Power Systems Lab

Experiment 1

Laboratory Report

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1 Objective

To evaluate the equivalent pi-model and the transmission matrix for a 3-phase long transmission line.

Let the given problem be as follows:

A 3-phase, 60 Hz, completely transposed, 345 kV, 200 km long line has two ACSR conductors per bundle and the following constants,
Impedance (Z) = 0.017 + j 0.12 Ω / km
Admittance (Y) = j 1.2 $\times 10^{-6}$ S / km
Find the transmission matrix using the equivalent pi-model.

2 Theoretical Background

A long transmission line is defined formally as a power transmission line with an effective **length more than 250 km** (150 miles). Unlike short transmission lines and medium transmission lines, it is no longer reasonable to assume that the line parameters are lumped. To accurately model a long transmission line we must consider the exact effect of the distributed parameters over the entire length of the line.

Although this makes the calculation of ABCD parameters of transmission line more complex, it also allows us to derive expressions for the voltage and current at any point along the line.

In a long transmission line the line constants are uniformly distributed over the entire length of line. This is because the effective circuit length is much higher than what it was for the former models (long and medium line) and hence we can no longer make the following approximations:

- **We cannot ignore the shunt admittance** of the network, like in a small transmission line model.
- Considering the circuit **impedance and admittance to be lumped** and concentrated at a point as was the case for the medium line model.

2.1 The Nominal π-model

In the Nominal π Model, the shunt capacitance of each line i.e. phase to neutral is divided into two equal parts.

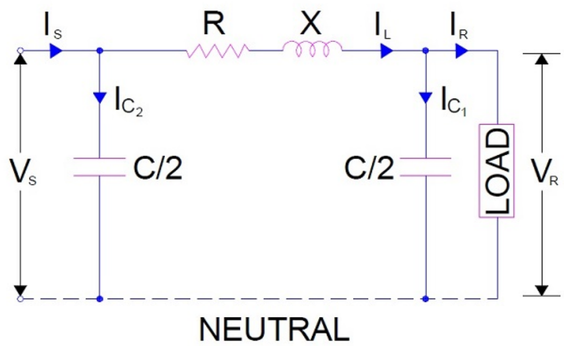

Figure 1: Nominal π-Model

One part is lumped at the sending end while the other is lumped at receiving end as shown in Figure 1.

2.2 The Equivalent π-model

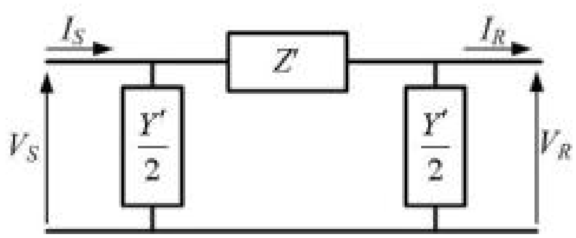

Figure 2: Equivalent π-Model

The equivalent π-model does not make the assumption that the impedance and admittance of the line is lumped at the ends like in the case of a short or medium transmission line. This model takes into account that the impedance and admittance of the line is distributed along the line.

3 Implementation

```matlab
% Equivalent pi-model and the transmission matrix

Zp  = 0.017 + 0.12i; % Impedance per km
Yp  = 1.2i;          % Admittance per km
len = 200;           % Length in km

Z = len * Zp; % Total Impedance
Y = len * Yp; % Total Admittance

A = ((Y*Z)/2) + 1;
B = Z;
C = Y*(((Y*Z)/4) + 1);
D = A;

T = [ A B; C D; ]
```

4 Observations

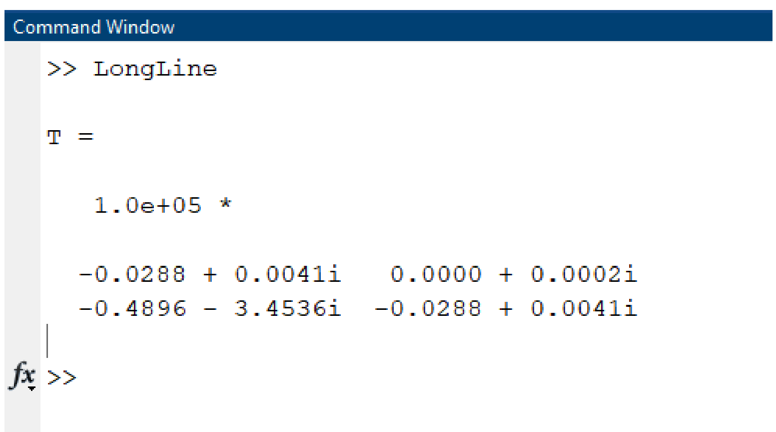

Figure 3: Result

The result of the above program with the given parameters is shown in figure 3.

5 Result

We calculated the transmission matrix (i.e. ABCD parameters) of the long transmission line using the Equivalent π-Model method in MATLAB.