contain any other impurity even in traces of 1in 109 and are structurally simple. Examples are n-hexane, n-heptane and other paraffin hydrocarbons.

12. What are the different types of solid insulating materials?

Organic materials: paper, wood and rubber, Inorganic materials: Mica, glass and porcelain Synthetic polymers: Persplex, PVC, epoxy resins

13. State the properties of good dielectrics

Low dielectric loss, high mechanical strength, should be free from gaseous inclusions and moisture and be resistant to thermal and chemical deterioration.

14. State and explain Paschen's law. (May 2011).

Townsends breakdown criterion for gases is given by $\gamma(e^{\alpha d}-1) = 1$,

Where α, γ are the Townsends co-efficients and are functions of (E/p).

$$f = (\frac{v}{pd})[e^{pdf(\frac{v}{pd})} - 1] = 1$$

This equation shows the relation between v and pd. V=f(pd)

The breakdown voltage of a uniform field gap is a unique function. The product of gas pressure p and gas length d for a particular gas and electrode material. This relation is known as Paschen's law.

15.What do you mean by 'Intrinsic strength'of a solid dielectric? (May 2011,Dec 2012)

When voltage is applied for a short time of the order of 10^{-8} , the electric strength of the solid material increases rapidly to an upper limit. This is called Intrinsic strength.

16. Define treeing and tracking. (Dec 2012)

Treeing is the formation of a continuous conducting path across the surface of the insulation mainly due to surface erosion under voltage application.

Insulation failure occurs when carbonized tracks bridge the distance between the electrodes. This phenomenon is called tracking**.**

17.What is meant by corona discharges? (May 2013)

In non-uniform fields, the increase in voltage cause breakdown in the gas at points with highest electric field intensity(sharp points), or where the electrodes are curved or on transmission lines. This form of discharge is called as corona discharge.

18. What are the properties required for a gaseous dielectric for HV application? (Nov 2013)

Generally , the preferred properties of a gaseous dielectric for high voltage applications are,

- 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
- Arc extinguishing ability
- Good heat transfer
- Commercial availability at moderate cost.

19. What are commercial liquid dielectrics and how are they different from pure liquid dielectrics? (Nov 2013)

- Pure liquids are those which are chemically pure and do not contain any other impurity even in traces of 1 in 10^9, and are structurally simple.

Examples of such simple pure liquids are n-hexane , n-heptane and other paraffin hydrocarbons.

- Commercial liquids which are insulating liquids like oils which are not chemically pure.
- Normally consist of mixtures of complex organic molecules which cannot be easily specified or reproduced in a series of experiments.

20. What is meant by "Penning effect"? (May 2014)

Penning Effect is a form of chemi-ionization, an ionization process involving reactions between neutral atoms or molecules. The process is named after the Dutch physicist Frans Michel Penning who first reported it in 1927. The Penning effect is put to practical use in applications such as gas-discharge neon lamps and fluorescent lamps, where the lamp is filled with a Penning mixture to improve the electrical characteristics of the lamps.

21. What are the factors which affect breakdown in gaseous dielectrics? (May 2014)

If the applied voltage are large , the current flowing through the insulation increases very sharply and an electrical breakdown occurs. The factors which affect breakdown in gaseous dielectrics are,

- Low dielectric strength
- Thermal and chemical instability
- Flammability and hazardous
- Bad heat transfer

22. What is Townsend's condition for breakdown? (May 2015)

Townsends breakdown criterion for gases is given by $\gamma(e^{\alpha d}-1) = 1$,

Where α, γ are the Townsends co-efficients.

Normally $e^{\alpha d}$ is very large, hence the above equation reduces to $\gamma e^{\alpha d}=1$

23. Define statistical time lag and formative time lag. (May 2015)

The time which lapses between the application of the voltage sufficient to cause breakdown and the appearance of the initiating electron is called a statistical time lag of the gap. After the appearance of electron, a time (t_t) is required for the ionization process to develop fully to cause the breakdown of the gap. This time is called formative time lag(t_t).

24. What do you mean by tracking index?(May 2015)

The numerical value of voltage that initiates or causes the formation of a track is called the "tracking index" and this is used to qualify the surface properties of dielectric materials.

25. Name the various secondary ionization process involved in gaseous dielectric breakdown. (Nov 2015)

Electron Emission due to Positive Ion Impact, Electron Emission due to Photons and Electron Emission due to Metastable and Neutral Atoms

26. What is Townsend's first ionization coefficient?

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

27. What is Townsend's secondary ionization coefficient?

The Townsend's secondary ionization coefficient is defined as the net number of secondary electrons produced per incident positive ion, photon, excited particle or meta stable particle.

