Engineering Faculty/Misuratah University

Dept: Elect. & Electro. Eng **Autumn 2013/2014** **Date of Exam: 25/01/14**

Final Ex: Electrical Power Eng. **Lecturer: Omar Gatous** **Time: 3:00 hrs**

Answer all the following questions and

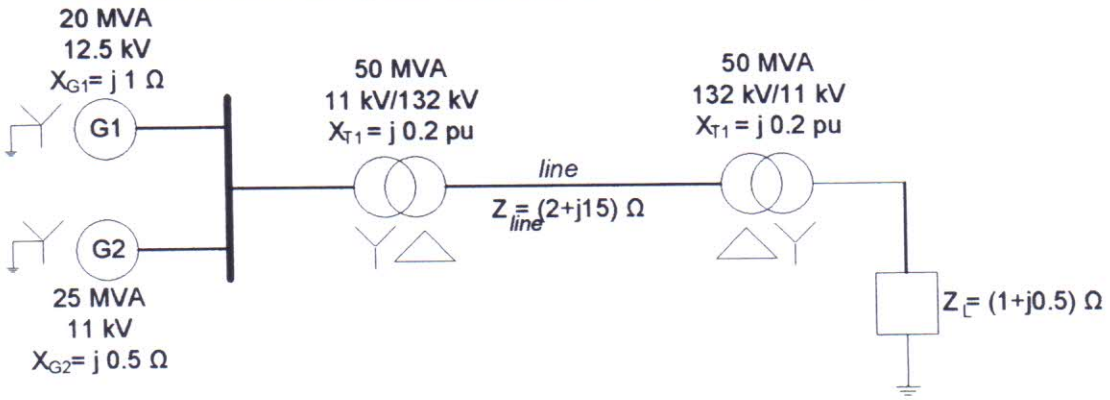
Important note: Draw the required sketches where it is necessary.

Question one: (15 Marks)

1. What are the factors affecting the sag in an overhead line.(4 Marks)

2. What are the two types of pressure cables. (1 Marks)

3. Redraw the power system shown below as an impedance diagram showing the pu values of each component on a common base of 100 MVA and 11 kV at generator bus. All impedances are given in their own base. (10 Marks)



Question two: (15 marks)

1. Choose the right answer: (1 Mark)
   a) For loads significantly above SIL.
      i. Shunt capacitors extremely needed to minimize voltage drop along the line.
      ii. Shunt capacitors may be needed to minimize voltage drop along the line.
      iii. Shunt capacitors not needed.

2. For a three-phase, 765 kV, 60 Hz transposed line composed of four ACSR 1,431,000, 45/7 Bobolink conductors per phase. The inductance and the capacitance are calculated and are found as 0.88853 mH/Km and 0.01268 μF/Km respectively. If the line is 400 Km long and assuming lossless line determine the following.

   a) The transmission line surge impedance (Z_C), phase constant β, wave length λ, the surge impedance loading SIL and the ABCD constants. (6 Marks)

   b) The receiving end quantities (receiving end voltage V_R, receiving end current I_R, receiving end power $S_{R(3\varphi)}$ and %VR) when 1290 MW and 600 Mvar are being transmitted at 765 kV at the sending end. (8 Marks)

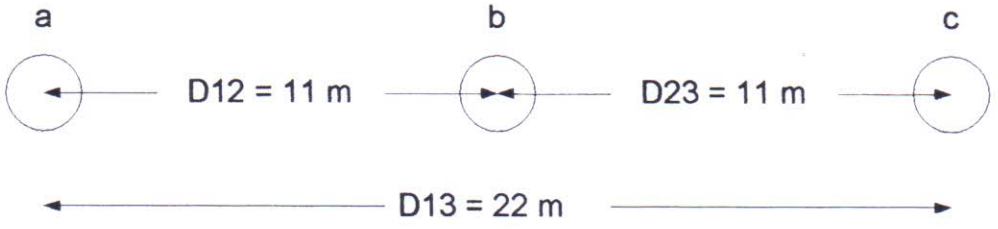
Question three: (15 marks)

1. Choose the right answers: (3 Marks)
   a) For all line models used for balanced steady-state analysis, the effect of earth on the capacitance can be.
      i. Considered.
      ii. Neglected.
      iii. Doubled.

