THE OPEN UNIVERSITY OF SRI LANKA
DIPLOMA IN TECHNOLOGY
ECX4232 POWER SYSTEMS I
FINAL EXAMINATION 2007/2008

047

Duration Three Hours
Date: 25 April 2008 Time: 0930-1230

*This paper contains seven questions. Answer **any five**. All questions carry equal marks.*

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

Q1

A 500 kV, 50 Hz transmission line having bundling arrangement of three conductors per phase is shown in figure Q1. Outside diameter of a conductor is 16 mm.

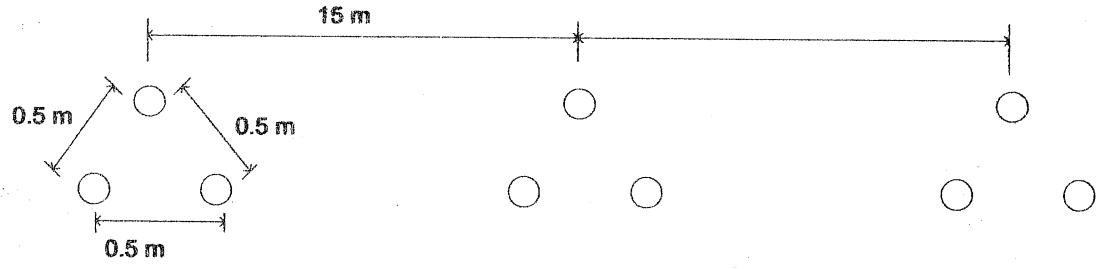

Figure Q1

(i). Calculate per phase per unit length inductance and capacitance (clearly state any assumptions made)

(ii). If the length of the line is 230 km draw and calculate the equivalent Π-parameters of the line (neglect the resistance of the line).

Q2.

(a). **A three phase load of 0.8+j0.7 pu is fed by a generator via transmission line as shown** in figure Q2. Voltage at the generator is maintained at ($\underline{V}_1$) 1.0 pu. Resistance of the line can be neglected and reactance of the line is j 0.1 pu. Calculate the approximate value of voltage at load.

(b). At the mid point of the said line a Static Var Compensator (SVR) is connected to maintain the voltage ($|\underline{V}_3|$)1.0 pu (figure Q2). Voltage at the generator is maintained as earlier. Calculate:

(i). voltage at load,
(ii). power flow,
(iii). reactive power given by SVC
(iv). power factor of the generator.

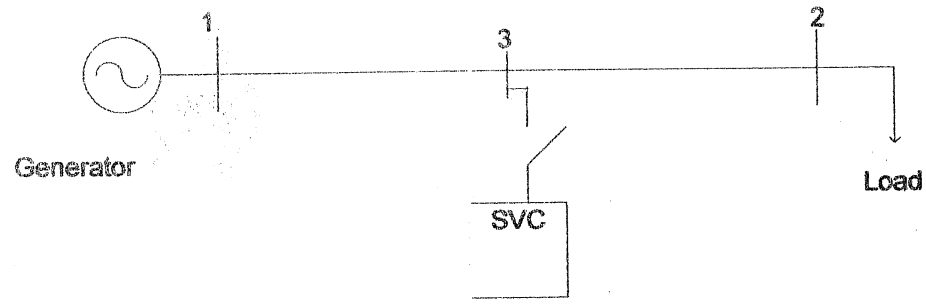

Figure Q2.

Q3.

(a). The high voltage side of 50 Hz, three phase star-star connected 1200 MVA, 24kV/345 kV transformer delivers power of 800 MVA at 0.85 power factor lagging. Equivalent impedance of the transformer is 12%. Calculate followings:

i. Per unit phase current

ii. Line voltage at low voltage side in volts at degrees

(b) Certain power system is shown in figure Q4. Parameters of the elements of the system on their own base are indicated in the figure.

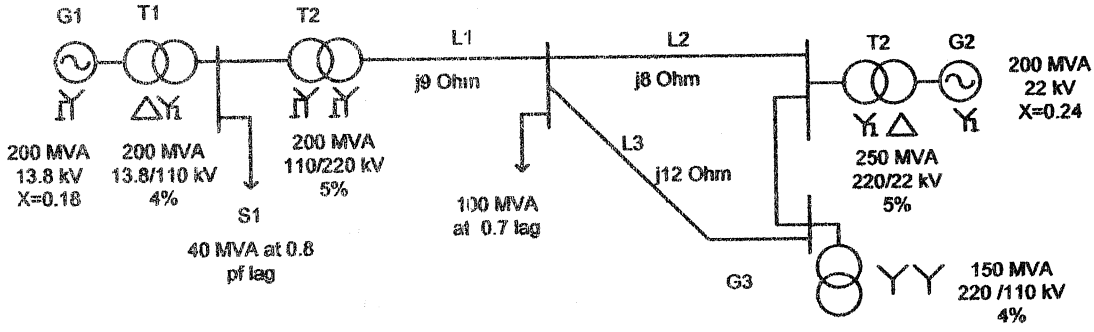

Figure Q3.