28. What is an electronegative gas?

An electronegative gas is one in which the electrons get attached to form negative ion.

29. Define an attachment coefficient.

An attachment co-efficient is defined as the number of attaching collusions made by one electron drifting one centimeter in the direction of the field.

30. What is meant by time lag?

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

PART B

1. What are the Electro negative gases? Why is the break down strength higher in these gases

compared to that in other gases? Explain the streamer theory of break down in air at atmospheric pressure.**(May 2014).**

2. Discuss the various mechanisms of vacuum break down.**(May 2014). (nov-2017) (apr-2017)**

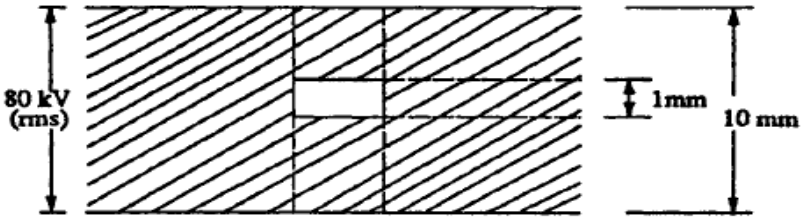
3. Explain the theories that explain break down in commercial liquid dielectrics. **(Nov 2013). (nov-2017) (apr-2017)**

4. Explain the Townsends criterion for a spark. **(May 2011). (May 2015) (apr-2017)**

5. What do you understand by intrinsic strength of solid dielectrics? Explain different mechanisms by which breakdown occurs in solid dielectrics in practice.**(Nov 2015)**

6. State the criteria for sparking potential and hence obtain the relation between sparking potential and (pd) values (Paschen's Law). Discuss on the nature of variations of sparking potential with (pd) values. **(May 2013)**

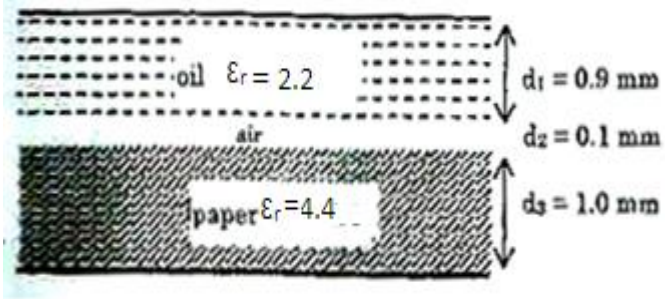
7. A solid dielectric specimen of dielectric constant of 4.0 shown in the figure has an internal void of thickness 1 mm. The specimen is 1 cm thick and is subjected to a voltage of 80 kV (rms). If the void is filled with air and if the breakdown strength of air can be taken as 30 k V (peak)/cm, find the voltage at which an internal discharge can occur.



8. Explain composite dielectrics and how the breakdown occurs in it? **(Dec 2012, Nov 2015) (apr-2017)**

9. Explain Thermal break down in solid dielectrics? Derive an expression for critical thermal breakdown voltage(Vc) and critical electric field (Ec) for the same. State clearly the assumption made. **(May 2014)**

10. A certain dielectric can be considered to be represented by the equivalent circuit shown in figure. What is the maximum voltage that can be applied across the dielectric, if partial discharges in air to be avoided? State any assumptions made. **(May 2015)**



UNIT III -GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS

PART A

1. What does the selection of BIL level for lines depend?

Atmospheric conditions, lightning activity, insulation pollution and acceptable outage of the line.

2. What are the disadvantages of half wave rectifier circuit?(Nov 2013)

- Low dc output power and lower efficiency.
- Higher ripple voltage & ripple current.
- Higher ripple factor.
- Low transformer utilization factor.
- The input supply current waveform has a dc component which can result in dc saturation of the transformer core.

3. What are the classifications of high voltages?

High dc, high ac of power frequency, high ac of high frequency and impulse voltages.

4. What is regulation?

The change of average voltage across the load from the no load theoretical value expressed as a percentage of no load is called regulation.

5. What is a tesla coil?

The high frequency resonant transformer is called as a tesla coil.

6. What are the uses of high frequency high voltages?

They are required for rectifier dc power supplies. Also it is used for testing electrical apparatus for switching surges.

7. Mention the advantages of high frequency transformers.

Saving in cost and size, pure sine wave output, uniform distribution of voltage across the winding coils due to subdivision of coil stack into number of units.

8. Mention the specifications of standard impulse wave.(May 2013) (Nov 2015)

By defining the rise of front time and tail time 1.2/50μs, 1000 KV (standard value), fall time to 50% peak value of 50μs and a peak value of 1000 kV.

