B.ELECTRICAL ENGG. Examination, 2018
(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 I

Answer ***any three*** questions.

Two marks are reserved for neat and well organized answers.

1.a) Explain why power is always transmitted at higher voltages. During power transmission, transmission level voltage cannot be increased indiscriminately – justify. 3+2

b) Discuss why in the case of high voltage power transmission suspension insulators are used. 3

c) Calculate the string efficiency of a three unit suspension insulator if the capacitance of the link pins to earth and the line are respectively 25% and 10% of self - capacitance C of each unit. What should be the values of link pins to the line capacitances for 100% string efficiency? 8

2.a) Discuss in brief about the development of corona on hv transmission line and derive expressions for disruptive critical voltage and visual corona voltage between two smooth circular conductors, assuming breakdown strength of air to be 30 kV_{peak} / cm. 10

b) A three phase, 50 Hz, 138 kV transmission line has conductors in equilateral formation spaced 2.5 meters apart. The conductor diameter is 1.04 cm and the surface factor is 0.85. The air pressure and temperature are 74 cm of Hg and 21^0C respectively. Determine the critical visual voltage for corona and the corona loss per km per phase of the line, $m_v = 0.72$. 6

3.a) What is a void in cable insulation? How is it formed? Explain the role of a void in breakdown of cable insulation. 8

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b) A single – core lead sheathed cable has a conductor of 1 cm diameter and uses two layers of insulating materials having relative permittivities of 3.0 (inner) and 2.5 (outer) respectively. If the allowable maximum stress for the inner layer is 100 kV/cm (peak) and that for the outer layer is 45 kV/cm (peak), calculate the thickness of each layer of insulation. The system voltage is 63.5 kV. 8

4. a) Explain what is meant by insulation co-ordination. 3

b) Discuss the phenomenon of back flash over. Explain the effect of tower footing resistance on back flash over. 2+2

c) A rectangular surge of 500 kV travelling on an overhead line of surge impedance 400 Ω, arrives at a point where the line is connected to a transformer through a cable 1 km long. The cable has an inductance and capacitance of 265 μH and 0.165 μF. The transformer has a surge impedance of 1000 Ω. Find (a) the surge impedance of the cable, (b) the velocity of the wave in cable, and (c) the first refracted voltage into the transformer. 9

5. a) Explain the phenomenon of 'Arcing grounds' and suggest the method to minimize the effect of this phenomenon. 6

b) State the working principle of Peterson coil. 4

c) A transmission line has a capacitance of 0.1μF per phase. Determine the inductance of Peterson coil to neutralize the effect of capacitance of (i) complete length of line, (ii) 97% of the line, and (iii) 90% length of the line. The supply frequency is 50 Hz. 6

Ex/EE/T/326/2018

BACHELOR OF ENGINEERING IN ELECTRICAL ENGINEERING EXAMINATION, 2018

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PART-II

Answer question No.1 any *TWO* from the rest

1. Correct or justify any four of the following 4x5=20

   a) Trapezoidal winding improves surge potential distribution along a transformer winding.

   b) Tail time of the lightning impulse waveform can be controlled only by discharge resistor (R_o).

   c) Capacitive voltage transformers (CVT) are used in resonant condition.

   d) Testing transformers have less short circuit impedance compared to power transformers.

   e) "Electrostatic voltmeter measures high voltage" - this is one way of indirect method of high voltage measurement.

2. a) Why is triggering required in an impulse generator? Describe a typical triggering arrangement. 6

   b) A Cockcroft-Walton voltage doubler circuit is used to test a cable at 200 kV. The insulation resistance of the cable is 2.5 x$10^7\Omega$/m and the length of the cable is 16 m. Stage capacitances are 0.1 μF and 0.12 μF respectively. The doubler is supplied from a 500V/300kV testing transformer. Calculate the voltage to be applied to the input of the transformer at 50Hz. 6

   c) A 300V/250 kV testing transformer is required to test a cable. The test voltage level is 170 kV and the short-circuit impedance of the transformer is 16%. Calculate the voltage to be applied to the primary to conduct the test. 4

3. a) Explain the significance of damping resistor (R_d) in the impulse generator circuit. 3

   b) Show that voltage regulation of testing transformer is equal to per unit impedance of the transformer. 4

   c) Why series resonance circuit is advantageous for high voltage testing of cables? 4

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d) With a neat sketch explain the operation of symmetric voltage doubler circuit. 5

4. a) Draw the circuit diagram of a peak voltmeter that contain a bleeder resistance. Describe the principle of operation of such a peak voltmeter and discuss about the errors associated with peak voltage measurement. 9

b) With a neat sketch explain the operation of multi stage impulse generator circuit. 7

5. a) Draw a Cockcroft-Walton voltage doubler circuit and explain its principle of operation in both loaded and unloaded condition 8

b) With a neat sketch, explain the principle of a three-stage cascade connection in testing transformer for producing high ac power frequency voltage. Why the lowest unit is loaded more. 8

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