

B.E. ELECTRICAL ENGINEERING THIRD YEAR SECOND SEMESTER - 2022**SUBJECT: HIGH VOLTAGE ENGINEERING**

Time: Three Hours

Full Marks 100
(50 Marks for each part)**Use a separate Answer-Script for each part**

Two marks for neat and well-organized answers

Question No.	Part I	Marks
--------------	--------	-------

Answer any three questions

1. (a) Justify the following statement: 5
 “Volume of copper is reduced if the transmission line voltage level is increased for the same power transmitted”.
- (b) For a string of three-suspension insulators, the equivalent arrangement of capacitance is shown in Fig. 1. The capacitance of each of C_1 , C_3 and C_5 is C , C_2 and C_4 is $0.1C$, C_6 and C_7 is $0.2C$. Express the voltage across each insulator as a percentage of the line voltage to earth with proper derivation. Also calculate string efficiency. 9+2

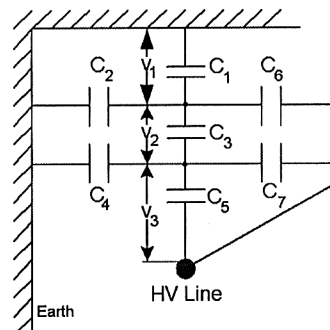


Fig. 1

2. (a) What do you mean by Visual Corona Voltage? Derive the expression of visual corona voltage for a three phase system. 2+6
- (b) Determine the disruptive critical voltage and visual corona voltage of a grid line operating at $132 \text{ kV}_{\text{rms}}$. The diameter of the conductors is 4cm and has a spacing of 4m. Temperature and pressure being 15.6°C and 737 mm of Hg. Take $m_d = 0.83$. 4+4

[Turn over

3. (a) Discuss the behavior of a travelling wave when it reaches the end of a (i) open circuited transmission line and (ii) short circuited transmission line. 3+3
- (b) Derive suitable expressions for surge impedance. From the derived expression, find the values for surge impedance in the cases of transmission lines and cables. Given, capacitance of transmission line is 6.67pF/m and that of cable is 100pF/m . Take ϵ_r for cable insulation to be 2.25. 6+4
4. (a) Explain what is meant by insulation co-ordination. State the utilities of using arcing horns. 7
- (b) Explain in brief what do you mean by arcing ground phenomenon. 3
- (c) A 33kV, 50Hz network has the capacitance to neutral of $1.0\mu\text{F}$ per phase. Calculate the value of inductance that is to be added to prevent the arcing ground condition. Draw the phasor diagram. 6
5. (a) Show that cable with inter-sheath can be operated with 44.5% higher conductor potential compared to the cable without inter-sheath. 8
- (b) A single core lead sheath cable has a conductor of 10mm diameter and two layer of different insulating material, each of 1mm thick. The relative permittivity of the inner insulation is 3 and the outer insulation is 2.5. Calculate the stress at the surface of the conductor when the potential difference between conductor and lead sheath is 60kV. 8

BACHELOR OF ENGINEERING IN ELECTRICAL ENGINEERING EXAMINATION, 2022

(3rd Year, 2nd Semester)

HIGH VOLTAGE ENGINEERING

Time: Three Hours

Full Marks: 100

(50 marks for each part)

Use a separate Answer-script for each Part

PART-II**Answer question No.1 any TWO from the rest**

1. Correct or justify any four of the following 4x5=20
- a) Series resonant circuit can only be used to test objects having large capacitance.
 - b) Front time of the lightning impulse waveform can be controlled by discharge resistor R_d .
 - c) Breakdown of sphere gap under impulse voltage is probabilistic in nature.
 - d) Voltage regulation of testing transformers is generally positive.
 - e) "Peak voltmeter developed by Davis, Bowdler and Standring measures high voltage" - this is one of the way of direct method of high voltage measurement.
 - f) Trapezoidal winding improves surge potential distribution along a transformer winding.
2. a) Draw a two stage symmetric voltage multiplier circuit for HVDC generation and explain the principle of its operation. 4+4
- b) A Cockcroft-Walton voltage doubler circuit is used to test a cable at 200kV. The insulation resistance of the cable is $2 \times 10^7 \Omega/m$ and the length of the cable is 15 m. Stage capacitances are $0.11 \mu F$ and $0.25 \mu F$, respectively. The doubler is supplied from a 500V/250kV testing transformer. Calculate the voltage to be applied to the input of the transformer at 50Hz. 7
3. a) Show that lightning impulse waveform is superposition of two exponential waveforms. Explain the significance of damping resistor (R_d) in the impulse generator circuit. What do you understand by "50kV, 1.2/50 lightning impulse voltage"? 4+4+2
- b) Why controlled triggering is required in an impulse generator? Describe a typical triggering arrangement. 2+3

[Turn over

4. a) Draw the circuit diagram of a Chubb-Fortescue peak voltmeter circuit. Describe the principal of operation of this peak voltmeter circuit and discuss about the limitation of peak voltage measurement with this method. 3+3+3
- b) Draw the circuit diagram of a capacitive voltage transformer (CVT) that is used for the measurement of the high voltage. Why a CVT is always used in resonant condition? Draw the phasor diagram of a CVT under resonant condition. 2+2+2
5. a) Draw a diagram of horizontal sphere gap arrangement used in the measurement of high voltage. Briefly explain the significance of gap spacing and correction factor associated with this method. In which conditions are external irradiation required? 2+2+2+3
- b) With a neat sketch, explain the principle of a three-stage cascade connection in testing transformer for producing high a.c. power frequency voltage. 3+3