9. Mention the circuits to produce impulse waves.

In the laboratory with a combination of a series R-L-C circuit under over damped conditions or by the combination of 2 R-C circuits.

10. Name the multi test sets used for high voltage testing.

Ac testing transformers, dc units, impulse voltage units.

11. What is transient voltage?

It is an oscillatory wave or a damped oscillatory wave of frequency ranging for few Hundred hertz to few kilohertz.

12. What are the components of a multistage impulse generator?

Dc charging unit, charging resistors, generator capacitors and spark gaps, wave shaping resistors and capacitors, triggering system, voltage dividers and gas insulated impulse generators.

13. Define the duration of the wave.

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

14. How are impulse currents of large value produced?

A bank of capacitors connected in parallel are charged to a specified value and are discharged through a series R-L circuit.

15.Explain Deltatron circuit. (Dec 2012)

A combination of Cockcroft Walton type voltage multiplier with cascaded transformer dc rectifier is developed for very high voltages but limited output currents having high stability, small ripple factor and fast regulation. This type of circuit is called deltatron circuit

16. Mention the advantage of trigatron gap?

It requires much smaller voltage for operation compared to the three-electrode gap.

17. What are the components of a trigatron gap?

It 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.

18. What are drawbacks of single stage circuit for the generation of very high impulse voltage? (May 2011)

For higher voltage requirements a single unit construction becomes difficult and costly due to insulation problems. Erection and transportation becomes difficult.

19. What is a cascaded transformer? (May 2011).

Input of the first transformer unit is supplied from a motor generator or from a voltage regulator. The primary winding is supplied from a source. The high voltage winding of the first unit is connected to the tank of the second unit. The rating of the excitation winding is almost identical with that of primary winding voltage.

20.Give some merits of vande Graff generator. (Dec 2012)

- Very high DC voltage can be generated easily.
- Ripple free output.
- Precision and flexibility of control.
- Stability of voltage can be achieved with suitable stabilizing devices.

21. Give any two methods of switching surge generation in laboratory. (May 2013)

- By changing the tail time constants of impulse generator.
- By connecting primary and secondary windings of power transformer in series.

22. Define the front and tail times of impulse wave.(Nov 2013)

Rise or Front time: It is the time required for the response to raise from 10 to 90% or 0 to 100% of the final value at the very first instance. Rise time for standard impulse wave of 1.2/50 μ s,1000 kV = 1.2 μ s.

Fall or Tail time : Fall time is the time to reach 50% peak value of 50 μ s. Fall time for standard impulse wave of 1.2/50 μ s,1000 kV = 50% peak value of 50μ s.

23. Mention the necessity of generating high dc voltage.(April 2014)

The generating high dc voltage is necessary for,

Research work in applied physics

Charging of impulse generators

- Insulation tests on cables and capacitors
- Rectifiers are used to get HVDC up to 100 kV and 100mA

24. What are the advantages of series resonant circuit? (April 2014)

- It gives an output of pure sine wave.
- Power requirements are less.(5 to 10% of total KVA required)
- No high power arcing and heavy current surges occur if the test object fails , a 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 failure of test objects.

25. How is the circuit inductance controlled and minimized in impulse current generator?

(Nov 2015)

If the series resistance *R*\ is increased, the wave front oscillations are damped, but the peak value of the voltage is also reduced. Thereby circuit inductance can be controlled and minimized in impulse current generator.

26. Define the duration of the wave.

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

27. How are impulse currents of large value produced?

A bank of capacitors connected in parallel are charged to a specified value and are discharged through a series R-L circuit.

28. How will you generate rectangular current pulses with high magnitudes?

They are generated by discharging a pulse network.

29. Mention the advantage of trigatron gap?

It requires much smaller voltage for operation compared to the three-electrode gap.

30. What are the components of a trigatron gap?

It 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.

PART B

1. Why is Cock croft –Walton circuit preferred for voltage multiplier circuits? Explain its working with a schematic diagram when it is unloaded and loaded.Derive an expression for total voltage drop and total ripple voltage of n-stage voltage multiplier circuit and hence deduce the condition for optimum number of stages. **(April 2014) (Nov-16)**

2. Describe with a neat sketch the working of a Van De Graff generator. What are the factors that limit the maximum voltage obtained?**(May 2013, Nov 2014) (Nov-17) (Nov-16)**

3.What is the principle of operation of a resonant transformer? How is it advantages over the cascade-connected transformer? Explain the basic principle of operation of an electrostatic generator. **(May 2011)**

4.How are damped high frequency oscillation obtained from a Tesla coil? Explain.**(Dec 2012) (Nov-17)**

5.Give the Marx circuit arrangement for multistage impulse generators. How is the basic arrangement modified to accommodate the wave time control resistances? **(May 2011, Nov 2015). (may-2017)**

