00085

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	**: EEX4542 – Power Systems I**
Academic Year	: 2020/2021
Date	: 11th February 2023
Time	: 0930-1230hrs

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of five **(5)** questions in four **(4)** pages.
3. Answer **ALL** the questions
4. Answer for each question should commence from a new page.
5. No charts / codes are required.
6. This is a Closed Book Test **(CBT).**
7. Answers should be in clear handwriting.
8. Do not use red color pen.

Question 1 [20 marks]

a) Explain why a power system should have various types of power plants with different unit capacities rather than a single type with same unit capacities to meet the demand in a power system. [5 marks]

b) Hydropower plants are grouped in to three: Hydropower plants with limited capacity, hydropower plants with ample storage and run off river plants. List down in which areas of the load curve these power plants operate. [3 marks]

c) Describe the functions of following elements of a hydropower plant.
   i. Penstock
   ii. Surge chamber

[6 marks]

d) Mahaweli Hydro Power Complex consists of number of hydro power plants which are built across the river Mahaweli as a cascade. The complex is meant for two purposes: generating electricity and providing water for irrigation purposes.
   i. What are the challenges faced by the hydropower plants which are located in cascade arrangement. [4 marks]
   ii. Briefly explain possibility of increasing generating capacity of these plants using pump storage system. [2 marks]

Question 2 [20 marks]

a) When solar panels are built on the surface of the source of source of water (such as lakes, reservoirs, ponds etc..), those are known as floating solar plants. Presently, these floating solar power plants are becoming popular in many countries.
   i. What are the factors that influence the use of floating solar for electricity generation rather than conventional solar plants built on the land? [3 marks]
   ii. Discuss the feasibility of electricity generation from floating solar plants in Sri Lanka. [4 marks]

b) Daily load curve of a domestic consumer is shown in figure Q2. As a solution to the scheduled power cuts in the country, the consumer decided to install a battery storage system to provide 50% of energy during the grid power interruption. Consider that there is only a two-hour power interruption during the night peak (18:30-22:30 h) per day.
   i. What is the most suitable time period for charging the battery storage system? Explain your answer. [3 marks]
   ii. Suppose the scheduled power interruption is from 19:00 h to 21:00 h. Draw the daily load curve of the consumer and indicate charging and discharging states of the battery on the same graph. [3 marks]
   iii. If the depth of discharge of the battery is 80% and storage efficiency is 90%, estimate the capacity of the battery storage system. [4 marks]
   iv. What are the factors that affect the financial feasibility of installation of battery storage system? [3 marks]

