THE OPEN UNIVERSITY OF SRI LANKA
DIPLOMA IN TECHNOLOGY
ECX4232 POWER SYSTEMS I
FINAL EXAMINATION 2005/2006

061

Duration Three Hours

Date: 17th March 2006 **Time: 0930-1230**

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

Q1. Two generators G1 and G2 are connected through 132 kV overhead transmission line in order to feed a load of S1=40+j24 MVA, as shown in figure Q1. The voltage at bus bar of G1 is maintained at 132 $\angle 0^0$ kV. Power delivered by G1 is 20 MW at 0.75 power factor lagging. The lenth of the line is 80 km and per kilometre reactance is 0.4 Ω (resistance and shunt capacitance of the liner can be ignored).

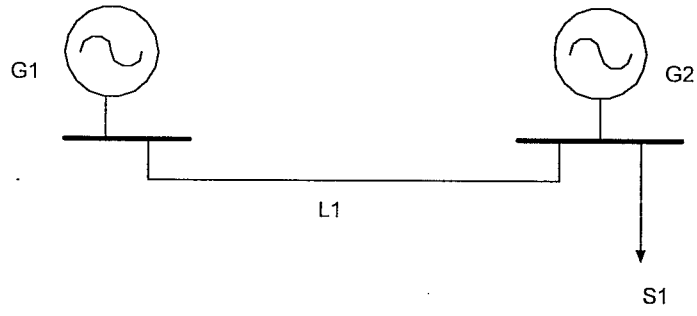

Figure Q1

(a). Determine

(i). Voltage at load S1

(ii). Power and power factor of generator G2.

(iii). Current supplied by generator G2.

(b). While keeping voltage at G1 as earlier (132 $\angle 0^0$ kV) the magnitude value of the voltage at G2 also increased up to 132 kV. Active power supplied by the generators remains unchanged.

(i). Calculate the phase angle of G2 with respect to the phase angle of G1.

(ii). Determine the reactive power contribution of G1 and G2 to meet the requirement above.

Q2. A small power system shown in figure Q2. The parameters of the system on common base are as follows:

X_{G1}=0.1 pu, X_{G2} =0.08 pu; X_{G3}=0.11 pu; X_{T1}=0.15 pu, X_{T2}=0.12 pu, X_{T3}=0.15 pu, X_{T4}=0.11 pu; X_{L1}= 0.57 pu; X_{L2}=0.37 pu

$E_{q(G1)} = E_{q(G2)}$=1.0 pu, $E_{q(G3)}$ =1.1 pu

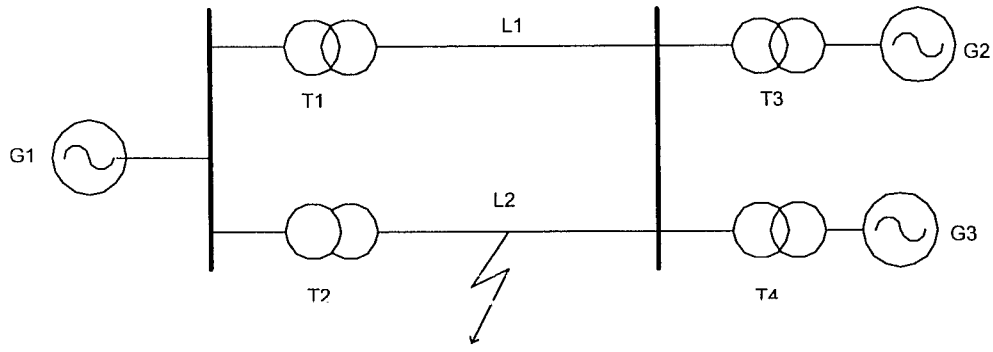

Figure Q2

If a three-phase fault occurs at the mid point of the transmission line L2, Calculate

(i). Short circuit current in pu

(ii). Current through generator G1 during the fault.

Q3. A small power system is shown in figure Q3.

