B.E. (EE) Part-III 5th Semester Examination, 2007

Power System – I

(EE-502)

Time : 3 hours **Full Marks : 100**

Use separate answerscript for each half.
Answer SIX questions, taking THREE from each half.
Two marks are reserved for neatness in each half.

FIRST HALF

1. a) Name the various types of conductors used for overhead EHV power transmission line. What do you mean by 24/7 ACSR conductor?

   b) "An overhead transmission line may be physically short but electrically long" – Justify.

   c) Show that the inductance per unit length of an overhead line due to internal flux is constant and is independent of the size of conductor. **[(4+2)+4+6]**

2. a) Deduce expressions for inductances of all the phases of a $3-\phi$ system with unsymmetrical spacing. How could these inductances be made equal with equilateral spacing?

   b) A $3-\phi$, 50 Hz line has flat horizontal spacing. The conductors have a GMR of 0.0133 m with 10 m between adjacent conductors. Determine the inductive reactance per phase in Ω/km. The line is fully transposed. **[(6+4)+6]**

3. a) Derive an expression for capacitance to neutral of a $3-\phi$ fully transposed line with unsymmetrical spacing. Neglect the effect of earth.

   b) What are the advantages of bundle conductor for power transmission? Determine the modified GMR for the calculation of capacitance of (i) 3-bundle and (ii) 4-bundle conductor system. **[10+(2+2+2)]**

4. a) Derive the formula to change pu impedance from one base to another.

   b) How could you choose base values of $1-\phi$ and $3-\phi$ transformers.

   c) A $3-\phi$, Y– Δ transformer is rated 400 MVA, 220/22 kV. The reactance measured on LT side is 0.121Ω. Determine pu reactance. Also determine pu reactance on a base of 100 MVA, 230 kV on HT side. **(5+5+6)**

5. a) What are the effects of active and reactive power flows through an interconnector on bus voltage magnitude and angle?

   b) Explain with phasor diagram, the phenomena of one phase to earth fault of an ungrounded long overhead transmission line. **(8+8)**

SECOND HALF

6. a) What is Ferranti effect? How can it be compensated?

   b) What is natural loading of a transmission line? On what factors does it depend?

   c) In a 10 km long single phase short 50 Hz line, the load bus voltage is 3.3 kV while the load end power is 316.8 kW at 0.8 p.f. (lag.). If the line impedance is $0.5\angle 60^\circ$ ohm/kW, find the % regulation, sending end voltage, line loss and sending end p.f. **(6+4+6)**

7. a) What is loadability of a transmission line? Find an expression for it in terms of surge impedance loading and line angle.

   b) Find an expression of receiving end reactive power for a power frequency line connecting two buses.

   c) In terms of ABCD parameters, show that for a medium long line, $AD - BC = 1$. Why for a short line $B = Z$ and $C = 0$? **(6+4+6)**

8. a) Explain briefly what do you mean by (i) Post insulator, (ii) Bushing, (iii) Creepage distance of insulator.

   b) Derive an expression for "Sag" in an overhead line when erected between two supports at identical levels. What is the expression for mid-span length in this case?

   c) How do you explain the effects of wind loading and ice loading in overhead lines? **(6+8+2)**

9. a) For the graded cable with permittivity ϵ_1 and ϵ_2, obtain the condition under which the maximum values of the electric fields in the two regions are equal.

   b) What do you mean by "Power factor of cables"? Explain.

   c) A 33 kV, 3 phase underground power cable, 4 km long, uses three single core cables. Each of the conductors has a diameter of 2.5 cm and the radial thickness

of insulation is 0.5 cm. The relative permittivity of the dielectric is 3.0. Determine a) Capacitance of the cable/ph. (b) Charging current/phase. (c) Total charging kVAR. (d) Dielectric loss/phase if the p.f. of the unloaded cable is 0.02. (e) maximum stress in the cable. **(4+4+8)**

10. a) A 50 Hz, 3 phase transmission line is 280 km long. It has a total series impedance of (35+j140) ohms and a shunt admittance of 930×10^{-6} mho. It delivers 40 MW at 220 kV(L–L) with 90% power factor (lag). Find the sending end voltage, regulation and transmission efficiency using long line theory.

b) Write a brief note on mechanism of lightning. **(10+6)**

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