6.Explain the different methods of producing switching impulses in test laboratories. Draw the typical impulse current generator circuit and explain its operation and applications.**(May 2011).**

7.A Cockcroft-Walton type voltage multiplier has eight stages with capacitances, all equal to 0.05 pF. The supply transformer secondary voltage is 125 kV at a frequency of 150 Hz. If the load current to be supplied is 5 mA, find (a) the percentage ripple, (b) the regulation, and (c) the optimum number of stages for minimum regulation or voltage drop.**(May 2011, May 2015) (May-2017)**

8.Explain tripping and control of impulse generators with Trigatron gap arrangements. How are the wavefront and wavetail time controlled in impulse generator circuits?**(Dec 2012, Nov 2015) (may-2017)**

9.What is a cascaded transformer? Explain why cascading is done? Describe with neat diagram, a 3-stage cascaded transformer.**(Dec 2013)**

10.A six stage impulse generator designed to generate the standard waveform (1.2/50 μs) has a per stage capacitance of 0.06 μF to be used to test transformers with an equivalent winding to earth

capacitance of 1nF. A peak output voltage of 550kV is required for testing the transformer. The wavefront time is to be defined based on 30% and 90% values. With the aid of appropriate calculations select the values of the resistive elements in the circuit to produce the required waveform. State any assumptions made. **(May 2015)**

UNIT IV - MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS

PART-A

1. Mention the techniques used in impulse current measurements.

Hall generators, Faraday generators and current transformers.

2.Mention the problems associated with bifilar strip design.

The shunt suffers from stray inductance associated with resistance element and its potential leads are linked to a small part of the magnetic flux generated by the current that is measured.

3.Mention the different ways in which the stray effect is reduced in resistance shunt?

Bifilar flat strip design, Co-axial tube or park's shunt design and Co-axial squirrel cage design.

4.State the advantages of Sphere gaps?

They are used for voltage measurements. They are suitable for all types ofwaveforms from d.c to impulse voltages of short times. They are used for radio frequency a.c voltage peak measurements upto 1 MHz.

5.State the advantages of magnetic potential transformers.

They are simple in construction and designed for any voltage. For very high voltages cascading of the transformers are possible.

6. How is an electric field is measured?

It is measured by introducing a small fixed capacitance probe into the field area and measuring the induced charge on it.

7. Mention the devices used to measure the d.c electric field strength.

Variable capacitor probe and a vibrating plate capacitor.

8. Give the advantages of generating voltmeters

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

9. How is an electric field is measured?

It is measured by introducing a small fixed capacitance probe into the field area and measuring the induced charge on it.

10.Explain the porosity test on insulators.

The insulator is broken and immersed in a 0.5 % alcohol solution under a pressure of 13800 kN/sq.m for 24 hours. The broken insulator is taken out and further broken. It should not show any sign of impregnation.

11. Why is the cable meant for a.c system to be tested with dc supply?

Cables are tested for power frequency ac and dc voltages. During manufacture the entire cable is passed through a higher voltage test and the rated voltage to check the continuity of cable. High voltage dc of 1.8 times the rated dc voltage of negative polarity for 30 minutes is applied and cable is set to have no failure.

12.An electrostatic voltmeter has two parallel plates. The movable plate is 10 cm in diameter. With 8 kV between the plates the pull is $5x10^{-3}$N. Determine the change in capacitance for a movement of 1mm of movable plate. (May 2011).

$$0.005=0.5*\frac{1}{36}*3.14*10^{-9}*\frac{10^2}{d^2}*25*3.14*10^{-4}$$

d = 26.35mm

Change in capacitance $=\frac{8000}{36}*10^{-9}*25*3.14*10^{-4}\left(\left(\frac{1}{26.35}\right)-\left(\frac{1}{27.35}\right)\right)=2.5*10^{-12}$F

13.What is the effect of nearby earthed objects on the measurements using sphere gaps?

(May 2011).

The spark over voltage is reduced due to the presence of nearby earthed objects.

Voltage reduction, $\Delta V=m\log\left(\frac{B}{D}\right)+C$

Where, B – diameter of earthed enclosing cylinder, D – diameter of the spheres

C – gap distance between spheres, m,c – constants

14. Define CVT. (May 2013)

CVT meant for capacitive voltage transformer. It is used for measurement, relaying applications and sometimes for carrier communications.

