The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX4552/EEX4252 – Power Systems I**
Academic Year	: 2019/2020
Date	: 10th August 2020
Time	: 1330-1630hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Seven (07)** questions in **Five (5)** pages.
3. Answer **any FIVE (05)** questions. All the questions carry equal marks
4. Answer for each question should commence from a new page.
5. No relevant charts / codes are provided.
6. This is a Closed Book Test **(CBT).**
7. Answers should be in clear handwriting.
8. Do not use red color pen.

Question 1

a) Explain briefly the effect of integrating non-conventional power plants into the national grid. [5 marks]

b) Certain power system consists of following types of power plants:

- Hydro power plants with ample storage capacity
- Run-off river hydro power plants
- Gas turbine power plants
- Diesel power plants
- Coal power plants
- Nuclear power plants
- Hydro power plants with limited storage capacity

Daily load curve of the system is shown in figure Q1. List the power plants that are more suitable for the areas of A, B and C of the curve. Give reasons for your answer.

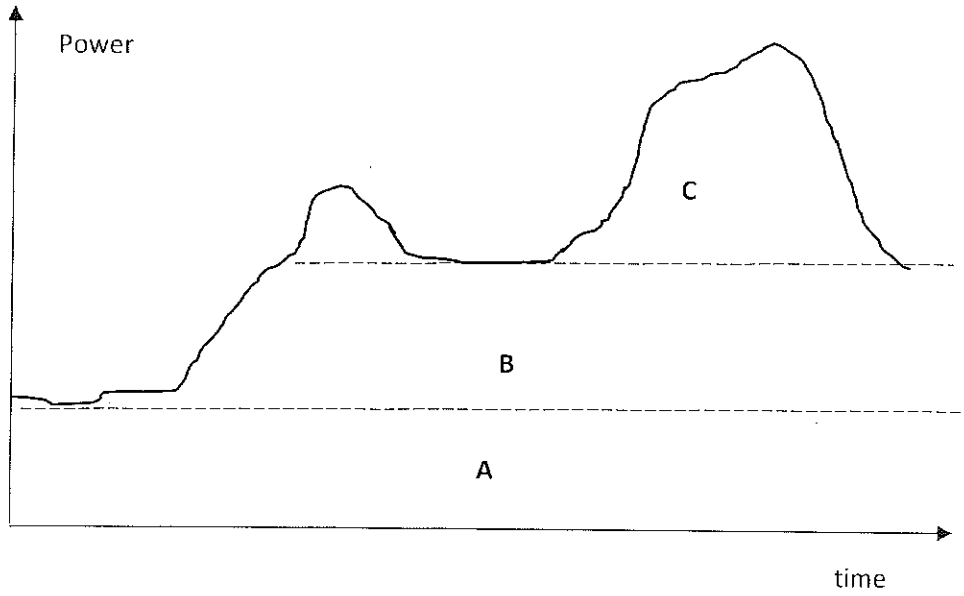


Figure Q1

[9 marks]

c) Daily load curve of Sri Lankan power system is similar to the power consumption pattern of the domestic consumers. Identify the main disadvantage of the pattern and if so, how it could be overcome? [6 marks]

[Total marks 20]

Question 2

a) Explain briefly the purpose of transposition of overhead transmission lines [3 marks]

b) Conductor arrangement of a 3-phase,50 Hz single circuit overhead transmission line is shown in figure Q2. Diameter of the conductor is 7.77 mm. Per-unit length resistance at 20 ^{0}C is about 0.062 Ω/km. Temperature coefficient of copper is 0.0068^{0}C

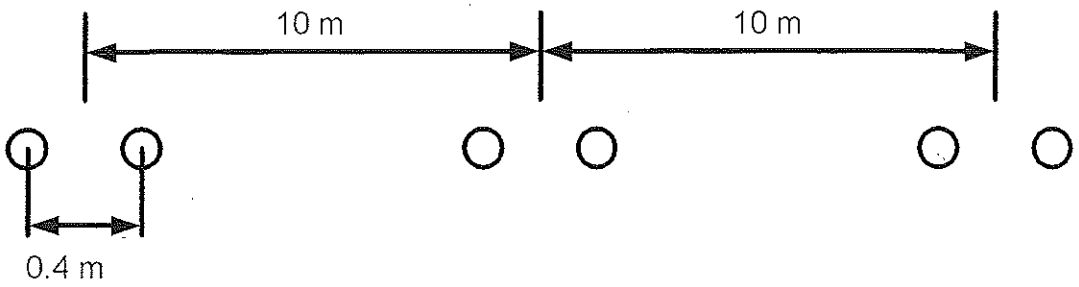


Figure Q2

I. Calculate geometric mean radius (GMR) and geometric mean distance (GMD) [4 marks]

II. Determine per-phase per unit length inductance and capacitance. [6 marks]

III. Explain why the effect of earth in capacitance calculation can be neglected? [2 marks]

IV. If the length of this line is 90 km and the ambient temperature is 30^0 C, calculate the parameters of equivalent π model of the line [5 marks]

[Total marks: 20]

Question 3

a) Define recovery voltage and re-striking voltage with reference to the electric arc extinction in a circuit breaker [4 marks]

b) List out three properties that makes SF_6 circuit breaker superior in High voltage applications [3 marks]

c) Four 220 kV transmission lines have to be connected to 33 kV feeders with the help of two 220 kV/33 kV transformers in a grid substation. Two types of bus bar schemes are proposed for the HV side of the grid substation:

- Main and transfer bus bar
- Mesh scheme

Compare the above bus bar schemes with respect to the following requirements and recommend a suitable bus bar arrangement for the grid substation

- Continuity of supply during the outages of breakers/ bus bar
- Future expansion
- Cost effectiveness

[8 marks]

d) Isolators are OFF load devices. But they can be used as ON load devices. With the help of suitable sketches explain how they are being used as ON load devices [5 marks]

[Total marks: 20]

Question 4

a) Explain briefly the reasons for overhead transmission line insulator failure [4 marks]

b) Insulators of the distribution lines in the coastal regions fails more frequently than the other areas of the country. What might be the reason? Analyze the possible solutions [4 marks]

c) Explain briefly how insulator grading improve the string efficiency [4 marks]

d) Certain string insulator is made up of 5 similar units. The capacitance between each interlink and earth is one tenth of the capacitance between the metal interlinks. The flashover voltage of one unit is 55 kV. Calculate the voltage at which this assembles will flashover. [8 marks]

[Total: 20 marks]

Question 5

A 132 kV, 100 km long transmission line delivers a load of 50 MW operating at 0.9 power factor lagging. Series impedance of the line is $(0.12 + j\,0.45)\ \Omega\ km^{-1}$ and shunt susceptance is $0.4 \times 10^{-6}\ Skm^{-1}$. Voltage at the load is equal to the rated voltage

a) Compute:
   I. sending end voltage and current
   II. sending end power and power factor
   III. transmission efficiency

[13 marks]

b) With the help of necessary calculations, show that the effect of line capacitance is negligible [3 marks]

c) In order to reduce the sending end voltage to 138 kV, capacitors have been connected to the line in series. If the per-phase capacitance is Xc, derive an expression to determine Xc. Solving the equation is not required. [4 marks]

[Total: 20 marks]

Question 6

Consider a power system shown in figure Q6. Ratings of the generators, transformers are indicated in the figure. Per unit values given are on equipment base.

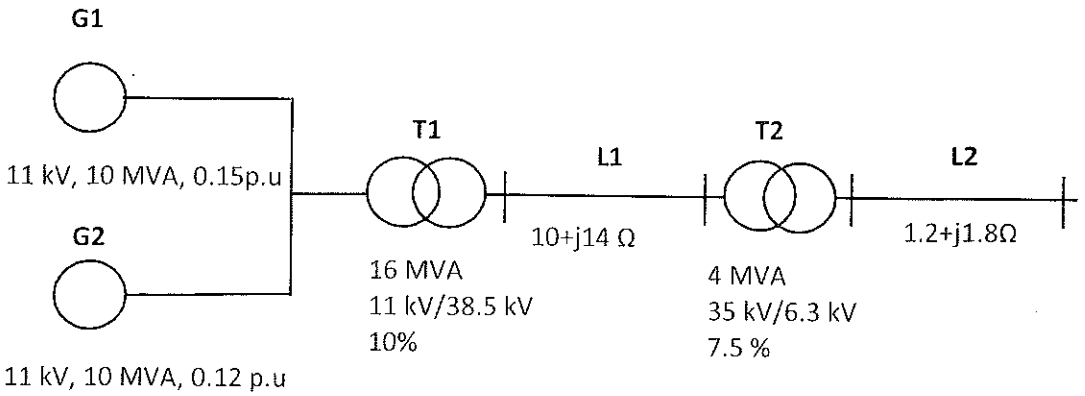


Figure Q6

a) Calculate the per unit values of the system on common base of 10 MVA at 11 kV generator G1 [8 marks]

b) A three-phase fault occurs at the end of distribution line L2. Calculate
   - Short circuit current in kA
   - Fault level in MVA

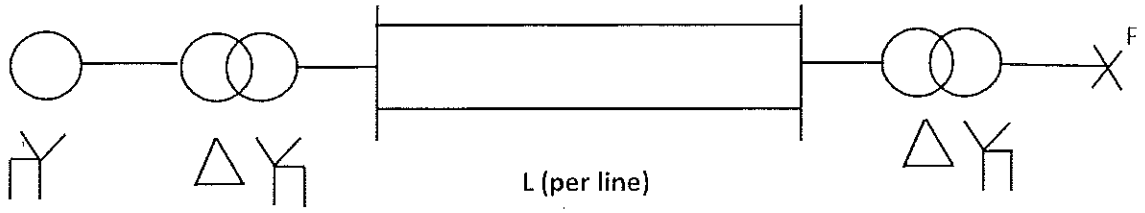
[10 marks]

c) Calculate generator output voltage in kV during the short circuit [2 marks]

[Total: 20 marks]

Question 7

The single line diagram of a three-phase power system is shown in figure Q7. Positive, negative and zero sequence reactance of the system elements in p.u. on common base are indicated in the figure. A single line to ground fault (in phase A) occurs at point F.



G1

X1=0.14;

X2=X0=0.08;

T1

X1=X2=X0=0.109

X1=X2=0.124

X0=0.31

T2

X1=X2=X0=0.18

Figure Q7

a) Sketch positive, negative and zero sequence networks and calculate equivalent positive, negative and zero sequence reactance with respect to the fault point [10 marks]

b) Calculate fault current in pu. [4 marks]

c) Calculate the phase currents (A, B, C) through the lines L during the fault [6 mark]

[Total: 20 marks]