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Department of Electrical Engineering

Final Examination Summer-20

Subject: Power System Analysis

Electrical Engineering

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Time Allowed: 180 minutes **23rd Sep, 2020**

ATTEMPT ALL QUESTIONS

Question No: 1

a) A three-phase 765-kV, 60-Hz, 300-km, completely transposed line has impedance and admittance of ***z = 0.0165 + j0.3306 ohm/km*** and y = j4.674 x 10^{-6} S/km. Calculate the exact ABCD parameters of the line. (10)

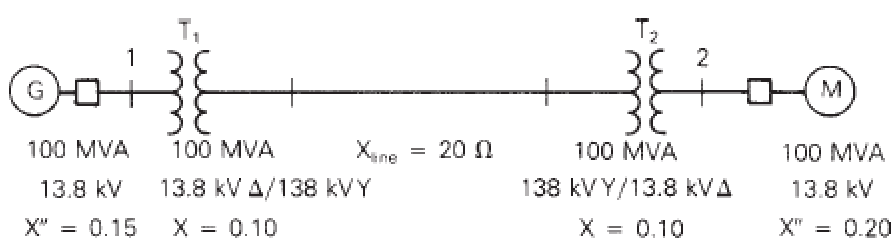
Question No: 2

a) What is surge impedance of transmission lines and how can it be found (5)

b) What are the different reactive power compensation techniques used in transmission lines (5)

Question No: 3

a) Draw and explain the equivalent fault circuit diagram of the following three phase circuit, and then draw and explain the post fault condition of the circuit. (5)



b) A fault occurs in the above system. The fault voltage is 1.05<0 kV. The load current is 3.984<-18.19 kA. Find the fault current and Generator current. (5)

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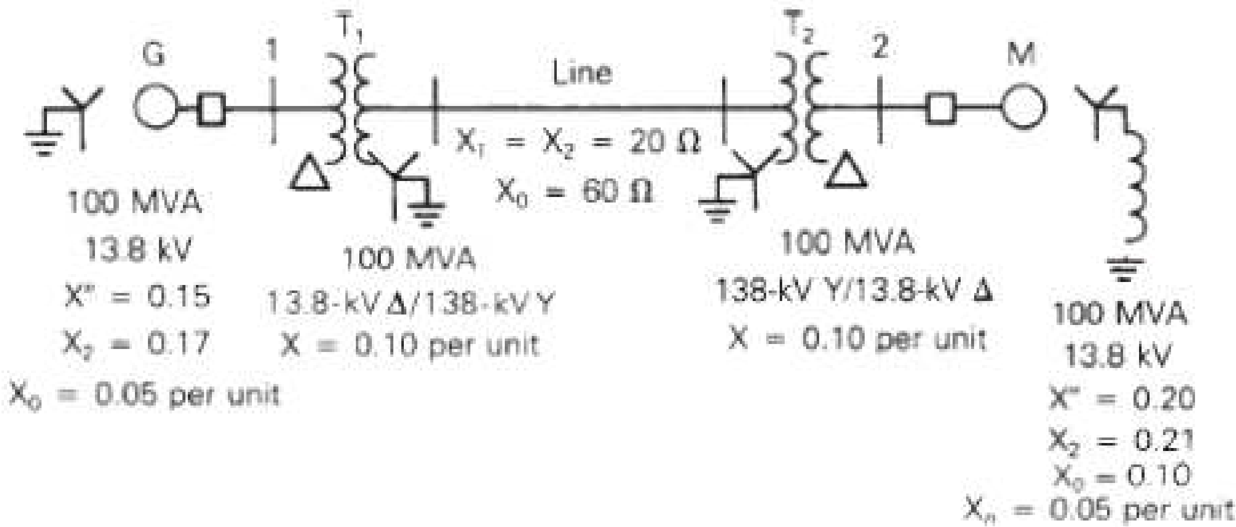
Question No: 4

a) What are bus-bars and what are the type of bus bars used in transmission lines (4)

b) What is the effect of Voltage on the number of insulators, distance from ground and distance between phases of Transmission Lines (5)

Question No: 5

A single-line diagram of the power system considered in Example 7.3 is shown in Figure 9.3, where negative- and zero-sequence reactances are also given. The neutrals of the generator and Δ–Y transformers are solidly grounded. The motor neutral is grounded through a reactance $X_n = 0.05$ per unit on the motor base. (a) Draw the per-unit zero-, positive-, and negative-sequence networks on a 100-MVA, 13.8-kV base in the zone of the generator. (b) Reduce the sequence networks to their Thévenin equivalents, as viewed from bus 2. Prefault voltage is $V_F = 1.05\underline{/0^\circ}$ per unit. Prefault load current and Δ–Y transformer phase shift are neglected.