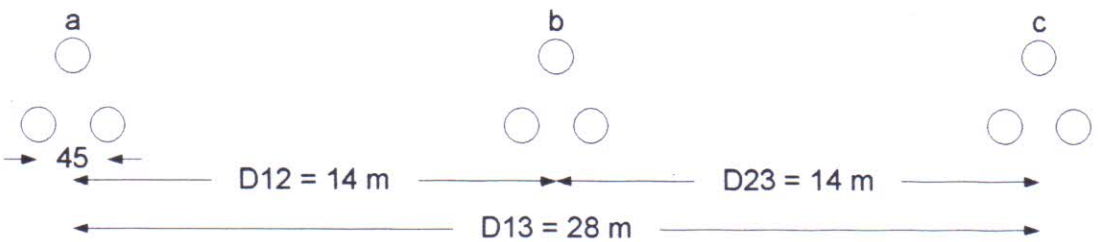
   b) Extra high voltage transmission lines are usually constructed with bundled conductors.
      i. To increase the line reactance.
      ii. To reduce the line reactance.
      iii. To control the line reactance.

2. A transmission line cable of 1 Km long, consists of 21 identical strands of aluminum, each 2.5 mm in diameter. The resistivity of aluminum at 20°C is 2.8×10^{-8} Ω-m. Find the 70°C AC resistance per Km of the cable. Assume a skin-effect correction factor of 1.02 at 60 Hz. (5 Marks)

3. A three-phase transposed line is composed of one ACSR 1,431,000 cmil, 47/7 Bobolink conductor per phase with flat horizontal spacing of 11 meters as shown in the figure below. The conductors have a diameter of 3.625 cm and a GMR of 1.439 cm. The line is to be replace by a three-conductor bundle of ACSR 477,000 cmil, 26/7 Hawk conductors having the same cross-section area of aluminum as the single-conductor line. The conductors have a diameter of 2.1793 cm and a GMR of 0.8839 cm. The new line will also have a flat horizontal configuration, but it is to be operated at a higher voltage and therefore the phase spacing is increased to 14 meters as measured from the center of the bundles as shown in the figure below. The spacing between the conductors in the bundle is 45 cm. determine (a) the percentage change in the inductance (b) the percentage change in the capacitance. (7 Marks)



Conductor layout for single conductor line



Conductor layout for bundle conductor line

Question four: (15 marks)

1. Choose the right answers: (3 Marks)
   a) The insulation resistance of a cable varies.
      i. Directly as the length of the cable.
      ii. Inversely as the length of the cable.
      iii. Non of the above.

   b) The electric stress in the dielectric of a cable is.
      i. Maximum at the sheath and minimum at the conductor surface.
      ii. Maximum at the conductor surface minimum at the sheath.
      iii. Non of the above.

2. Find the overall diameter (D) of single core cable and its most economical core diameter (d) when working on 220 kV, 3-phase system. The maximum permissible stress in the dielectric is not exceed 250 kV/cm. (5 Marks)

3. A kilometer of 3-cores, 3-phase metal sheathed cable gave the following results on a test for capacitor (i) Capacitance between shorted conductors and sheath is 1.0 μF, (ii) capacitance between two shorted conductors with the sheath and third conductor 0.6 μF. With the sheath insulated find the capacitance (a) between any two cores (b) between the three cores shorted and the sheath. (7 Marks)

Question five: (15 marks)

1. An overhead line has a span of 200 meters between level supports. The conductor diameter is 1 cm and weighs 0.65 kg/m. The allowable tension is 550 kg. Calculate the maximum sag. (3 Marks)

2. For the problem in question two, if a series capacitors are installed at the midpoint of the line providing 40% compensation of the equivalent line reactance X' for lossless line. Determine the sending end voltage, sending end current, sending end power and the voltage regulation when the line delivers 2000 MVA at 0.8 lagging power factor at 735 kV. (Hint: use the nominal π model) (12 Marks)

Good luck