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THE OPEN UNIVERSITY OF SRI LANKA
DIPLOMA IN TECHNOLOGY
ECX4232 POWER SYSTEMS I
FINAL EXAMINATION 2010/2011

Duration Three Hours

Date: 12 March 2010 **Time: 0930-1230**

*This paper contains eight (08) questions. Answer **any five (05)**. All questions carry equal marks.*

Electric space constant ε_o=8.85x10^{-12} Fm^{-1}

Magnetic space constant μ_o=4π x 10^{-7} Hm^{-1}

Question 1

(a) Explain briefly the presence of capacitance and inductance in AC transmission lines **[3]**

(b) Explain why short length line models are not being used for underground cables **[2]**

(c) Figure Q1 shows the bundle arrangement of 500 kV overhead transmission line. Outside diameter and AC resistance at 20^{0}C per conductor are 16 mm and 0.9 Ohm /km respectively. The length of the line is 115 km and ambient temperature is 35^0 C. (temperature coefficient is 0.0044 $^{-1}$C)

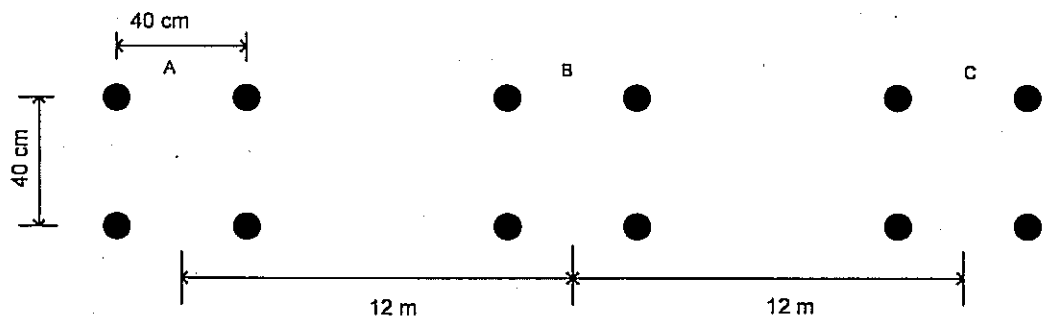

Figure Q1

I. Calculate per-phase, per length inductance and capacitance **[8]**

II. Calculate parameters of equivalent π-model of the line **[5]**

III. State whether the positions of phases A, B and C of above line remains same throughout length of the line. Explain your answer **[2]**

Question2

Certain grid substation delivers power to a load centre via 132 kV transmission line. Power consumed by the load centre is 60 MW at 0.88 power factor lag. The length of the line is 100 km. Per-unit length parameters of the line are:

Resistance: 0.22 Ω /km

Inductive reactance: 0.4 Ω /km

Shunt susepctance : 4.2 x10^{-6} S/km

(a) If the voltage at the load is to be maintained at 138 kV, determine

I. Voltage, power and power factor at the substation bus [10]

II. Voltage regulation and transmission efficiency [4]

(b) Calculate reactive power compensation at the load-end in order to maintain 132 kV at both ends of the line [6]

Question 3

(a) Explain why isolator is not used as an on-loads device [2]

(b) What is the function of earthing switch? [2]

(c) Distinguish load break switch and circuit breaker [2]

(d) What are the materials used in overhead transmission line insulators? [1]

(e) List the types of insulators used in overhead lines [1]

(f) Define string efficiency and explain the methods of improving string efficiency [4]

(g) A 132 kV overhead line is hanged by an insulator consisting four discs. If the capacitance to the earth is half of the interlink capacitance determine:

I. voltage distribution across the discs [6]

II. string efficiency [2]

Question 4

(a) Explain briefly the methods involved in extinguishing of an electric arc in

I. DC circuits II. AC circuits [4]

(b) What are the rated characteristics/values of a circuit breaker? [2]

(c) Explain terms " restriking voltage" and "recovery voltage" [4]

(d) Explain briefly arc extinguish mechanism in [6]

I. Air blast circuit breaker II. SF_6 circuit breaker

(e) Explain briefly the necessity of interlocking. Certain transmission line is connected to a bus via circuit breaker with two isolators at both sides of the line. With suitable sketch explain mechanical interlocking system for this arrangement [4]

Single line diagram of a certain power system is given in figure Q. Parameters of the elements of the systems in pu on common base are given. Answer the questions 5 and 6 (independently) using this system.

