



# SAI RAM INSTITUTE OF TECHNOLOGY

An Autonomous Institution | Affiliated to Anna University & Approved by AICTE, New Delhi

Accredited by NBA and NAAC "A+" | An ISO 9001:2015 Certified and MHRD NIRF ranked institution

Sai Leo Nagar, West Tambaram, Chennai - 600 044. [www.sairamit.edu.in](http://www.sairamit.edu.in)



20EEPL601 SDG NO. 4	POWER SYSTEM SIMULATION LABORTARY	L 0	T 0	P 3	C 1.5
------------------------	--------------------------------------	--------	--------	--------	----------

## LIST OF EXPERIMENTS:

1. Computation of Transmission Line Parameters
2. Formation of Bus Admittance and Impedance Matrices and Solution of Networks
3. Power Flow Analysis using Gauss-Seidel Method.
4. Power Flow Analysis using Newton-Raphson Method
5. Symmetric and unsymmetrical fault analysis
6. Transient stability analysis of SMIB System
7. Economic Dispatch in Power Systems
8. Load – Frequency Dynamics of Single- Area and Two-Area Power Systems
9. State estimation: Weighted least square estimation
10. Electromagnetic Transients in Power Systems : Transmission Line Energization

**TOTAL: 45 PERIODS**

## CONTENT BEYOND THE SYLLABUS

11. Methods of FACTS device
12. MATLAB Program to Solve Swing Equation using Point-by-Point Method



# SAI RAM INSTITUTE OF TECHNOLOGY

An Autonomous Institution | Affiliated to Anna University & Approved by AICTE, New Delhi

Accredited by NBA and NAAC "A+" | An ISO 9001:2015 Certified and MHRD NIRF ranked institution

Sai Leo Nagar, West Tambaram, Chennai - 600 044. [www.sairamit.edu.in](http://www.sairamit.edu.in)



EXP.NO: 1

## COMPUTATION OF TRANSMISSION LINES PARAMETERS

### AIM :

- (i) To determine the positive sequence line parameters L and C per phase per kilometre of a three phase single and double circuit transmission lines for different conductor arrangements.
- (ii) To understand modeling and performance of medium lines.

**SOFTWARE REQUIRED:** MATLAB 8.1 / Mi POWER

### THEORY :

Transmission line has four parameters – resistance, inductance, capacitance and conductance. The inductance and capacitance are due to the effect of magnetic and electric fields around the conductor. The resistance of the conductor is best determined from the manufacturers data, the inductances and capacitances can be evaluated using the formula.

#### (A) INDUCTANCE:

The general formula:

$$L = 0.2 \ln (D_m / D_s)$$

where  $D_m$  = geometric mean distance (GMD)

$D_s$  = geometric mean radius (GMR)

#### I) Single phase 2 wire system

$$GMD = D$$

$$GMR = r e^{-1/4} = r'$$

Where,  $r$  = radius of conductor

#### II) Three phase – symmetrical spacing

$$GMD = D$$



# SAI RAM INSTITUTE OF TECHNOLOGY

An Autonomous Institution | Affiliated to Anna University & Approved by AICTE, New Delhi

Accredited by NBA and NAAC "A+" | An ISO 9001:2015 Certified and MHRD NIRF ranked institution

Sai Leo Nagar, West Tambaram, Chennai - 600 044. [www.sairamit.edu.in](http://www.sairamit.edu.in)



$$GMR = re^{-1/4} = r'$$

Where,  $r$  = radius of conductor

## III.) THREE PHASE – ASYMMETRICAL TRANSPOSED:

GMD = geometric mean of the three distance of the symmetrically placed conductors

$$\text{conductors} = \sqrt[3]{DAB DBC DCA}$$

$$GMR = re^{-1/4} = r'$$

Where,  $r$  = radius of conductors

## IV) COMPOSITE CONDUCTOR LINES:

The inductance of composite conductor X., is given by

$$L_X = 0.2 \ln \left( \frac{\text{GMD}}{\text{GMR}} \right)$$

$$\text{GMD} = \sqrt[mn]{(D_{aa}' D_{ab}') \dots (D_{na}' \dots D_{nm}')}$$

$$\text{GMR} = \sqrt{n^2} \sqrt{(D_{aa} D_{ab} \dots D_{an}) \dots (D_{na} D_{nb} \dots D_{nn})}$$

