Power Systems Lab

Experiment 2

Laboratory Report

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Experiment 2

1 Objective

To find the sending end voltage and power, voltage regulation of a 3-phase medium transmission line.

Let the given problem be as follows:

The received voltage from a 3-phase, 60 Hz, transmission line is 170.012 kV.
The line is 100 km long and has the following constants,
Impedance (Z) = 0.017 + j 0.12 Ω per km
Admittance (Y) = j 1.2 $\times 10^{-6}$ S per km
Find the sending end voltage and power if the line is delivering a load of 17.12 MVA.
Also find the voltage regulation.

2 Theoretical Background

The transmission matrix, i.e. the ABCD parameters, of the line relate the sending end voltage and current to the receiving end voltage and current, according to the following equation:

$$\begin{bmatrix} V_S \\ I_S \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_R \\ I_R \end{bmatrix}$$

$$V_S = AV_R + BI_R$$
$$I_S = CV_R + BD_R$$

To find the sending end power, we can simply use the following:

$$S_S = V_S I_S$$

Voltage Regulation

Voltage regulation is a measure of change in the voltage magnitude between the sending and receiving end of a component. It is commonly used in power engineering to describe the percentage voltage difference between no load and full load voltages distribution lines, transmission lines, and transformers.

The voltage regulation can be calculated as follows:

$$\% \text{ Regulation} = \frac{|V_S| - |V_R|}{|V_R|} * 100$$

3 Implementation

```
% Sending end voltage, power and voltage regulation of
% 3-phase medium transmission line.

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Vr = 170.012; % Received voltage in kV
Sr = 17.12;  % Received power in MVA

Zp  = 0.017 + 0.12i; % Impedance per km
Yp  = 1.2e-6i;      % Admittance per km
len = 100;          % Length in km

% ABCD Parameters
Z = len * Zp;
Y = len * Yp;

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

T = [ A B; C D; ]

% Calculating sending end voltage and power

Ir = Sr / Vr;         % Received current

Vs = A * Vr + B * Ir  % Sending end voltage
Is = C * Vr + D * Ir; % Sending end current

Ss = abs(Vs * Is)     % Sending end power in MVA

% Calculating voltage regulation

R = ((abs(Vs) - Vr)/Vr) * 100 % Voltage regulation
```

4 Observations

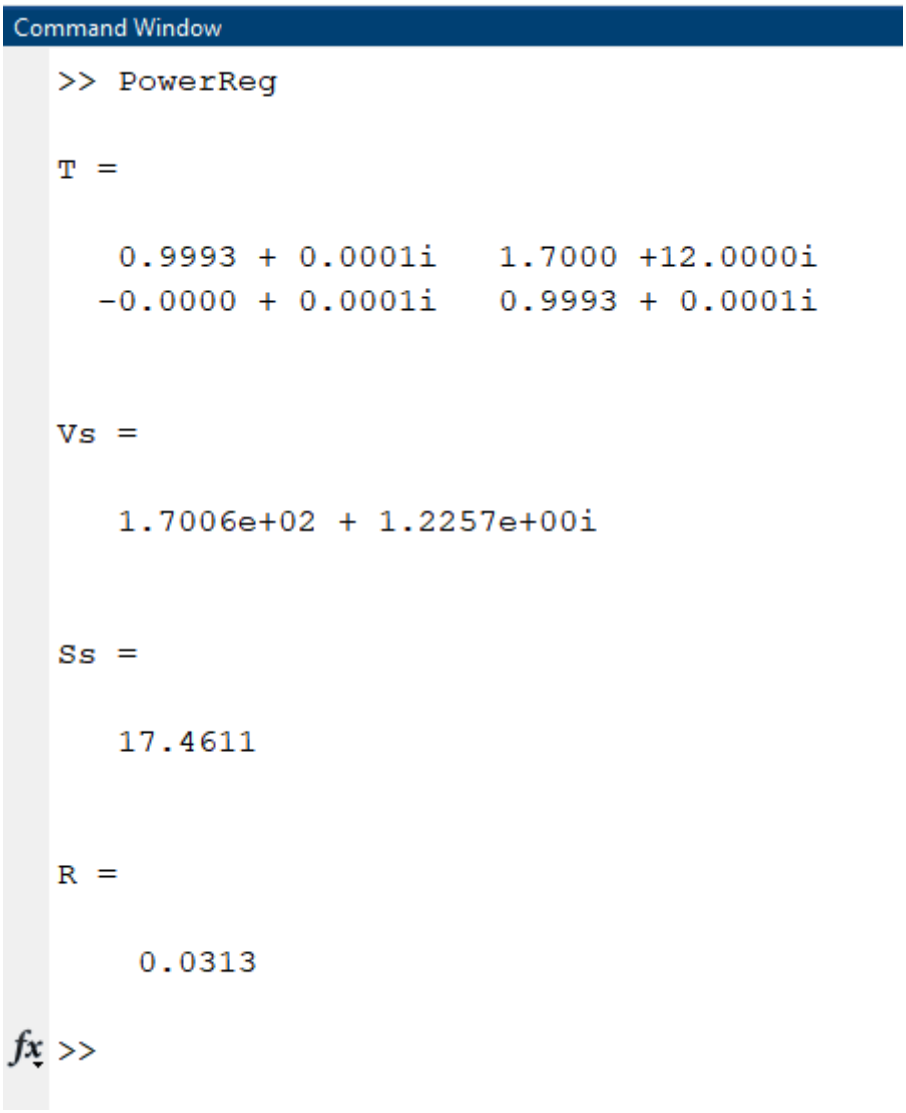

Figure 1: Result in MATLAB

The result of the above program with the given parameters is shown in figure 1.

5 Result

For the given problem, the calculated **sending end voltage is 170.0652 kV.** The **sending end power is 17.4611 MVA,** which means a power loss of 0.3411 MVA and a voltage drop of 1.2267 kV over the line.

The calculated **voltage regulation of the transmission line is 0.0313%.**

Thus we calculated the requied quantities using a program in MATLAB.