THE OPEN UNIVERSITY OF SRI LANKA
DIPLOMA IN TECHNOLOGY
ECX4232 POWER SYSTEMS I
FINAL EXAMINATION 2006/2007

065

Duration Three Hours

Date: 02nd March 2007 **Time: 0930-1230**

This paper contains six questions. Answer ***any four****. All questions carry equal marks. Show your work.*

Electric space constant $\varepsilon_o = 8.85 \times 10^{-12}\ Fm^{-1}$
Magnetic space constant $\mu_o = 4\pi \times 10^{-7}\ Hm^{-1}$

Question (1)

a. Explain the term "line transposition" and its effects on the electrical performances of high voltage transmission.
b. Explain how bundling of conductors improves the performances of overhead transmission lines.
c. Figure Q1 shows relative positions of conductors of a three-phase high voltage transmission line. ACSR conductors are used in this transmission line and has following properties:

Outside diameter : 33 mm
AC resistance at 20^0 C : 0.0512 Ω/km
Temperature coefficient : 0.0043

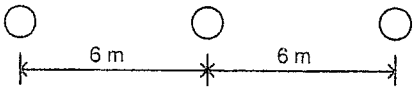

Figure Q1

i. Calculate inductance and capacitance per km of the above line. (Clearly state assumptions that you made).
ii. If the line length is 80 km and average ambient temperature is 35^0C, calculate the parameters and draw the equivalent π-model of the line. *f=50 Hz*

Question (2)

a. Explain the functions of the circuit breakers and isolators used in power system.
b. With the help of suitable graphs and diagrams explain following terms :
(i). Arc voltage (ii).Re-striking voltage (iii).Recovery voltage
c. Explain briefly the advantages of SF_6 circuit breakers used in power systems

d. The transmission line right-of-way passes across a hill as shown in figure Q2. Weight of the conductor per km is 1.2 kg and the tension of the conductor is 120 kN. Height of a transmission tower is 12 m.

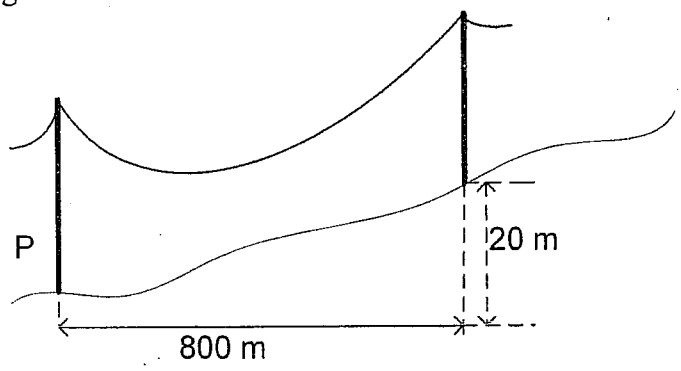

Figure Q2

i. Calculate the distance between lowest point of the conductor to the ground.
ii. What is the horizontal distance between transmission tower P to the lowest point of the conductor.

Question(3).

Single line diagram of a certain power system is shown in figure Q3. Voltages at generator G1 and load are 500 $\angle 0^0$ kV and 515 $\angle -15^0$ kV respectively. Power consumed by the load is 150+j30 MVA. The reactances of the transmission lines are given in figure Q3.

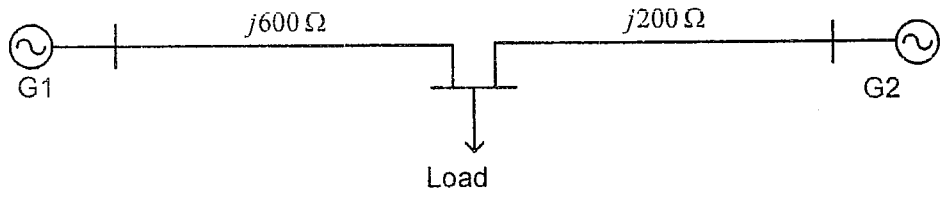

Figure Q3

a. Express parameters of the system in pu values Use base voltage of 500 kV and 100 MVA as base values.
b. Calculate the pu current flows through the lines.
c. Determine the voltage at G2.
d. Find the power and power factor of generators G1 and G2.

