S. KARAKI AMERICAN UNIVERSITY OF BEIRUT FALL 2002/2003

FACULTY OF ENGINEERING AND ARCHITECTURE

MIDTERM

FUNDAMENTALS OF ELECTRIC POWER SYSTEMS
(EECE 071E)

CLOSED BOOK (1.5 HOUR) **December 10, 2002**

PROGRAMMABLE CALCULATORS ARE NOT ALLOWED

THIS QUESTION SHEET MUST BE RETURNED WITH THE ANSWER BOOKLET.

NAME: _____ **ID#:** _____

1. Consider the tower structure of Fig. 1 below, which corresponds to a 3-phase 220 kV transposed transmission line. The system frequency is 50 Hz and the line length is 120 km.

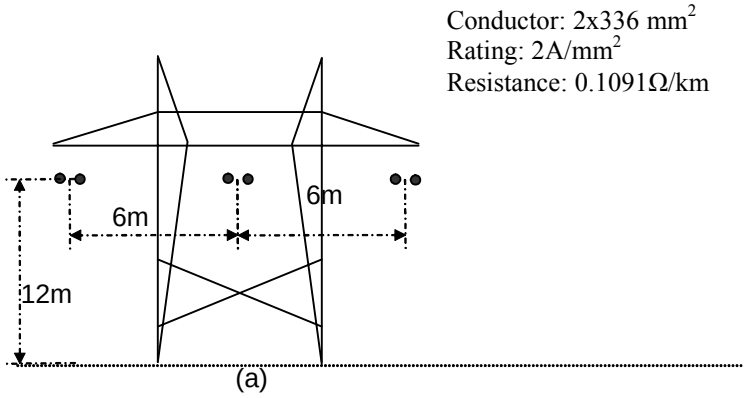

Fig. 1: Tower configuration of a 220 kV transmission line

a) Determine the series impedance z and the shunt admittance y of the transmission line in Ω/km and μS/km, respectively.
b) Determine the propagation constant γ in km^{-1}.
c) Determine the characteristic impedance Z_c in ohms.
d) Draw the equivalent circuit of the line and indicate its components values in per unit on the diagram considering an S_{base}= 100MVA and V_{base}= 220 kV.
e) If the line is terminated by its characteristic impedance Z_c at one end and supplied at the other end with a voltage of 1 per unit, what would be the voltage and the complex power delivered to the load point? Determine the line losses and transmission efficiency.

2. Consider the system shown in Fig. 2 below. The ratings of the system components are as follows:

   Generator: 50 MVA, 13 kV, X_G= 0.12 p.u.
   Motors: 10 MVA, 11kV, X_M = 0.08 p.u. for each
   T_1: 60 MVA, 13-115 kV, X_l = 0.1 p.u.
   T_2: 40 MVA, 115-11 kV, X_l = 0.12 p.u.
   Line: 24 + j 120 Ω actual.

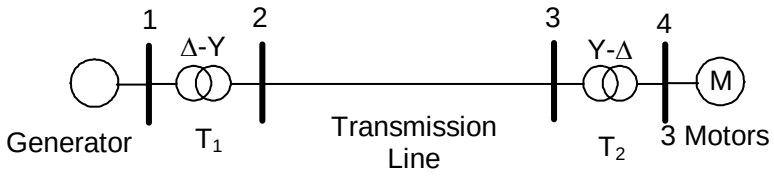

Fig. 2.

   a) It is required to draw an impedance diagram of the system shown above. Pick the generator ratings as the bases in the generator section. Select other bases appropriately and tabulate all bases in the different regions of the network.
   b) Calculate all impedances in per unit to the base system identified in Part a) above. Draw and label the per-phase equivalent impedance circuit in per unit.
   c) If the generator voltage is regulated at 13 kV and the each of the motors draws 8MW at 0.85 power factor lagging, determine the voltage at the motor end, the current at the generator end and the complex power supplied by the generator.

3. Consider the system shown in Fig. 3 below. Assume that $|V_1|$= 1.05 and $|V_2|$= 0.95 and Z_{line}= 0.01+j0.1. Use the power circle diagram to determine the following:
   a) The maximum power that can be sent from 1 to 2 (P_{12max}) and the maximum power received at node 2 from 1 ($-P_{21max}$).
   b) The phase angle difference θ_{12} at which we get P_{12max}.
   c) The active power loss in the line when θ_{12}= 15° .

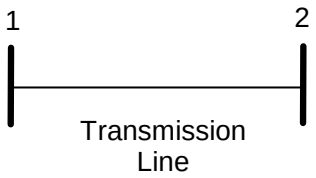

Fig. 3.

4. A 3-phase Δ-Y 11/5.5 kV transformer is rated at 500 kVA. Draw a connection diagram when it is connected as aY-Y autotransformer and determine its voltage and kVA ratings.