15. Explain the basic principle of Hall generator. (Dec 2012)

It is based on the principle of hall effect. Whenever electric current flows through a metal plate located in a magnetic field perpendicular to it, Lorentz forces will deflect the electrons in the metal structure in a direction normal to the direction of both currents and magnetic field. The charge displacement generates an emf. This is called Hall voltage. $V_H \alpha$ BI/d

16.List some advantages of Faraday generator. (Dec 2012)

- There is no electric connection between the source and the device.
- No thermal problems even for large currents of several kilo amperes.
- There is no insulation problem, as the signal transmission is through an optical system.

17. Give the advantages of electrostatic voltmeter. (May 2013)

The electrostatic voltmeter is (i)compact and smaller in size (ii) it has high input impedance, therefore no need to have meter protection additionally (iii) the range of the meter can be easily changed by changing gap separation.

18.What is the effect of dust particles on the measurement using sphere gaps? (Nov 2013)

Field configuration may change will leads to incorrect measurement. Therefore the surface of the sphere should be free from dust, grease, or any other coating.

19.List out the limitations of generating voltmeters.(Nov 2013)

- Need calibration.
- Careful construction is needed.
- Any disturbance due to position and mounting of the electrodes make the calibration invalid.

20.Give the procedure for dc and ac peak voltage measurement using sphere gap. (April 2014)

A uniform field spark gap will always have a spark over voltage within a known tolerance under constant atmospheric conditions. Hence a spark gap can be used for measurement of the peak value of the voltage, if the gap distance is known. A spark over voltage of 30 kV (peak) at 1 cm spacing in air at 2O0C and 760 torr pressure occurs for a sphere gap or any uniform field gap. But experience has shown that these measurements are reliable only for certain gap configurations. Normally, only sphere gaps are used for voltage measurements.

21.What are the different types of resistive shunts used for impulse current measurements? (April 2014)

(a) Bifilar flat strip design,(b) coaxial tube or Park's shunt design, and(c) coaxial squirrel cage design

22. What are the drawbacks of series resistance micro ammeter technique in HVAC measurements?(Nov 2015)

The drawbacks of this technique are (i)power dissipation and source loading, (ii) temperature effects and long time stability, (iii)voltage dependence of resistive elements, and (iv) sensitivity to mechanical stresses.

23. How the stray effect of capacitance potential divider is minimized for impulse measurements? (Nov 2015)

The effect to residual and lead inductances becomes pronounced when fast rising impulses of less than one microsecond are to be measured. The residual inductances damp and slow down the fast rising pulses. Secondly, the layout of the test objects, the impulse generator, and the ground leads also require special attention to minimize recording errors.

24. What is the principle behind the operation of generating voltmeter?(May 2015)

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.

25. What are the differences between a high voltage testing transformer and a power transformer? (May 2015)

A high voltage testing transformer (a)gives an output of pure sine wave, (b) power requirements are less (5 to 10% of total kVA required),(c) no high-power arcing and heavy current surges occur if the test object fails, as resonance ceases at the failure of the test object,(d) cascading is also possible for very high voltages,(e) simple and compact test arrangement, and(f) no repeated flashovers occur in case of partial failures of the test object and insulation recovery. It can be shown that the supply source takes Q number of cycles at least to charge the test specimen to the full voltage.

Power transformers are generally used in transmission network for stepping up or down the voltage level. It operates mainly during high or peak loads and has maximum efficiency at or near full load.

26. State the advantages of magnetic potential transformers.

They are simple in construction and designed for any voltage. For very high voltages cascading of the transformers are possible.

27. How is an electric field is measured?

It is measured by introducing a small fixed capacitance probe into the field area and measuring the induced charge on it.

28. Mention the devices used to measure the d.c electric field strength.

Variable capacitor probe and a vibrating plate capacitor.

29. Give the advantages of generating voltmeters

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

30. Define type test.

They are intended to prove or check the design features and the quality. They are done on samples when new designs or design changes are introduced.

