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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	**: EEX4533 / ECX 4233 - Communications**
Academic Year	: 2019/2020
Date	: 30th September 2020
Time	: 0930-1230hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **eight (8)** questions in **Six (6)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer to each question should commence from a new page.
5. Relevant charts/codes are provided.
6. This is a Closed Book Test **(CBT).**
7. Answers should be in clear handwriting.
8. Do not use a red colour pen.

Erlang's B Formula

$$P(N,A) = B = \frac{\frac{A^N}{N!}}{1+\frac{A}{1!}+\frac{A^2}{2!}+\frac{A^3}{3!}+\ldots.+\frac{A^N}{N!}} = \frac{\frac{A^N}{N!}}{\sum_{X=0}^{X=N}\frac{A^X}{X!}}$$

Where:

A = Average offered traffic
N = No of outlets (circuits)
r = No of simultaneously occupied outlets or circuits

Question 1

1. List down four factors should consider in telephone network planning.

(4Marks)

2. Give two reasons why network operators are interested in global telecommunication standards.

(4Marks)

3. Explain how a 2W/4W hybrid prevents the signal from the network (receiving pair) from looping back to the transmitting pair. **(2Marks)**

4. Consider an 11-digit international number with 2-digit country code, 2-digit area code and a 7-digit subscriber number. Prefixes "0" and "00" are used for identifying national and international numbers, respectively.
   Government special services like ambulance and fire are given short subscriber numbers in the range 100-199. For other special purposes, number range 900-999 is reserved.
   (i) Find the total number of digits with all the prefixes.
   (ii) Calculate the available number space for subscribers
   (iii)The fraction of space lost due to shortcodes and reservations.

(10Marks)

Question 2

1. State one advantage and one disadvantage each of 'Time switching' and 'Space Switching' technique. What advantages are gained by combining these two techniques?

(4Marks)

2. A 2-stage space-division full availability switching network acts as a concentrator. It has M incoming trunks, N outgoing trunks and N links between the two switching stages (Where M>N). The number of switches in the second stage is twice as the number of switches in the first stage.
   (i) Show the formation of each of the above switching networks using a diagram. You need to mark all the necessary parameters.
   (ii) Obtain an expression for the total number of cross points.
   (iii) Use your results in part (i) and (ii) to design a network for a 2-stage concentrator having 400 incoming trunks and 200 outgoing trunks. Find the total number of cross points.
   (iv) If you add a middle level with nine(9) switches to the above switching network in part (iii), calculate total cross points in a modified arrangement.

(14Marks)

3. Explain two advantages of the increasing number of stages in a switching network.

(2Marks)

Question 3

1. Define the following terms related to a telephone exchange and explain how they affect the performance of the exchange.
   (i) Congestion
   (ii) Availability
   (iii) Grade of service

   (06 Marks)
2. What is the ideal value for the grade of service? Can this value be achieved in practice? Justify your answer.

   (02Marks)
3. A particular group of circuits in a telephone exchange carried 200 calls during the busy hour. The duration in seconds of 10 successive calls in the exchange were 160, 100,120, 85, 190, 75, 62, 140, 158, 110. Calculate:
   (i) average holding time
   (ii) the traffic volume
   (iii) the traffic intensity
   (iv)the average number of calls in progress simultaneously. **(12 Marks)**

Question 4

1. State the Erlang's B formula with all the parameters clearly defined.

   (02Marks)
2. A full availability group of 5 trunks is offered 4E of traffic. Find,
   (i) the Grade of Service
   (ii) the probability that only two trunks are busy
   (iii)the probability that at least two trunks are free
   (iv)If one trunk is out of service, what will be the Grade of Service?
   (v) If a 10% increase in the offered traffic in an emergency, what will be the Grade of Service?

   (10 Marks)
3. Table Q5 gives a part of a traffic table. Clearly explain how you use the given traffic table in the following situations:

   (i) To find the number of trunks required for a system which has offered traffic of 56E and a GOS of 0.005.

   (ii) To find the value of offered traffic for a system which has 74 trunks and a GOS of 0.001.

   (08 Marks)

Table Q5

Number of trunks	1 lost call in			
	50 (0.02)	100 (0.01)	200 (0.005)	1000 (0.001)
	E	E	E	E
68	57.2	54.2	51.9	47.5
79	58.2	55.1	52.8	48.3
70	59.1	56.0	53.7	49.2
71	61.0	57.0	54.6	50.1
72	62.0	58.0	55.5	50.9
73	62.9	58.9	56.4	51.8
74	62.9	59.8	57.3	52.6
75	63.9	60.7	58.2	53.5

Question 5

1. State 4 advantages of digital transmission over the analogue transmission.

(04 Marks)

2. "In telephony, Pulse Code Modulation (PCM) samples a signal at 8kHz using 256 quantization levels." According to this statement, answer the following questions:

   (i) Briefly explain how the sampling rate is chosen.
   (ii) Draw the complete block diagram of the system.
   (iii) Explain how this system works.
   (iv) Calculate the output bit rate.

