

**IV B.Tech I Semester Regular/Supplementary Examinations, Nov/Dec - 2015**  
**HIGH VOLTAGE ENGINEERING**  
**(Electrical and Electronics Engineering)**

Time: 3 hours

Max. Marks: 75

**Answer any FIVE Questions**  
**All Questions carry equal marks**

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- 1 a) Discuss the relative advantages and disadvantages of different numerical methods for solution of field problems.  
 b) Explain how the electric field intensity controlled.
- 2 Explain various primary ionization processes of Townsend's mechanism. Derive an expression for current growth due to these processes.
- 3 a) What is electromechanical breakdown strength of a solid insulating material? Show that the highest apparent electric stress before breakdown in electromechanical breakdown mechanism is  $E_{\max} = 0.6 \sqrt{\frac{Y}{\epsilon_0 \epsilon_r}}$ , where Y is Young's modulus of the material and  $\epsilon_0$  and  $\epsilon_r$  are permittivity in space and relative permittivity.  
 b) Explain the applications of solid insulating materials in power capacitors and cables.
- 4 a) Draw a typical impulse current generator circuit and explain its operation and application.  
 b) Discuss why three electrode gaps are required for impulse generator.
- 5 a) What is a mixed potential divider? How is it used for impulse voltage measurements?  
 b) What is capacitance voltage transformer? Explain the phasor diagram how a tuned capacitance voltage transformer can be used for high voltage measurements in power systems.
- 6 a) Draw a neat diagram of the high voltage Schering Bridge and analyze it for the balance condition. Also draw its phasor diagram. Assume series equivalent representation of the insulating material.  
 b) Following measurements are made to determine the dielectric constant and complex permittivity of a test specimen: the air capacitance of the electrode system is 50 pF, the capacitance and loss angle of the electrodes with specimen are 190 pF and 0.0085 respectively. Calculate the values of dielectric constant and complex permittivity of the test specimen.
- 7 a) What are the different power frequency and impulse tests done on insulators? Mention the procedure for testing.  
 b) What is an operating duty cycle test on a surge arrester? Why is it more significant than other tests?
- 8 With a neat diagram, explain the electrostatic precipitator used for charging of dust particles in a gas and their subsequent separation under the effect of high electric field.

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**R10**

**Set No. 2**

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- 1 a) Discuss briefly the Charge Simulation Method for solving the field problems and estimating the potential distribution.  
b) Explain about uniform and non-uniform electric fields.
- 2 a) Discuss the drawbacks of the Townsend's mechanism?  
b) Derive an expression for minimum breakdown voltage of the Pachen's curve from the first principles.
- 3 a) Explain the applications of solid insulating materials in transformers.  
b) Explain the breakdown mechanism in composite dielectrics due to aging and partial discharges.
- 4 a) Explain a Cockroft-Walton circuit with a schematic diagram? Why is a Cockroft-Walton circuit preferred for voltage multiplier circuits?  
b) A ten stage Cockroft-Walton circuit has all capacitors of  $0.06 \mu\text{F}$ . The secondary voltage of the supply transformer is 100 kV at frequency of 150 Hz. If the load current is 1 mA, find (i) the optimum number of stages for maximum output voltage (ii) the maximum output voltage (iii) Voltage regulation (iv) the ripple.
- 5 a) With a neat circuit diagram explain the Chubb-Fortescue method for the measurement of peak value of AC voltage. State its advantages over other methods.  
b) What are the different types of resistive shunts used for impulse current measurements? Discuss their characteristics and limitations.
- 6 a) Derive an expression for the quantities at balance in Schering Bridge used for loss factor.  
b) The lossless standard capacitor used in the high voltage Schering Bridge has a value  $100 \text{ pF}$ . In a certain measurement, the other arms of the bridge at balance are (i) a resistance of 641 ohms and (ii) a capacitance of  $0.052 \mu\text{F}$  in parallel with a resistance of 2500 ohms. Determine capacitance and loss tangent of the specimen at 50 Hz.
- 7 Explain the method of impulse testing of high voltage transformers. What is the procedure adopted for locating the failure. Discuss the fault diagnosis techniques used in testing of high voltage transformer.
- 8 Explain the principle of electro static separator. Discuss its applications of electro static separator used in high voltage engineering.

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**Set No.3**

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- 1 What is Finite Element Method? Give the outline of this method for solving the field problems.
- 2 a) Explain briefly various theories of breakdown in liquid dielectrics.  
b) Explain in detail ionization by collision with neat diagrams.
- 3 a) Explain the applications of solid insulating materials in rotating machines.  
b) Explain the phenomena of thermal breakdown in solid dielectrics.
- 4 a) Explain with diagrams, different types of rectifier circuits for producing high DC voltages.  
b) Determine the ripple voltage and regulation of a 10 stage Cockroft-Walton type DC voltage Multiplier circuit having a stage capacitance =  $0.01 \mu\text{F}$ , supply voltage = 100 kV at a frequency of 400 Hz and a load Current = 10 mA.
- 5 a) Discuss and compare the performance of resistance and capacitance potential dividers for measurement of impulse voltages.  
b) What are the requirements of a sphere gap for measurement of high voltages? Discuss the advantages of sphere gap for measurements.
- 6 a) Explain various methods to determine the volume resistivity of a solid dielectric material.  
b) The capacitance and dissipation factor of a bakelite sample were determined by using circular electrodes and found to be 150 pF and  $15 \times 10^{-4}$  respectively by Schering bridge measurements. For the same electrode system the air capacitance was found to be 31 pF. What is the complex permittivity of the sample?
- 7 Mention the different electrical tests done on isolators and circuit breakers. Why is synthetic testing advantageous over the other testing methods for short circuit tests? Give the layout for synthetic testing.
- 8 Explain the principle of electro static coating/painting. Discuss its applications in HV engineering.

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- 1 Discuss about surge voltage and their distribution and control in high voltage power apparatus.
- 2 a) State and explain Pachen's law. How do account for the minimum voltage for breakdown under the given 'pd' condition, where p is the pressure and d is the distance between the electrodes in the gap.  
b) What is stressed oil volume theory? How does it explain breakdown in large volumes of commercial liquid dielectrics.
- 3 a) Explain the applications of solid insulating materials in circuit breakers and bushings.  
b) Derive the expression for critical electric field and show that the field is independent of critical temperature of the solid dielectric. State the assumptions made.
- 4 a) Give the Marx circuit arrangement for multistage impulse generators. How is the basic arrangement modified to accommodate the wave time control resistances?  
b) An impulse current generator is rated for 60 kW-secs. The parameters of the circuit are  $C=53 \mu\text{F}$ ,  $L=1.47 \mu\text{H}$  and the dynamic resistance = 0.0156 ohms. Determine the peak value of the current.
- 5 a) Explain the different methods of high current measurements with their relative merits and demerits.  
b) Give the schematic arrangement of an impulse potential divider with an oscilloscope connected for measuring impulse voltages. Explain the arrangement used to minimize errors.
- 6 Explain the balanced and straight detection methods for locating the partial discharges in a solid insulating system.
- 7 a) Explain any one method of measuring RIV of transmission line hardware with a schematic diagram.  
b) Explain the partial discharge tests on high voltage cables. How is a fault in the insulation located by using this test?
- 8 Explain the application of electro static copying in high voltage engineering.