THE OPEN UNIVERSITY OF SRI LANKA
DIPLOMA IN TECHNOLOGY
ECX4232 –POWER SYSTEMS I
FINAL EXAMINATION 2013/2014

Duration: Three hours

Date: 20th August 2014 Time: 0930-1230 hrs.

This paper contains of seven **(07)** questions. Answer any **five (5)**. All questions carry equal marks.

Permittivity of free space (ε_0) $= 8.85 \times 10^{-12}$ Fm^{-1}
Permeability of free space (μ_0) $= 4\pi \times 10^{-7}$ Hm^{-1}

Q1.

I. Draw conceptual single line diagrams for both One – and – half and Double bus single breaker configurations and explain briefly what would be the most reliable bus bar configuration [4]

II. Briefly explain the following terms associated with respect to circuit breakers:
   a) recovery voltage
   b) re-striking voltage
   c) High resistance interruption [6]

III. Briefly describe the switching operation of circuit breakers as to a resistive and an inductive load [5]

IV. A schematic diagram of a Nuclear power plant is shown in Figure Q1, identify the components 1 – 7 and briefly describe the operating principle of that power plant [5]

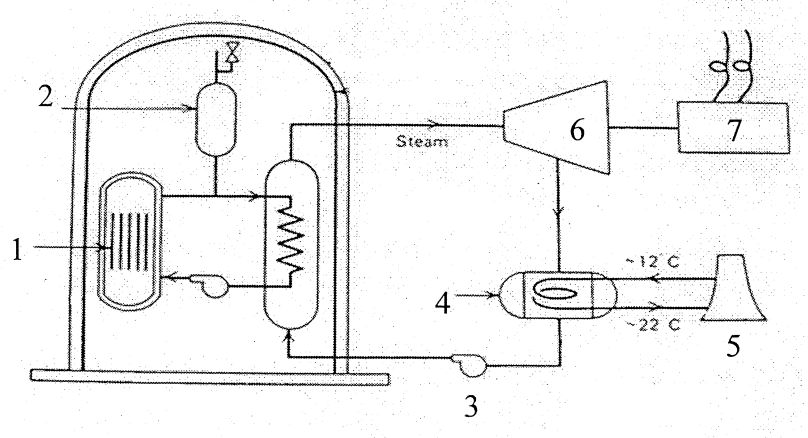

Figure Q1

Q2.

A three-phase, 50 Hz, transposed overhead transmission line consisting of three-conductor bundle with equal spacing per-phase is shown in figure Q2. Outside diameter of each conductor is equal to 1.8 cm. Resistivity and temperature coefficient of the Conductor material at 20°C are 1.78×10^{-8} Ω m and 0.00382 $^{\circ}C^{-1}$ respectively.

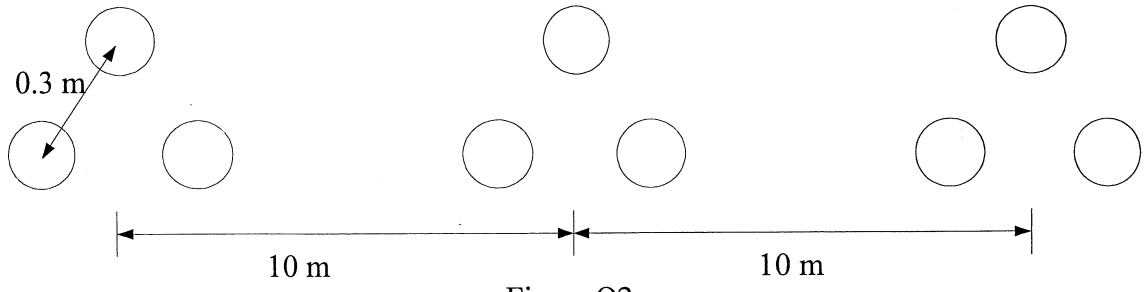

Figure Q2

I. Calculate the GMD between conductors and self GMD [6]

II. Determine per unit length inductance and capacitance of the line [6]

III. If the length of the transmission line is 250 km and ambient temperature is 42 °C, calculate per-phase parameters of the equivalent T model of the transmission line [8]
(State any assumptions you made)

Q3.

A 100 km long single phase, double circuit overhead transmission line delivering 5MW of power at 0.85 power factor lagging has following parameters per unit length as : Resistance = 0.8 Ω/km, Inductance 1.2 Ω/km and Susceptance 7×10^{-6} S/km.
Receiving end voltage is maintained at 33 kV. Assuming the total capacitance of the line is localized at the receiving end.

I. Calculate voltage, current, power and power factor at the sending end of the line [6]

II. Determine voltage regulation and transmission efficiency [4]

III. Draw the phasor diagram to show all the voltages and currents [4]

IV. What is the ferranti effect of the transmission line and reasons it to occur [4]

V. What are the permissible percentage limits of transmission voltage levels 132 kV and 220 kV operating in Sri Lankan power system [2]

Q4.