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QNo 1

Solution:

$Z = 0.0165 + j0.3306$

$= 0.3310 \angle 87.14^\circ \ \Omega \, Km$

$y = j4.674 \times 10^{-6}$

$= 4.674 \times 10^{-6} \angle 90^\circ S/Km$

The Characteristic impedance

$$Z_C = \sqrt{\frac{Z}{y}} = \sqrt{\frac{0.3310 \angle 87.14^\circ}{4.674 \times 10^{-6} \angle 90^\circ}}$$

$= 266.1 \angle -1.43^\circ \ \Omega$

The propogation Constant

$\gamma l = \sqrt{zy} \times l$

$= \sqrt{(0.3310 \angle 87.14^\circ)(4.674 \times 10^{-6} \angle 90^\circ)} \times 300$

$= \sqrt{1.547 \times 10^{-6} \angle 177.14^\circ} \times 300$

$= 0.3731 \angle 88.57^\circ$

$= 0.00931 + j\,0.3730$ p.u

$e^{\gamma l} = e^{0.00931} \, e^{j0.3730}$

$= 1.0094 \angle 0.3730$ radians

$= 0.9400 + j0.3678$

$e^{-(\gamma l)} = e^{-0.00931} \, e^{-j0.3730}$

$= 0.9907 \angle -0.3730$ Radians

$= 0.9226 - j0.3610$

$\cosh \gamma l = \frac{e^{\gamma l} + e^{-\gamma l}}{2}$

$= \frac{0.9400 + j0.3678 + 0.9226 - j0.3610}{2}$

$= 0.9313 + j0.0034$

$= 0.9313 \angle -0.209^\circ$

$\sinh \gamma l = \frac{e^{\gamma l} + e^{-\gamma l}}{2}$

$= 0.9400 + j0.3678 - (0.9226 - j0.3610)$

$= 0.0087 + j0.3664$

$= 0.3645 \angle 88.63^\circ$

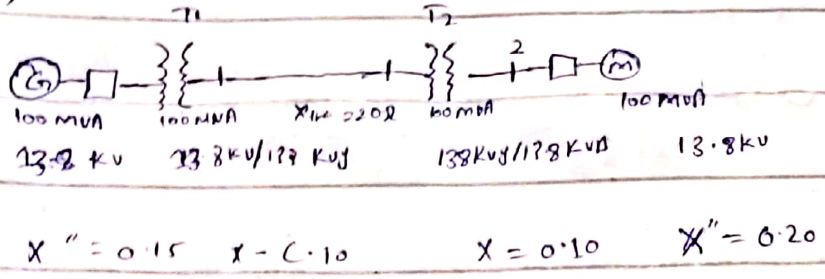
Q No 2 Part a

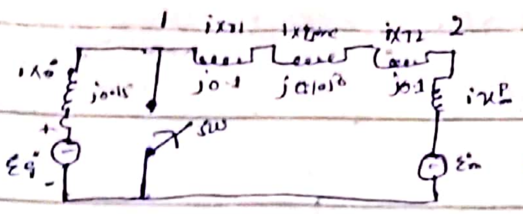
Ans) The Characteristic impedance or Surge impedance (usually written Z_0) of a uniform transmission line is the ratio of the amplitude of Voltage and Current of a single wave propagating along the line; that is a wave travelling in one direction in the absence of reflection in other direction

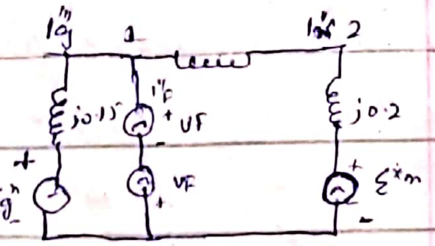
Part b:

Ans) There are different technologies for reactive power Compensation, these include; Capacitor Bank, Series Compensator, Shunt Reactor, Static VAR Compensator (SVC), Static Synchronous Compensator (STATCOM), and Synchronous Condenser.