PART B

1. Explain with neat diagram the principle of operation of an electrostatic voltmeter. Discuss its advantages and limitations for high voltage measurements. **(May 2011).(apr-2017) (Nov-2017)**
2. Explain the different methods of high d.c, a.c and impulse current measurement with their relative merits demerits.
3.(i) Give the schematic arrangement of an impulse potential divider with an oscilloscope connected for measuring impulse voltages. Explain the arrangement used to minimize the errors.
(ii) What are the requirements of a digital storage oscilloscope for impulse and high frequency measurement in HV test circuits? **(Nov 2015)**
4. A Rogowski coil is to be designed to measure impulse currents of 10 kA having a rate of change of current of 10^{10}A/s .The current is read by a VTVM as a potential drop across the integrating circuit connected to the secondary. Estimate the values of mutual inductance, resistance, and capacitance to be connected, if the meter reading is to be 10 V for full-scale deflection. . **(May 2011).**
5. i) Enumerate digital peak voltmeter. (8) **(Dec 2012) (Nov-2016)**
ii) What is CVT? Explain how CVT can be used for high voltage ac measurement. (8). **(Nov-2016)**
6. Describe the construction, principle of operation of a Generating voltmeter and give its applications and limitations. **(May 2014). (Nov-2017)**
7. Discuss and compare the performance of resistance capacitance and mixed R-C potential dividers for measurement of impulse voltages. Draw the simplified equivalent circuit of resistance potential divider and discuss its step response**(Dec 2013, May 2014).**
8. Describe the construction of uniform field spark gap and discuss its advantages and disadvantages for high voltage measurements. Explain the procedure for peak value measurement of high voltage DC,AC and impulse voltage using standard sphere gap.Explain the parameters and factors that influence the sphere gap measurement. **(Nov 2015) (apr-2017) (Nov-2016)**
9. Explain in detail various techniques for the measurement of high DC voltages. **(May 2015) (apr-2017)**
10. With neat sketch, explain in detail the various methods used to measure the RMS and peak values of high AC voltages. **(May 2015)**

UNIT V - HIGH VOLTAGE TESTING & INSULATION COORDINATION

PART-A

1.What is a surge diverter?

It is a non-linear resistor in series with a spark gap kept at line terminals in the substations.

2.Define creeping distance.

It is the shortest distance on the contour of the external surface of the insulator unit.

3.What is the importance of radio interference voltage measurements for extra high voltage power apparatus?

In the power apparatus it produces unwanted electrical signals in radio and high frequency ranges. It is important to see that the noise generated should be reduced. For this purpose this measurement is important.

4. Define withstand voltage.

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

5. Define an isolator.

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

6. Define partial discharge.(Dec 2012)

An electrical discharge that only partially bridges the dielectric between the conductors. Examples are surface discharge, internal discharge

7. Define a circuit breaker.

It is a switch, which automatically interrupts the circuit when a critical current ovrvoltage rating is exceeded.

8.What is the function of surge arrester?

They are capable of discharging 10 to 20 KA of long duration surges and 100 to250 KA of short duration surge currents.

9. State the consequences of RIV.

When the noise meter measurements are stated the information regarding the specification of meters used in the band pass characteristics and the open circuit the detector characteristics has to be mentioned.

10. What do you mean by radio interference?

The power apparatus produces unwanted signals in the radio and high frequency ranges.These are called radio interference.

11. Mention the characteristics of the spray used in wet flashover test. (Nov 2013)

The characteristics of the spray are

- ✓ Precipitation rate : 3 ± 10% (mm/min)
- ✓ Direction : 45° to the vertical
- ✓ Conductivity of water : 100 micro Siemens ± 10%
- ✓ Water temperature : ambient ±15°C

12.How is impulse with-stand voltage test conducted? (April 2014)

This test is done by applying standard impulse voltage of specified value under dry conditions with both positive and negative polarities of the wave. If five consecutive waves do not cause a flashover or puncture, the insulator is deemed to have passed the test. If two applications cause flashover, the object is deemed to have failed. If there is only one failure, additional ten applications of the voltage wave are made. If the test object has withstood the subsequent applications, it is said to have passed the test.

13. Define 50% flashover.

It is the voltage, which has the 50 % flashover when applied to test object.

14. Define 100 % flash over.

The voltage that causes a flashover at each of its application under specified conditions when applied to test objects as specified.

15. State two standard tests to be conducted on HV Transformers.

Induced over voltage test and partial discharge test

16.List out various tests to be carried out on insulator and give a brief account of each test. (May2011)

High voltage test include power frequency test and impulse tests. These tests are carried out on all insulators. (i) 50% dry impulse flashover test (ii) impulse withstand test (iii) dry flashover & dry one minute test (iv) wet flashover test (v) temperature cycle test(vi) electromechanical test (vii) porosity test(ix)puncture test (x) mechanical routine test.

17. What are significance of power factor test? (May 2011).

High voltage schering bridge is used to perform dielectric power factor test on the cable sample. The power factor is measured for different values of voltages eg 0.5,1,1.5,2 times of rated operating voltages. The maximum value of power factor at normal working voltage does not exceed a specified voltage at a series of temperatures ranging from 15 to 65^0C .

18.Find and locate the fault during impulse testing of transformer. (Dec 2012)

Fault can be located by any one of the following methods:

General observation, voltage oscillogram method, neutral current method, and transformer surge current methods**.**

19.Define 100 % flash over.

The voltage that causes a flashover at each of its application under specified conditions when applied to test objects as specified.

20. What are type and routine test? (May 2013)(May 2015)

Type test is conducted on the sample to test the quality of the material with which the component is made. Routine test is conducted on the equipment or component periodically to check the deterioration in the quality during operation.