(08 Marks)

3. Briefly explain how the above scheme is used in forming the T1 carrier system. Show it using a complete block diagram. **(04 Marks)**

4. Explain PDH and how the T1 carrier system is multiplexed to PDH. **(04 Marks)**

Question 6

1. A lossless transmission line of the electrical length of 0.3λ and characteristic impedance of 50Ω is terminated with a load impedance $Z_L = (50 + 100j)\ \Omega$. Use the same Smith chart to find the following (Clearly show your work on the Smith chart, attached on page 6).

   (i) The reflection coefficient of the load.
   (ii) The standing wave ratio of the line.
   (iii) The reflection coefficient at the input. **(12 Marks)**

2. An underground cable is 30km long and has the following parameters per km per wire.

   $R = 90\ \Omega$, $L = 2mH$, $G = 1.5\mu S$ and $C = 40nF$

The considered frequency is 10 kHz.
If the cable wire is terminated with its characteristic impedance and supplied with 6mW of input power at the sending end, calculate,

(i) the characteristic impedance
(ii) the received current magnitude
(iii) phase deviation in sending and receiving currents
(iv) The received power.

(08 Marks)

Question 7

1. Using diagrams appropriately, explain how the frequency reuse concept is used for the optimum use of the available frequency band for communication. **(2 Marks)**

2. A cellular operator is planning a cellular network in a metropolitan area. Total bandwidth allocated to the operator is 70MHz. 1MHz is assigned for a control purpose, and another 1.1 MHz is reserved for control channels for future needs. The bandwidth of a simplex channel is 25kHz. Duplex channels are used for both voice and control purposes. If frequency reuse factor is7; find,
   (i) Total number of channels per cell
   (ii) Voice channels per cell
   (iii) If the frequency reuse factor changes to 4, calculate (i) and (ii).
   (iv)Hence, comment best frequency reuse arrangement in the area.

   (12 Marks)

3. Differentiate following,
   (i) Adjacent and channel interferences.
   (ii) Soft and hard handoff
   (iii)HLR and VLR **(6Marks)**

Question 8

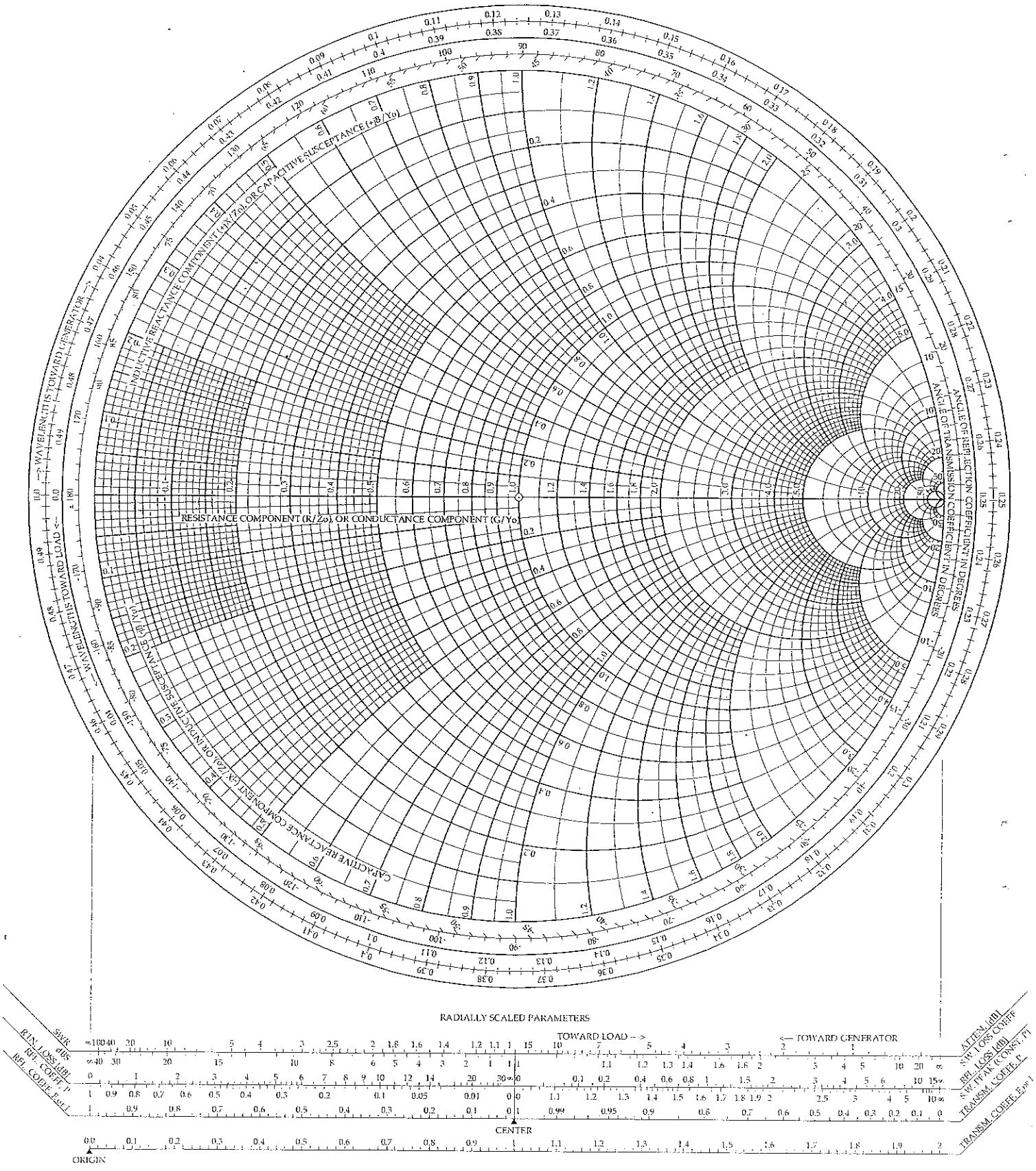
1. Define the following with respect to antennas. **(2x4Marks)**
   i. Beamwidth
   ii. Gain
   iii. Directivity
   iv. Isotropic radiator