Qno2 (a)

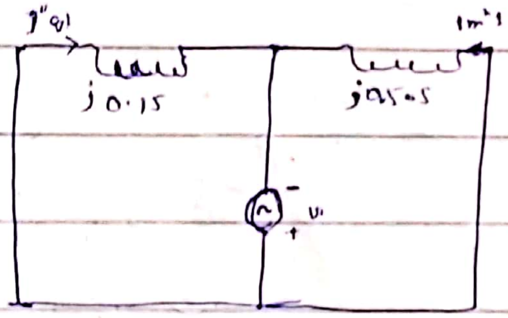


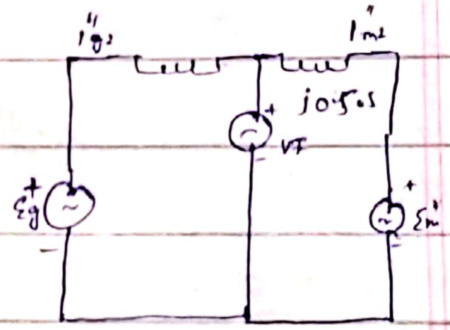


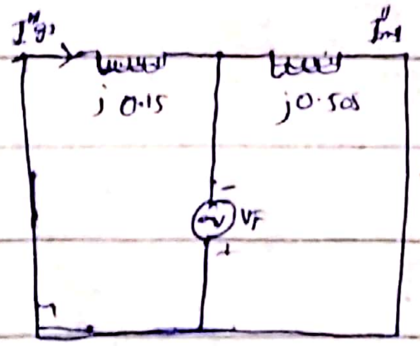


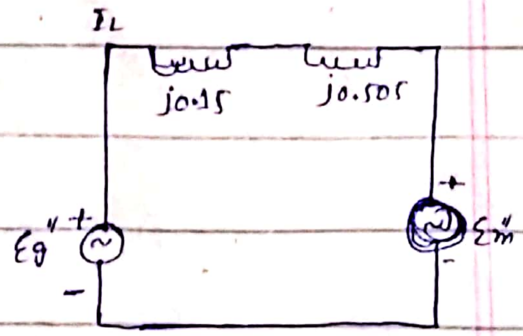
Three phase short circuit

Short circuit represented by two opposing Voltage source.









Q No 3 Part b

Solutions:

1) fault Currents

$$I''_F = \frac{V_F}{Z_{TH}}$$

by putting values, we get

$$= \frac{1.05\angle 0°}{j0.11565}$$

$$= -j9.079$$

(2) Genector Current

$$I_L = \frac{100}{(\sqrt{3})(1.05 \times 13.8)} \angle -\cos^{-1} 0.95$$

$$= 3.9845 \angle -18.19° \text{ kV}$$

putting values we get

$$= \frac{3.9845 \angle -18.19°}{4.1837} = 0.9524 \angle -18.19°$$

$$= 0.9048 - j0.2974$$

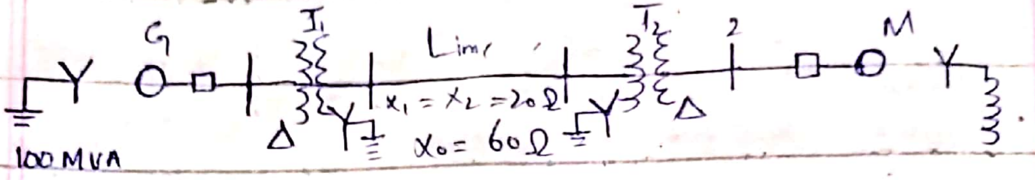
Q.No 11 Part A:

A busbar is a metallic strip or bar typically housed inside switchgear, panel board and busway enclosures for local high current power distribution. They are also used to connect high voltage equipment at electrical switchyards and low voltage equipment in battery banks.

