EE309 - POWER SYSTEMS
Assignment-1

Group- 10

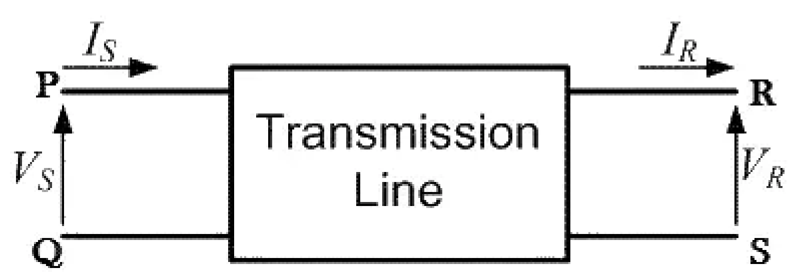
Srihith Bansal - 2021EEB1217
Vishakha Agarwal - 2021EEB1221
Vivek Chadgal - 2021EEB1222

Given Problem Statement:

A three-phase 50 Hz transmission line is 400 km long. The sending-end voltage is 220 kV. The
line parameters are r = 0.125 Ω/km, x = 0.4 Ω/km and y = 2.8 x 10-6 ℧/km.

Find the following (and answer phasor form) using MATLAB code:
a. The A, B, C, and D constants of the line for no-load.
b. sending-end current for no-load.
c. receiving-end voltage for no-load.
d. repeat (a), (b), and (c), assuming the given line is a short transmission line.
e. repeat (a), (b), and (c) assuming the given line is a medium transmission line (nominal Π-representation).

A significant section of power system engineering deals with transmitting electrical power from one place (e.g. generating station) to another (e.g., substations or residential homes) with maximum efficiency.



An input port (PQ) and an output port (RS) comprise a two-port network. It is possible to express the input voltage and input current in terms of the output voltage and output current in any 4 terminal network, such as a linear, passive, or bilateral network. Every port includes two terminals to connect to an external circuit. As a result, it is a circuit with two or four terminals where

Supply End Voltage = Vs
Supply End Current= Is
Receiving End Voltage = Vr
Receiving end Current = Ir

Thus the relation between the sending and receiving end specifications is given using ABCD parameters by the equations below.

$$\boxed{\begin{bmatrix} Vs \\ Is \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} VR \\ IR \end{bmatrix}}$$

$$V_S = AV_R + BI_R \cdots\cdots\cdots\cdots\cdots\cdots (1)$$

$$I_S = CV_R + DI_R \cdots\cdots\cdots\cdots\cdots\cdots (2)$$

Therefore, it's critical that power system engineers thoroughly model the transmission of this power. These intricate computations are made simpler by using a two-port model with ABCD parameters.

The receiving end is open-circuited (No load condition), meaning the receiving end current IR = 0.

Applying this condition to equation (1) we get,

$$V_S = A\,V_R + B\,0 \Rightarrow V_S = A\,V_R + 0$$

$$A = \left.\frac{V_S}{V_R}\right|_{I_R = 0}$$

we get parameter A as the ratio of the sending end voltage to the open circuit receiving end voltage. Since dimension-wise A is a ratio of voltage to voltage, A is a dimensionless parameter.

Applying the same no-load condition i.e. IR = 0, to equation (2)

$$I_S = C V_R + D\,0 \Rightarrow I_S = C V_R + 0$$

$$C = \left.\frac{I_S}{V_R}\right|_{I_R = 0}$$

We get parameter C as the ratio of sending end current to the open circuit receiving end voltage. Since dimension-wise, C is a ratio of current to voltage, and its unit is mho.

Transmission lines are divided into three categories: small transmission lines, medium transmission lines, and long transmission lines, to preserve the precision of the mathematical model. The transmission line's length will affect the formula for these ABCD parameters. This is required because some electrical phenomena only affect long transmission lines, such as corona discharge and the Ferranti effect.