(i).Calculate the pu impedances on common base of 400 MVA and 230 kV.

(ii). Draw the zero sequence network of the system.

Q4

A single line diagram of a certain power system is shown in figure Q4. Reactances of the elements of the power system on a common base are indicated in the figure Q4. A three phase short circuit with zero short circuit impedance occurs at point A

(i).Calculate the short circuit current at point A.

(ii). Determine the currents and at voltages at generator G1 and G2 during the fault.

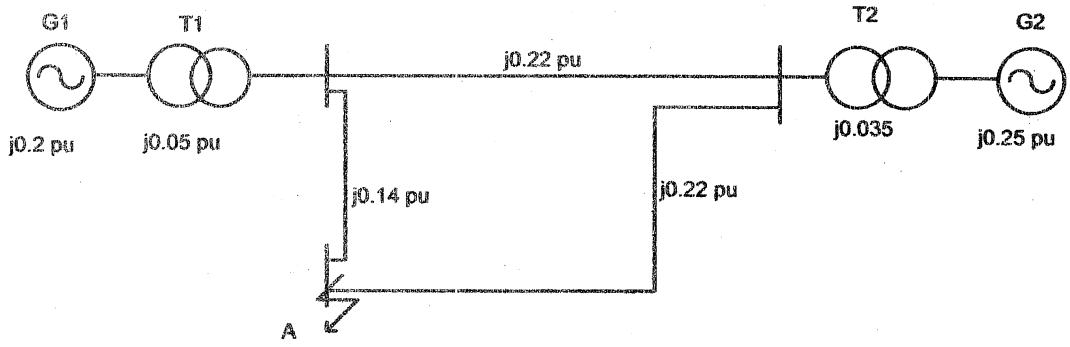

Figure Q4

Q5

Consider the systems shown in figure Q5. Parameters of the elements of the system on common base are given in table Q5. A single line to ground fault occurs at point P of the system. Calculate the fault current and currents through the lines during the fault.

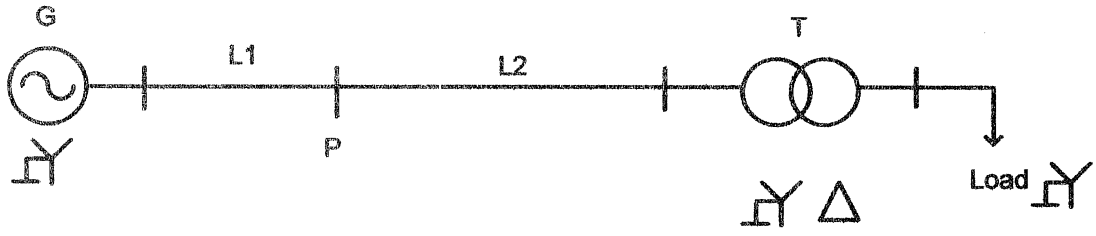

Figure Q5

Table Q5

G	$X_1=X_2$ =j0.12 pu, X_0=j0.05 pu
L1	$X_1=X_2$= j0.2 pu, X_0 =j0.4 pu
L2	$X_1=X_2$= j0.35 pu, X_0 =j0.65 pu
T	$X_1=X_2= X_0$ =j0.045 pu
Load	V=0.9 pu, S_L=1+j0.5 pu

Q6

(i). What are the advantages of suspension type insulator when compare with pin type insulator.

(ii). Why isolators are not being used as on load devices?

(iii). Why SF_6 circuit breakers are more popular than oil circuit breakers?

(iv). Briefly explain the operating principle of Air Blast circuit breaker.

(v). Describe the function of bus sectionalizer and bus coupler.

(vi). Certain substation consists of four (4) 230 kV transmission lines and two parallel connected 230 kV/11 kV transformers and twenty four (24) 11 kV underground cables. Draw the suitable bus bar arrangements for the high voltage and low voltage sides of the substation. Justify your choice.

Q7.

(i). Explain why coal and nuclear power stations cannot be used as "peak load plants".

(ii). Define the term "thermal rating" of a conductor.

(iii). Sketch the approximate daily load curve of Sri Lankan power system. What are the types of power stations use to dispatch same?

(iv). Write a short note on "Meet the electrical energy demand in Sri Lanka for next 10 years" from your point of view.

(vi). Give the meanings of 'load factor' and 'diversity factor'. What are the optimum values for above parameters in order to minimize overall cost per unit generated? What are the methods of improving load factor?