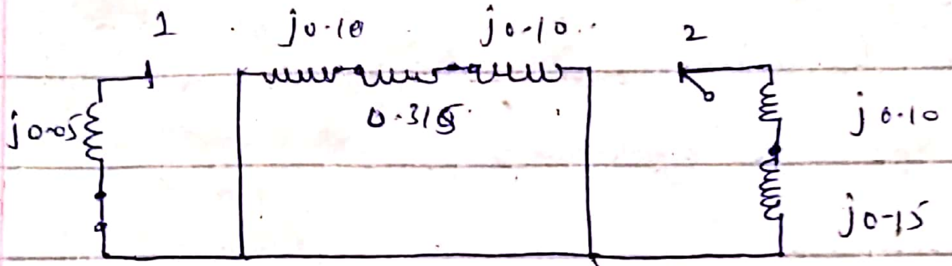
Types of busbar

- Single Bus-Bar Arrangement
- Single Bus-Bar Arrangement with Bus Sectionalizing.
- Main and transfer Bus Arrangement
- Dauble Bus Double Breaker Arrangement
- Sectionalized Double Bus Arrangement
- one - and - a - Half Breaker Arrangement
- Ring Main Arrangement.
- Mesh Arrangement.

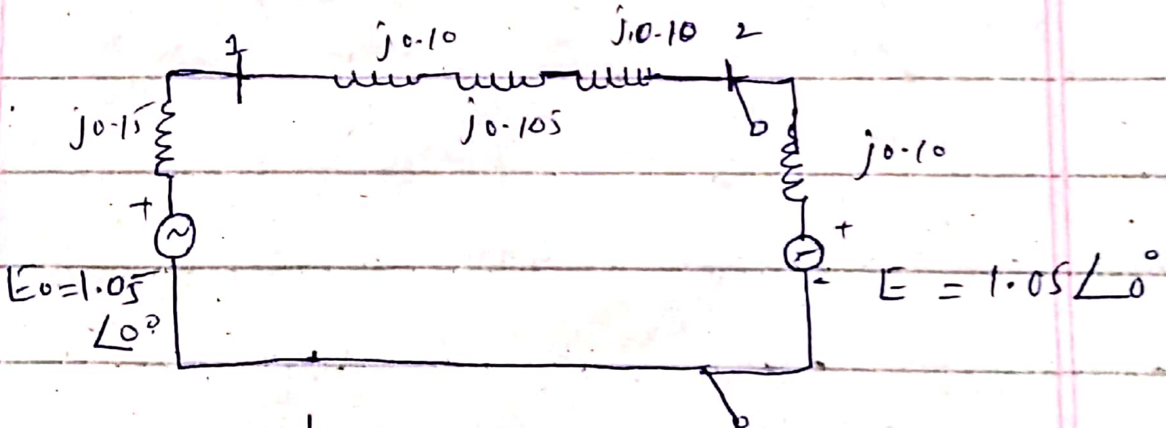
Q no 5) Solution



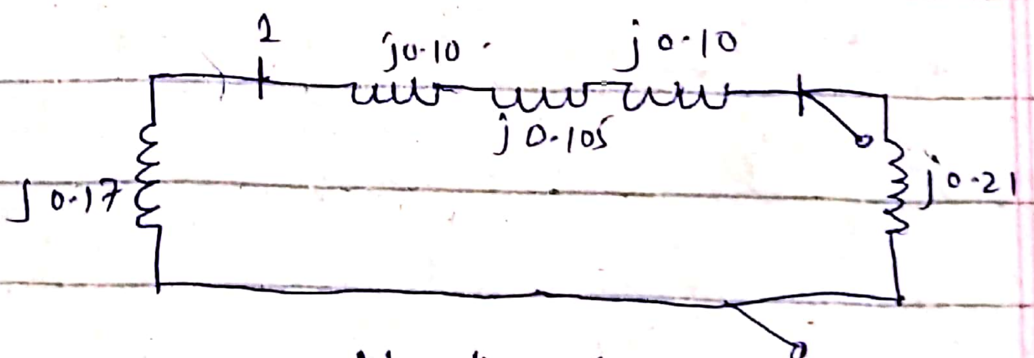
G	T1	T2	M
100 MVA			100 MVA
13.8 KV	100 MVA	100 MVA	13.8 KV
$X'' = 0.15$			$X_n = 0.20$
$X_2 = 0.17$	13.8 KV Δ / 138 KY	138 KV Y / 13.8 KV Δ	$X_2 = 0.21$
$X_0 = 0.05$ per unit	$X = 0.10$ per unit	$X = 0.10$ per unit	$X_0 = 0.10$
			$X_n = 0.05$ per unit



(a) Zero Sequence network.



(b) positive sequence network



(c) Negative-Sequence network.