2. Draw the radiation patterns for a Yagi antenna array. Compare it to that of a half-wavelength dipole and that of a parabolic antenna. **(4Marks)**

3. What is the benefit of using a folded dipole? **(2Marks)**
4. The radiated power of a low-frequency transmitting antenna is 750W. If the radiation resistance and the loss resistance of the antenna are 3Ω and 0.2 Ω respectively, Find,
   i. The current fed into the antenna
   ii. The input power
   iii. The efficiency of the antenna **(6Marks)**

The Complete Smith Chart

Black Magic Design



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	: 2019/2020
Date	: 10th August 2020
Time	: 13.30-16.30hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Six (6)** questions in **Six (6)** pages.
3. Answer **ALL** the questions
4. Answer for each question should commence from a new page.
5. No Relevant 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

a) In the recent time electrical energy generated by solar and wind has been significantly increasing in Sri Lanka. At the same time, construction of large-scale power plants has been delayed due to various reasons. From the demand side, domestic loads share the larger portion of the daily energy consumption.
Considering the above facts, explain the significance of introducing energy storage devices for grid application in Sri Lanka.

[6 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.

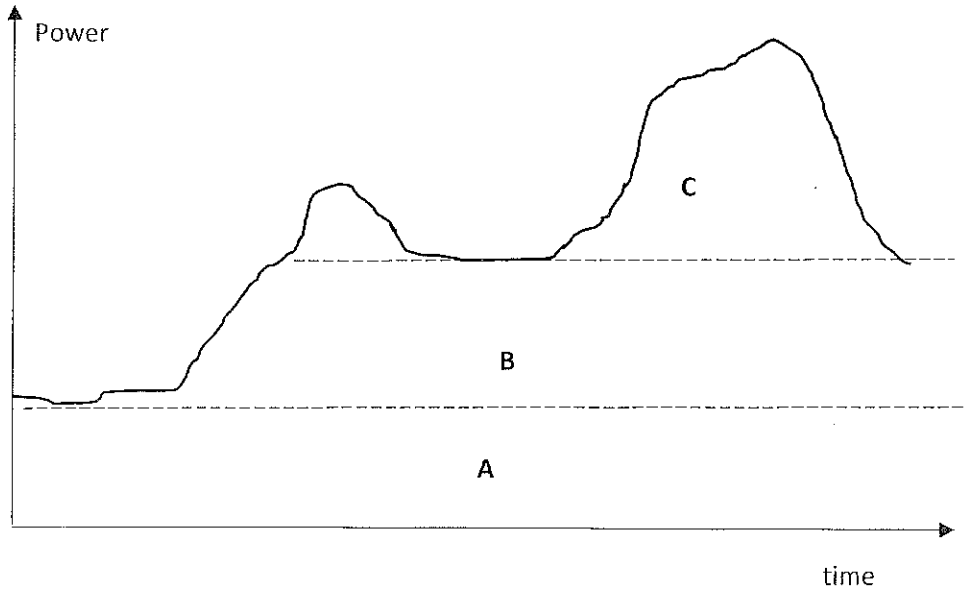


Figure Q1

[9 marks]