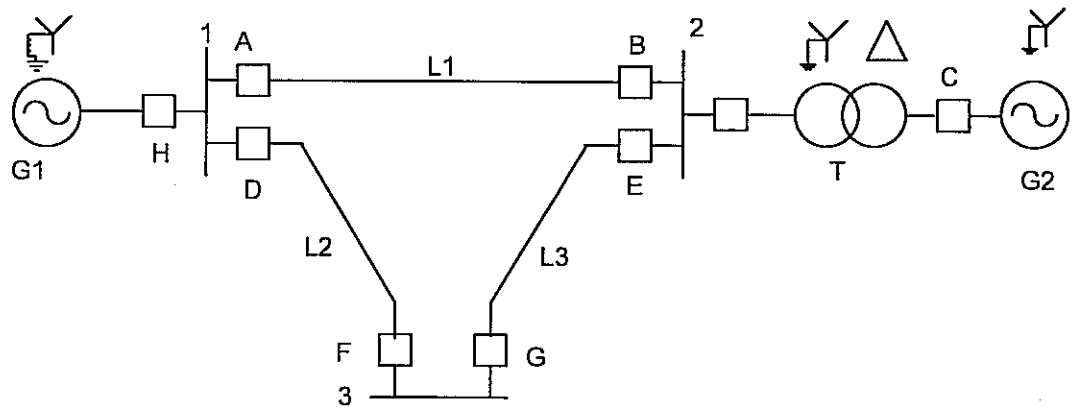

Figure Q

Synchronous generators:

G1: $X_1=X_2=0.175$ pu $X_0=0.05$ pu, $X_n=0.03$ pu

G2: $X_1=X_2=0.125$ pu., $X_0=0.075$

Transformer

T: X=0.08 p.u.

Transmission Lines

L1:	X1=X2=0.05 pu	X0=0.15 p.u
L2:	X1=X2=0.03 p.u.	X0=0.09 p.u
L3:	X1=X2=0.03 p.u.	X0=0.09 p.u

Question 5

A three-phase fault with zero impedance occurs at one third length from the circuit breaker A in line L1 of the system shown in figure Q.

Determine

I. Fault current **[7]**

II. Current through the circuit breakers A, B and C during the fault **[3]**

III. Voltage at the output terminals of the generator G2 during the fault **[3]**

IV. Explain briefly how this fault can be eliminated **[2]**

V. If the fault resistance is 0.01 p.u. determine fault current **[5]**

Question 6

Single line to ground fault occurs at bus 3 of the system shown in figure Q.

I. Draw the positive, negative and zero sequence networks **[4]**

II. Calculate fault current **[10]**

III. Determine the current driven by the generator G2 during the fault **[6]**

Question 7

(a) Sketch daily load curve of the present Sri Lankan power system and clearly indicating peak and off-peak load times. Explain briefly major disadvantage of having this type of load curve in a power system. What measures can be taken to improve the "shape" of this load curve **[8]**

(b) List the types of electrical power stations available in Sri Lanka? Group these stations to cover the base, intermediate and peak loads of the system **[7]**

(c) Explain briefly functions of following elements of hydro and thermal power stations:

Hydro:	(i).reservoir	(ii). penstock	(iii)surge tank
Thermal:	(i)boiler	(ii)condenser	

[5]

Question 8

(a) What are the advantages and disadvantages using series capacitors in electrical power systems **[4]**

(b) List the various methods of voltage control and explain one of them briefly **[4]**

(c) Explain why the power systems are not allowed to operate beyond the permissible range of voltage levels **[4]**

(d) What are the advantages of use of per unit systems in power system calculations **[4]**

(e) Explain why zero sequence does not flow through faults not involving ground **[4]**