21. Define Disruptive discharge voltage.(Nov 2013)

This is defined as the voltage which produces the loss of dielectric strength of an 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. In solids, this causes a permanent loss of strength, and in liquids or gases only temporary loss maybe caused. When a discharge takes place between two electrodes in a gas or a liquid or over a solid surface in air, it is called flashover. If the discharge occurs through a solid insulation it is called puncture.

22. Distinguish between flashover and puncture. (April 2014, Nov 2015)

When a discharge takes place between two electrodes in a gas or a liquid or over a solid surface in air, it is called flashover. If the discharge occurs through a solid insulation it is called puncture.

23.Define safety margin as applied to insulation coordination. (Nov 2015)

Safety margin is defined by selecting the risk of failure, the statistical safety factor and by firing the withstand level of any equipment or apparatus corresponding to 90% or 95% of the withstand voltage.

24. What is BIL?(May 2015)

It is defined as the minimum insulation impulse withstands voltage of any power equipment or apparatus. The BIL of a power system is usually chosen as 25% to 30% more than the protective level offered by the protective devices.

25. Calculate the correction factor for atmospheric conditions, if the laboratory temperature is 37°C, the atmospheric pressure is 750 mmHg and the wet bulb temperature is 27°C.(May 2015)

Air density correction factor, $d=\frac{0.296b}{273+T}$ for 27°C, Atmospheric pressure in mbar, b = 999.91mbar, T=37°C then d= 0.954

26. Define an isolator.

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

27. Define a circuit breaker.

It is a switch, which automatically interrupts the circuit when a critical current or voltage rating is exceeded.

28. Define 50% flashover.

It is the voltage, which has the 50 % flashover when applied to test object.

29. Define 100 % flash over.

The voltage that causes a flashover at each of its application under specified conditions when applied to test objects as specified.

30. State 2 standard tests to be conducted on HV Transformers.

Induced over voltage test and partial discharge test

PART -B

1.What are the different power frequency tests done on insulators? Mention the procedure for testing.
What is the significance of impulse tests? Briefly explain the impulse testing of insulators.

2.What are the significance of power factor tests and partial discharge tests on bushings? How are they conducted in testing laboratory?
3.Explain the method of impulse testing of high voltage transformers. What is the procedure adopted for locating the failure. **(May 2011, Nov 2015, May 2015).(apr-2017) (nov-2016)**
4.Why is synthetic testing advantages over the other testing methods for short circuit tests? Give the layout for synthetic testing.
5. Explain the importance of RIV measurements for EHV power apparatus. Explain, with a neat schematic diagram, one method of measuring RIV of Transmission line hardware.
6.Discuss the different high voltage tests conducted on bushings. **(Dec 2012, May 2015)**
7.Explain the various tests conducted in high voltage insulators.**(May 2013, May 2014, May 2015)**
8.Explain the various tests conducted in high voltage cables.**(May 2013, May 2014)**
9.Describe the various tests to be carried out on a circuit breaker.**(Nov 2013) (nov-2017) (nov-2016)**
10. Explain the different aspects of insulation design and insulation co-ordination adopted for EHV systems. **(May 2011, Nov 2013,Nov 2015, May 2015) (apr-2017) (nov-2017)**

Reg. No. : | | | | | | | | | | | |

Question Paper Code : 71784

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Seventh Semester

Electrical and Electronics Engineering

EE 6701 — HIGH VOLTAGE ENGINEERING

(Regulations 2013)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define: Corona Critical Disruptive Voltage.

2. What are the different methods employed for protection of over head lines against lightning?

3. State Paschen's Law.

4. Define Townsends first ionization coefficient

5. A 12 stage impulse generator has 0.12 μF capacitors. The Wave front and wave tail resistances connected are 400 Ω and 600 Ω respectively. If the load capacitor is 800pF, find the front and tail time of the impulse wave produced.

6. What is trigatron gap?

7. What are the different types of resistive shunts used for impulse and high frequency measurements?

8. What are the problems associated with measurement of very high impulse voltages?

9. List out the various electrical tests to be carried out for bushings.

10. Define: Air density correction factor.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Explain the construction and working principle of expulsion gaps and protector tubes. (10)

(ii) Describe the causes for switching and power frequency over voltages. (6)

Or

(b) Explain the different theories of charge formation in clouds. (16)

12. (a) Discuss about the Various mechanisms of Vacuum breakdown. (16)

Or

(b) (i) Explain the various theories that explain breakdown in commercial liquid dielectrics. (10)

(ii) Discuss about the various properties of composite dielectrics. (6)