[Total marks 15]

Question 2

Table Q2 shows the details of electrical appliances and their usage in a private residence

Table Q2

Electrical Appliance	Power rating W	Power factor*	Number of appliances	Average Usage
LED bulbs	8	0.9	7	6 hrs/per day
Desktop computer	250	0.85	1	3 hrs/per day
Ceiling fan	30	0.9	2	6 hrs/per day
Television	91.5	0.96	1	3 hrs/ per day
Microwave oven	425	0.9	1	0.5 hrs/ per day
Washing machine	300	0.85	1	2 hrs/per week
Air Conditioners	1400	0.95	2	2 hours per day

*(*all the appliances have lagging power factor)*

a) Maximum demand of the house occurs between 7 pm-8 pm when all the appliances except washing machine and air conditioners are in operation

i. Calculate the maximum power consumed by the house between 7 pm -8 pm

ii. What is the power factor during the maximum demand?

iii. Calculate the energy consumed by the house per month

[12 marks]

b) Calculate the expected electricity bill of the consumer under domestic tariff structure. Domestic tariff structures are given in tables Q2.2 (a) and Q2.2(b) [3 marks]

Monthly energy consumption between 0- 60 kWh

Table Q2.2(a)

Monthly consumption kWh	Unit charge Rs/kWh	Fixed charge Rs.
0-30	2.50	30.00
31-60	4.85	60.00

Monthly energy consumption greater than 60 kWh

Table Q2.2(b)

Monthly consumption kWh	Unit charge Rs/kWh	Fixed charge Rs.
0-60	7.85	N/A
61-90	10.00	90.00
91-120	27.75	480.00
121-180	32.00	480.00
>180	45.00	540.00

[Total marks: 15]

Question 3

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

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

[Total marks: 15]

Question 4

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 (while keeping receiving end voltage at rated value), 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 5

Consider a power system shown in figure Q5. Ratings of the generators (G1,G2), transformers (T1,T2) and line impedance (L1,L2) are indicated in the figure. Per unit values given are on equipment base.

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) How does the location of the fault in line L2 and the fault impedance affect the short circuit current?

[2 marks]

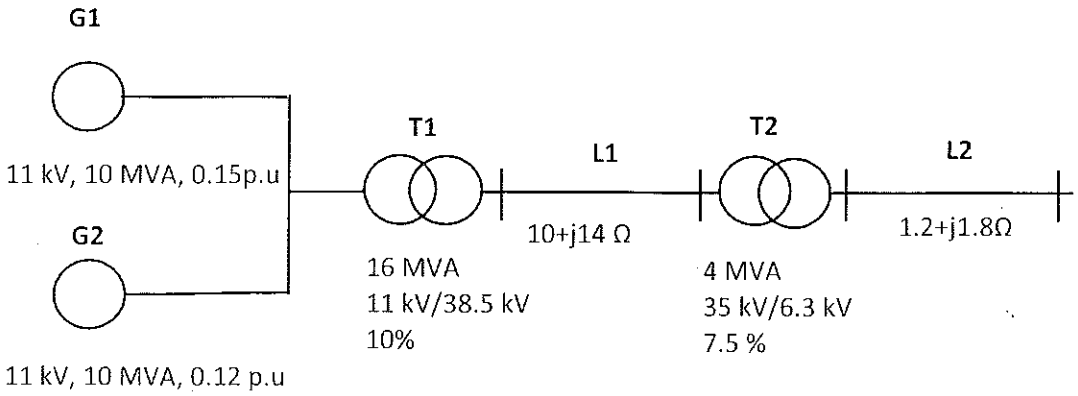
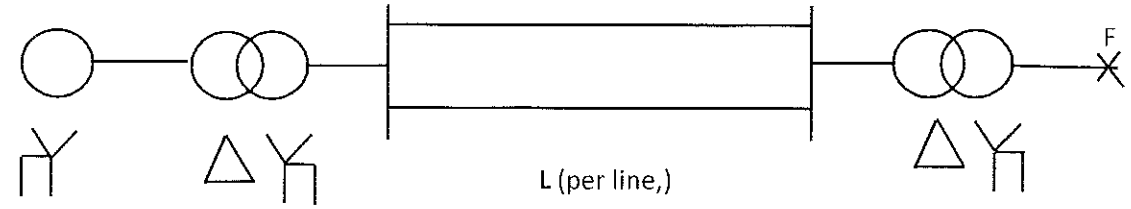


Figure Q5

[Total: 20 marks]

Question 6

The single line diagram of a three-phase power system is shown in figure Q6. Positive, negative and zero sequence reactances 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

T2

X1=X2=X0=0.18

Figure Q6

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 p.u. [4 marks]

c) What would be the current in phase B [1 mark]

[Total: 15 marks]