I. List types of short circuit faults in power system according to as their decreasing frequency of occurrence [4]

II. In the single line diagram shown in figure Q4, each generator A and B are rated at 200 MVA, 33 kV having reactance of 0.95 p.u and are generating voltage of 1.05 p.u. Transformers are rated at 150 MVA, 33 kV/132 kV and have reactance of 6% each. The transmission line has a reactance of 10.5 Ω.

a) Convert all quantities to a common base of 300 MVA, and 132 kV on the line and draw the circuit diagram with values expressed in p.u. [8]

b) if a three phase short circuit to ground fault occurs at the quarter distance of one of the transmission line from BUS 1 ,calculate the fault current in p.u and its actual value. [8]

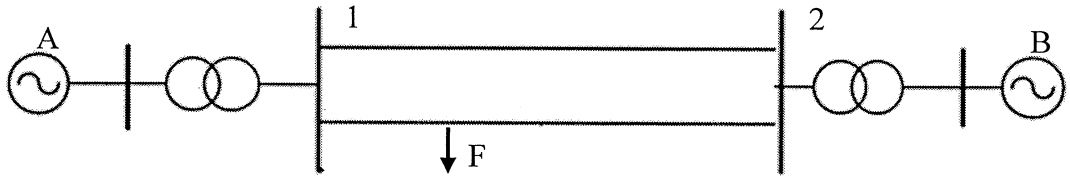

Figure Q4

Q5

I. In a test of a three conductor underground cable, the three conductors are first bunched together and the capacitance between the bunched conductor and sheath is found to be 0.9 μF. Then two of the conductors are bunched with the sheath and the capacitance between these and third conductor is found to be 0.4 μF. Determine line to ground capacitance of this cable. [8]

II. A single core cable of conductor diameter 2 cm and lead sheath of diameter 5.8 cm is to be used on a 66 kV three phase system. Two intersheaths of diameter 3.1 cm and 4.2 cm introduced between core and outersheath. If maximum stresses in all sections are same, calculate the potentials at which the intersheaths must be maintained. Use peak value of the voltage. [12]

Q6.

I. Show that symmetrical component currents are equal in a single line to ground phase of an unloaded generator [6]

II. A single line diagram of a power system is shown in figure Q6. Reactances of the elements are given to common base values are indicated in the Table Q6. Current limiting reactor Zn connected between neutral of generator A and earth is j0.315 p.u.

Equipment	Positive Sequence impedance	Negative Sequence impedance	Zero Sequence impedance
Generator A	j0.4	j0.3	j0.08
Generator B	j0.3	j0.2	j0.05
Transmission lines	j0.4	j0.4	j0.7
Transformers	j0.15	j0.15	j0.15

Table Q6

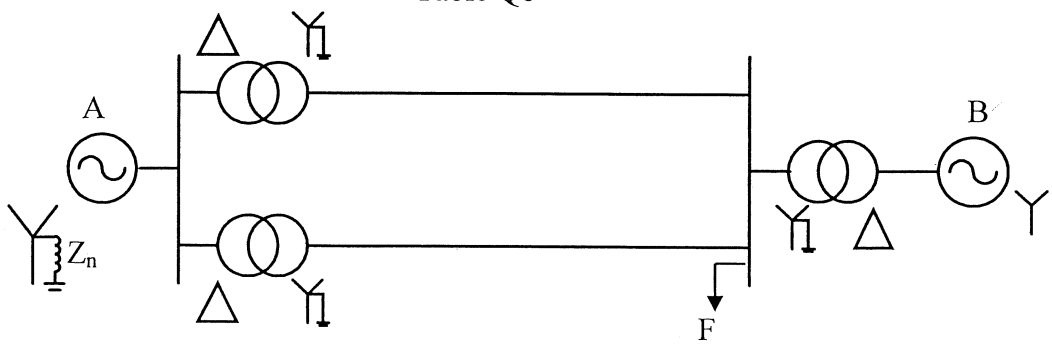

Figure Q6

a) Draw positive, Negative and Zero sequence networks for the power system in Figure Q6 [8]

b) Draw an equivalent sequence network when the fault at F is Single line to ground fault and calculate the p.u line fault currents [6]

Q7.

I. Briefly explain the nature of voltage distribution over a string of suspension insulator [2]

II. Briefly explain

a) Strain insulator

b) Stockbridge damper

c) Pin insulator [6]

III. A string of suspension insulators consists of three units. The capacitance between each link pin and earth is one sixth of the self-capacitance of each unit. If the maximum voltage of the each unit must not exceed 35 kV, determine the maximum voltage that the string can withstand. Also compute the efficiency of the string [12]