The **ABCD parameters of the transmission line** can be tabulated as:

Parameter	Specification	Unit
$A = V_S / V_R$	Voltage ratio	Unit less
$B = V_S / I_R$	Short circuit resistance	Ω
$C = I_S / V_R$	Open circuit conductance	mho
$D = I_S / I_R$	Current ratio	Unit less

Code part:

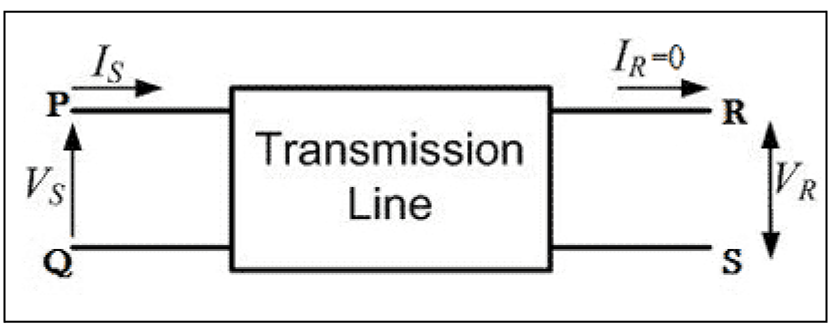
```
O = input('Type (0) for given Parameters/ Type (1) for giving new input parameters: ');
%Here we are checking whether the input is user defined or the one given in
%the ques
if O==0
    % Given parameters
    f = 50; % Frequency (Hz)
    L = 400; % Line length (km)
    V_s = 220e3; % Sending-end voltage (V)
    r = 0.125; % Resistance (Ω/km)
    x = 0.4; % Reactance (Ω/km)
    y = 2.8e-6; % Shunt admittance (℧/km)
else
    % Taking input from the user
    f = input('Enter frequency (Hz): ');
    L = input('Enter line length (km): ');
    V_s = input('Enter sending-end voltage (V): ');
    r = input('Enter resistance (Ω/km): ');
    x = input('Enter reactance (Ω/km): ');
    y = input('Enter shunt admittance (℧/km): ');
end
```

Here, we first check whether the inputs are user-defined or the one given in the question.
After getting the Resistance (r), Reactance (x), and Admittance (y) values, we can calculate the series impedance and shunt admittance.
Series impedance = Z = r + ι*x
Shunt Admittance = ι*y
The shunt admittance is defined using the imaginary unit, denoted by 'iota' (i), because admittance is a complex quantity.

```
disp(' ')
% Line parameters
Z = r + 1i*x; % Series impedance
Y = 1i*y; % Shunt admittance
%Calculate Characteristic impedance
Zc = sqrt(Z/Y);
% Calculate propagation constant
gamma = sqrt(Z*Y);
I_r = 0; % At no Load Conditions

```

Parameters when Receiving end is open-circuited (No load):



Now, we are calculating the Characteristic impedance (Zc) and propagation constant (gamma) in our code.
In no load condition, Receiving end current (Ir) = 0

```
disp('Choice of transmission line')
disp('0: Long')
disp('1: Short')
disp('2: Medium -pi Model')
v = input('Type of Transmission Line:');
```

Here we are taking input from the user about the type of transmission line.

```
if v == 0
    % No-load constants
    A = cosh(gamma*L);
    B = Zc*sinh(gamma*L);
    C = sinh(gamma*L)/Zc;
    D = A;
    disp('Long Transmission Line')
```

For the Long Transmission line, ABCD parameters can be calculated by:

$$A = cosh\delta l$$
$$B = Z_C sinh\delta l$$
$$C = \frac{sinh\delta l}{Z_C}$$
$$D = cosh\delta$$

Where delta is gamma.

```
elseif v == 1
    % Short transmission line constants
    A = 1;
    B = conj(Z)*L;
    C = 0;
    D = A;
    disp('Short Transmission Line')
```

ABCD parameters for the short transmission line.

$$\boxed{A = 1,\ B = Z,\ C = 0,\ D = 1}$$

Here B = Z conjugate

```
else
    % Medium transmission line constants (nominal Π-representation)
    A = 0.5*Z*Y*L*L+1;
    B = Z*L;
    C = Y*L*(1+0.25*Z*Y*L*L);
    D = A;
    disp('Medium Transmission Line Nominal-Π-Model')
```