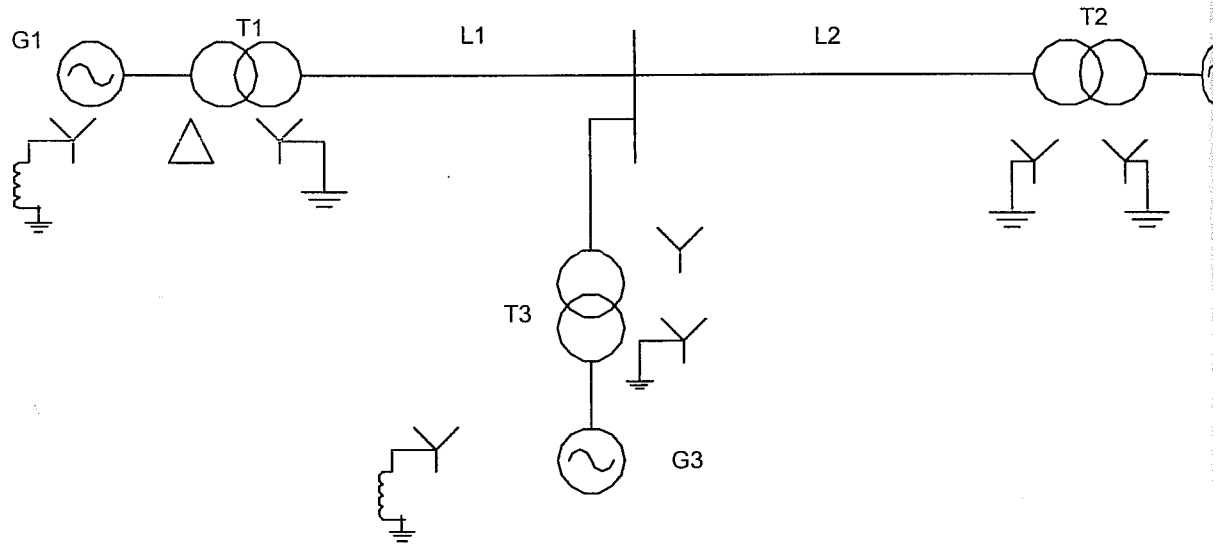

Figure Q3

Information for the system given below. Per unit quantities are given on the equipment basis.

G1: 25 MVA, 17 kV, x=0.12 pu, $x_{(0)}$ =0.05 pu
G2: 40 MVA, 13.5 kV, x=0.15 pu, $x_{(0)}$ =0.05 pu
G3: 20 MVA, 12 kV, x=0.15 pu, $x_{(0)}$ =0.05 pu
T1: 30 MVA, 18 kV/135kV, x=10%
T2: 50 MVA, 15 kV/ 138 kV, x=12 %
T3: 20 MVA, 11.5 kV/ 133 kV, x=12%
L1: $x_{(1)}$=40 Ω,

L2: $x_{(1)}=80\ \Omega$,
For L1 and L2 $x_{(0)}=3x_{(1)}$

(i). Chose the base of 50 MVA, 132 kV in transmission line L1 and calculate the per unit quantities of the system.
(ii). Draw the positive and zero sequence networks of the system and indicate the respective vales

Q4. A generator is connected to a three-phase transformer as shown in figure Q4 and operating at open circuited condition. A single-phase to ground fault occurs in phase "A" at the high voltage side of the transformer (point F). Emf of the unloaded generator can be considered as $1.0\ \angle 0^0$ p.u

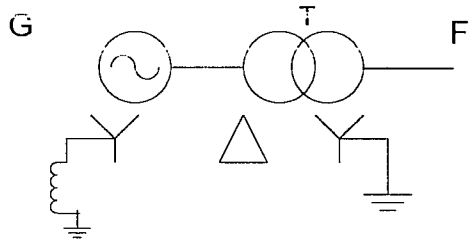

Figure Q4.

G: 50 MVA, 11 kV, $x_{(1)}=x_{(2)}=0.18$; $x_{(0)}=0.12$; $x_{(N)}=0.5$
T: 60 MVA, 12.5 kV/ 66 kV, x=0.05
(pu values are given on equipment base)
Calculate
(i). Fault current at point F
(ii). Phase currents through the generator during the fault (Consider the vector group of transformer as Yd1).
(iii). Line voltages at the output terminals of the generator.

Q5. (i). Sketch the layout of a conventional thermal power plant and briefly explain function of each element.
(ii). Explain why thermal power plant cannot be used to meet the peak loads.
(iii). "A 300 MW thermal power station will be added to the Sri Lankan power system in order to meet the high energy demand". From the technical point of view how do you comment above statement. Are there any alternative solutions to meet the energy demand? Explain breifly.

Q6. (i). Draw the mesh scheme and explain the situation at which it is broken to two separate systems.
(ii). A certain power station consisting two generator units is used to feed six 230 kV overhead lines via two three phase transformers (see the block diagram shown in

figure Q5). Draw a suitable bus bar arrangement for HV side of transformer. Give reason for your choice.

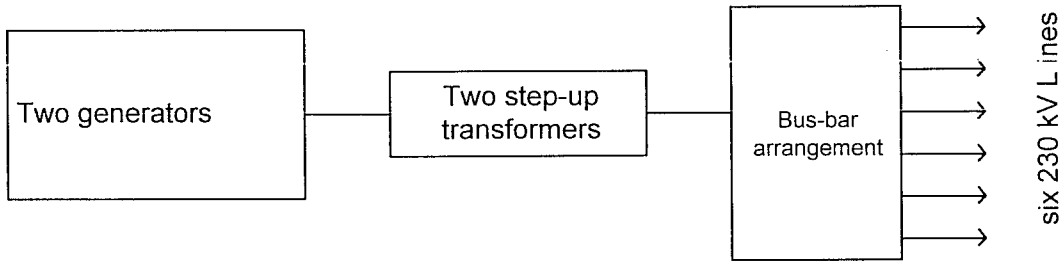

Figure Q5.

(iii). With the help of sketches explain the types of insulators that are used for electrical transmission and distribution lines. Briefly explain the advantages and disadvantages of them. What are the materials that are used for such insulators?