13. (a) (i) A Cockroft Walton type voltage multiplier has eight stages with capacitances, all equal to 0.05 μF. The supply transformer secondary voltage is 125 kV at a frequency of 125Hz. If the load current to be supplied is 4.5mA. Find (1) the % ripple, (2) the regulation. (8)

(ii) Describe the construction and working principle of a Van de Graff generator with a neat sketch. (8)

Or

(b) Describe the construction and principle of operation of a multistage Marx Generator. (16)

14. (a) (i) Explain how a sphere gap can be used to measure the peak value of voltages. (8)

(ii) A co axial shunt is to be designed to measure an impulse current of 40kA. If the bandwidth of the shunt is to be at east 10 MHz and if the voltage drop across the shunt should not exceed 50V.Find the ohmic value of the shunt and its dimensions. (8)

Or

(b) Explain the principle and construction of a generating voltmeter for the measurement of high dc voltages. List out its advantages and disadvantages. (16)

15. (a) Explain the method of impulse testing of high voltage transformers. What is the procedure adopted for locating the failure? (16)

Or

(b) (i) Write short notes on statistical methods for insulation coordination. (6)

(ii) Draw the layout for synthetic testing and explain the procedure. (10)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 50493

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017
Seventh Semester
Electrical and Electronics Engineering
EE 6701 : HIGH VOLTAGE ENGINEERING
(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. What are the causes for power frequency over voltage in power system ?
2. What is isokeraunic level ?
3. What are electronegative gases ? Give example.
4. What are pure liquid dielectrics ?
5. What are the advantages of Vande-Graff generator ?
6. Draw the standard impulse waveform.
7. What are the advantages of CVT measurement in HVAC ?
8. What type of measuring devices preferred for measurement of high frequency impulse current ?
9. Define disruptive discharge voltage.
10. What is meant by insulation coordination ?

PART – B (5×16=80 Marks)

11. a) Explain in detail about the protection of transmission lines against over voltage. (16)

(OR)

b) i) Explain the theories of charge formation in clouds. (10)

ii) Derive the mathematical model for lightning discharges. (6)

12. a) Explain in detail about the various mechanisms of breakdown in vacuum. (16)

(OR)

b) Explain the various theories of breakdown mechanism of the commercial liquid dielectrics. (16)

13. a) What is Tesla coil ? How is damped high frequency oscillations obtained from a Tesla coil ? (16)

(OR)

b) Describe with a neat sketch the working of a Vande Graff generator. What are the factors that limit the maximum voltage obtained ? (16)

14. a) Explain the construction features and operation of generating type voltmeter. (16)

(OR)

b) Explain the operation of Electrostatic voltmeter with neat sketch and give its advantages and limitations. (16)

15. a) Explain the direct and synthetic testing of isolators and circuit breakers in detail. (16)

(OR)

b) Explain in detail about the insulation coordination. (16)

Reg. No. A U H I P P O . C O M *

Question Paper Code : 80385

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016

Seventh Semester

Electrical and Electronics Engineering

EE 6701 — HIGH VOLTAGE ENGINEERING

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is back flashover?
2. Define Isokeraunic level or thunderstorm days.
3. What is ionization by collision?
4. Define Gas law.
5. What is a tesla coil?
6. What is Deltatron circuit?
7. What are the advantages of generating voltmeters?
8. List some advantages of Faraday generator.
9. Define 50% flash over voltage.
10. What are the tests need to be conducted on power transformer?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Explain the mechanism of lightning stroke. (10)

(ii) Give the mathematical model for lightning discharges and explain them. (6)

Or

(b) Explain the different methods employed for lightning protection of overhead lines. (16)

12. (a) From the fundamental principles, derive Townsend's criteria for the breakdown of gaseous dielectric medium. (16)

Or

(b) Explain the various breakdown theories involved in commercial liquid dielectrics. (16)

13. (a) (i) Mention the necessity of generating high DC voltages. (4)

(ii) Explain with a neat diagram the generation of high DC voltages using Van-de-graff generator. State the factors which limit the voltage developed. (12)

Or

(b) Explain the working principle of Cockroft-Walton voltage multiplier circuit. Derive an expression for total voltage drop and total ripple voltage of n-stage voltage multiplier circuit and hence deduce the condition for optimum number of stages. (16)

14. (a) (i) Enumerate digital peak voltmeter. (8)

(ii) What is CVT? Explain how CVT can be used for high voltage AC measurement. (8)

Or

(b) Explain how a sphere gap can be used to measure the peak value of voltages? Also discuss the parameters and factors that influence such voltage measurement? (16)

15. (a) Discuss the various tests carried out in a circuit breaker at HV labs. (16)

Or

(b) Explain in sequence the various high voltage test being carried out in a power transformer. (16)