ABCD parameter for Medium Transmission line :

$$A = (\frac{Y}{2}Z + 1)$$

$$B = Z(\frac{Y}{4}Z + 1)\ \Omega$$

$$C = Y \text{ mho}$$

$$D = (\frac{Y}{2}Z + 1)$$

```
M =[A, B; C, D];
disp(' ');
% Receiving-End Voltage
V_r = (V_s - M(1,2)*I_r) / M(1,1);

%Sending-End Current
I_s = (M(2,1)*V_r + M(2,2)*I_r)/sqrt(3);

disp('ABCD Parameters:');
disp(['A = ', num2str(M(1,1))]);
disp(['B = ', num2str(M(1,2)), 'ohm']);
disp(['C = ', num2str(M(2,1)),'mho']);
disp(['D = ', num2str(M(2,2))]);
disp(' ');

disp('Sending-end Current for No-load:');
disp(['I_s = ', num2str(abs(I_s)), ' ∠', num2str(rad2deg(angle(I_s))), ' degrees A']);
disp(' ');
disp('Receiving-end Voltage for No-load:');
disp(['V_r = ', num2str(abs(V_r)/1e3), ' kV ∠', num2str(rad2deg(angle(V_r))), ' degrees']);
disp(' ');
```

Now, we are making a matrix for the ABCD parameters. The Receiving end voltage and sending end current can be calculated by equations 1 and 2 mentioned above.
Lastly, we convert the required values into phasor form.

Here it is given a 3 phase transmission line , so we are dividing Is by sqrt (3)

Note:
Here in the code we have taken the units of parameters as :

- Frequency - Hz
- Line length - Km
- Sending end Voltage - KV
- Resistance - Ω/Km
- Reactance - Ω/Km
- Admittance - ℧/Km

For other units , first change it into the units mentioned above .

```
>> Group_10_Assi_1
Type (0) for given Parameters/ Type (1) for giving new input parameters: 0

Choice of transmission line
0: Long
1: Short
2: Medium -pi Model
Type of Transmission Line:2
Medium Transmission Line Nominal-Π-Model

ABCD Parameters:
A = 0.9104+0.028i
B = 50+160iohm
C = -1.568e-05+0.0010698imho
D = 0.9104+0.028i

Sending-end Current for No-load:
I_s = 149.205 ∠89.0781 degrees A

Receiving-end Voltage for No-load:
V_r = 241.5378 kV ∠-1.7616 degrees
```

Answers for the medium line transmission with the given input parameters in the question.

```
Enter line length (km): 50
Enter sending-end voltage (V): 220e3
Enter resistance (Ω/km): 0.125
Enter reactance (Ω/km): 0.4
Enter shunt admittance (℧/km): 2.8e-6

Choice of transmission line
0: Long
1: Short
2: Medium -pi Model
Type of Transmission Line:1
Short Transmission Line

ABCD Parameters:
A = 1
B = 6.25-20iohm
C = 0mho
D = 1

Sending-end Current for No-load:
I_s = 0 ∠0 degrees A

Receiving-end Voltage for No-load:
V_r = 220 kV ∠0 degrees
```

Answers for Short Line Transmission line

```
Enter frequency (Hz): 50
Enter line length (km): 500
Enter sending-end voltage (V): 220e3
Enter resistance (Ω/km): 0.125
Enter reactance (Ω/km): 0.4
Enter shunt admittance (Ʊ/km): 2.8e-6

Choice of transmission line
0: Long
1: Short
2: Medium -pi Model
Type of Transmission Line:0
Long Transmission Line

ABCD Parameters:
A = 0.86293+0.041736i
B = 56.7842+191.6701iohm
C = -1.9851e-05+0.0013355imho
D = 0.86293+0.041736i

Sending-end Current for No-load:
I_s = 196.3672 ∠88.0826 degrees A

Receiving-end Voltage for No-load:
V_r = 254.6488 kV ∠-2.769 degrees
```

Answers for Long Transmission lines

Conclusion:

The line parameters provided are per-phase values. The analysis conducted through MATLAB provides insight into the behavior of the transmission line under various assumptions. It allows us to understand the performance characteristics such as sending-end current and receiving-end voltage under different transmission line models. By comparing the results obtained for short, medium, and general transmission line models, we can infer the impact of line parameters on transmission line behavior and performance.