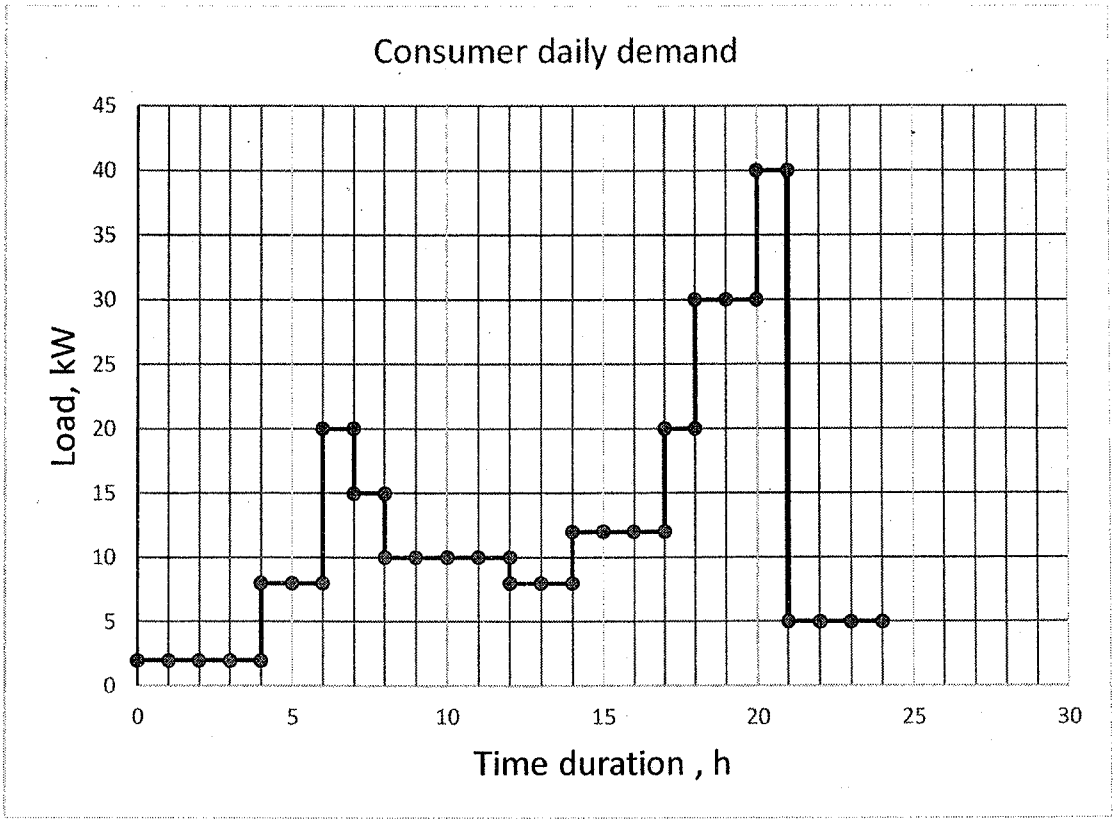


Figure Q2

Question 3 [20 marks]

a) Write main functions and sketch standard symbols of following elements of a power system.

i. Current transformer
ii. Voltage transformer
iii. Earthing switch
iv. Surge arrester

[12 marks]

b) Conductor arrangement of 132 kV, 50 Hz fully transposed overhead line is shown in figure Q3. Conductor diameter is 7.77 mm. (ε=8.85 x10^{-12} Fm^{-1})

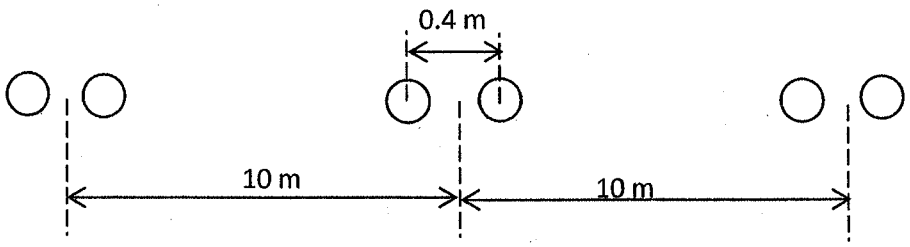


Figure Q3

i. Calculate per phase per km inductance and capacitance of the line. [5 marks]
ii. What would happen if the line was not transposed? [3 marks]

Question 4 [20 marks]

A 132 kV, 50 Hz, 180 km long, three phase transmission line has following per-phase parameters.

$R=0.12\ \Omega\ km^{-1}$; $X=0.45\ \Omega\ km^{-1}$ $Y=0.366 \times 10^{-6}\ Skm^{-1}$

The line connects power plant to a grid substation. Consider a situation, when the line is opened at gird substation-end while the voltage at the power plant -end is kept at 138 kV.

a) Sketch equivalent π- model of the line for the above situation and indicate the line parameters in the figure. [5 marks]

Determine followings.

b) Voltage at the grid-substation end of the line. [5 marks]
c) Current delivered by the plant. [4 marks]
d) Reactive power at the power plant. [4 marks]
e) Power loss of the line. [2 marks]

Question 5 [20 marks]

Consider a power system shown in figure Q5. Power taken by the motor at the motor terminal K is 0.5 p.u. at 0,8 power factor lagging. The motor terminal's voltage at this situation is 1.0 p.u. Parameters of the elements of the power system on common base of 100 MA are given bellow.

G: 100 MVA, 22 kV, Xd = 0.9 pu

T1: 75 MVA, 22 KV /132 kV, XT1 = 11%

T2: 50 MVA, 132 kV / 0.415 kV, XT2 = 5%

TL: 90 km, XTL = j 0.4 Ω/km/ph

Motor (M): 50 MVA, $X_M = 0.25$ pu

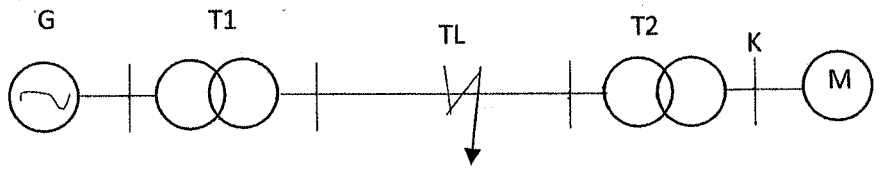


Figure Q5

a) Calculate emf of the generator (G) and the motor (M) [7 marks]
b) A three -phase short circuit occurs at the midpoint of the transmission line TL. Calculate:
   i. Short circuit current in kA [8 marks]
   ii. Fault level at the midpoint of the line [3 marks]
   iii. Current delivered by the motor [2 marks]