Question (4)

a. What are the consequences of short circuit faults on electric power systems?
b. The ratings of a power system shown in figure Q4 are given bellow:

G1: 50 MVA, 12 kV, x''=0.2 pu
G2: 100 MVA, 15 kV, x''=0.2 pu
T1: 50 MVA, 12 kV/132 kV, x=0.1 pu
T2: 100 MVA, 15 kV/132 kV, x=0.1 pu
132 kV line : x=40 Ω

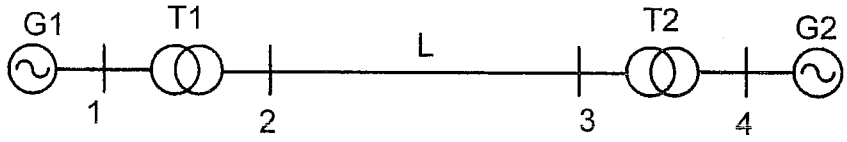

Figure Q4

i. Calculate pu values of the elements of the system by selecting common base of 100 MVA and 132 kV at transmission line.
ii. A three phase fault occurs at point 4. Determine the fault current
iii. Find fault current contributions through the G1 and G2 in kA.

Question (5)

Consider a power system shown in figure Q5. The pu values (on common base) of elements of the system are as follows:

G1: $X_1=X_2=0.15$ pu $X_0=0.06$ pu
G2: $X_1=X_2=0.25$ pu $X_0=0.10$ pu
G3: $X_1=X_2=0.4$ pu $X_0=0.10$ pu
G4: $X_1=X_2=0.4$ pu $X_0=0.12$ pu
T1-T4: $X_{T1}=X_{T2}=0.1$ pu $X_{T3}=0.24$ pu $X_{T4}=0.15$ pu
L1-L3: Positive and Negative sequence : $X_{L1}=X_{L2}=X_{L3}=0.15$ pu
Zero sequence : $X_{L1}=X_{L3}=0.4$, $X_{L2}=0.6$ pu

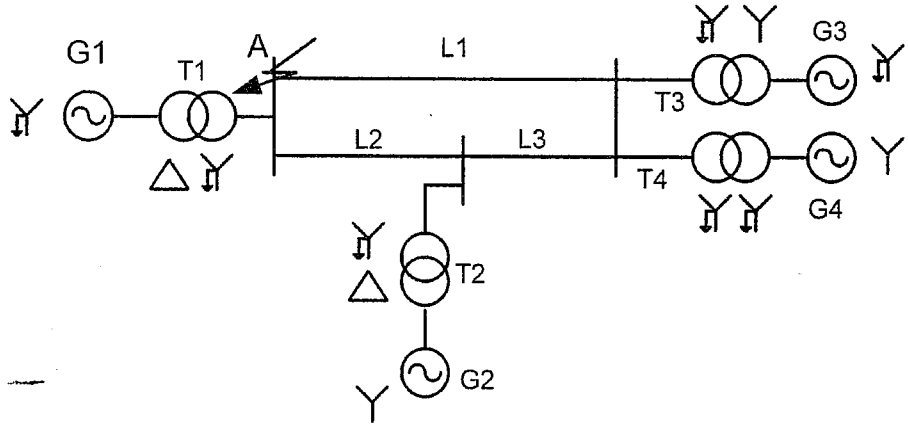

Figure Q5

i. Draw positive, negative and zero sequence networks
ii. A single line to ground fault occurs at busbar A . Determine the fault current.

Question (6)

a. Briefly explain why voltage regulation is closely related with reactive power.
b. What are the advantages of suspension type insulators used in overhead power transmission lines?
c. Determine the term "string efficiency". What are the methods of improving string efficiency?
d. Draw the typical load curve of Sri Lankan power system. How would you dispatch the available generation types in Sri Lanka to fit into the load curve? Give reasons to the your choise.
e. What are the mâin factors that should be considered when basbar arrangement is selected.