$$\text{where, } r'_a = r_a e^{(-1/4)}$$

## V) BUNDLE CONDUCTORS:

The GMR of bundle conductor is normally calculated

$$\text{GMR for two sub conductor } c = (D_s * d)^{1/2}$$

$$\text{GMR for three sub conductor } D_s^b = (D_s * d^2)^{1/3}$$

$$\text{GMR for four sub conductor } D_s^b = 1.09 (D_s * d^3)^{1/4}$$

where,  $D_s$  is the GMR of each sub conductor and  $d$  is bundle spacing

## Three phase – Double circuit transposed:

The inductance per phase in milli henries per km is

$$L = 0.2 \ln \left( \frac{\text{GMD}}{\text{GMRL}} \right) \text{ mH/km}$$

where



# SRI SAI RAM INSTITUTE OF TECHNOLOGY

An Autonomous Institution | Affiliated to Anna University & Approved by AICTE, New Delhi

Accredited by NBA and NAAC "A+" | An ISO 9001:2015 Certified and MHRD NIRF ranked institution

Sai Leo Nagar, West Tambaram, Chennai - 600 044. [www.sairamit.edu.in](http://www.sairamit.edu.in)



GMRL is equivalent geometric mean radius and is given by

$$GMRL = (DSA \cdot DSB \cdot DSC)^{1/3}$$

DSA, DSB and DSC are GMR of each phase group and given by

$$DSA = \sqrt[4]{(Ds^b \cdot Da_1a_2)^2} = \sqrt{[Ds^b \cdot Da_1a_2]}^{1/2}$$

$$DSB = \sqrt[4]{(Ds^b \cdot Db_1b_2)^2} = \sqrt{[Ds^b \cdot Db_1b_2]}^{1/2}$$

$$DSC = \sqrt[4]{(Ds^b \cdot Dc_1c_2)^2} = \sqrt{[Ds^b \cdot Dc_1c_2]}^{1/2}$$

$Ds^b$  = GMR of bundle conductor if conductor  $a_1, a_2, \dots$  are bundle conductors

$Ds^b = r_{a1} = r_{b1} = r_{a'2} = r_{b'2} = r_{c'2}$  if  $a_1, a_2, \dots$  are bundle conductor

GMD is the equivalent GMD per phase" & is given by

$$GMD = [DAB * DBC * DCA]^{1/3}$$

DAB, DBC & DCA are GMD between each phase group A-B, B-C, C-A

Which are given by

$$DAB = [Da_1b_1 * Da_1b_2 * Da_2b_1 * Da_2b_2]^{1/4}$$

$$DBC = [Db_1c_1 * Db_1c_2 * Db_2c_1 * Db_2c_2]^{1/4}$$

$$DCA = [Dc_1a_1 * Dc_2a_1 * Dc_2a_1 * Dc_2a_2]^{1/4}$$

## (B)CAPACITANCE

A general formula for evaluating capacitance per phase in micro farad per km of a transmission line is given by

$$C = 0.0556 / \ln(GMD/GMR) \text{ F/km}$$

GMD is the "Geometric mean distance" which is same as that defined for inductance under various cases

## PROCEDURE :

1. Enter the command window of the MATLAB.



# SRI SAI RAM INSTITUTE OF TECHNOLOGY

An Autonomous Institution | Affiliated to Anna University & Approved by AICTE, New Delhi

Accredited by NBA and NAAC "A+" | An ISO 9001:2015 Certified and MHRD NIRF ranked institution

Sai Leo Nagar, West Tambaram, Chennai - 600 044. [www.sairamit.edu.in](http://www.sairamit.edu.in)



2. Create a new M – file by selecting File - New – M – File
3. Type and save the program.
4. Execute the program by either pressing Tools – Run.
5. View the results.

## Exercise:

1. A three phase overhead line 200km long  $R = 0.16 \text{ ohm/km}$  and Conductor diameter of 2cm with spacing 4,5,6m transposed. Find A,B,C,D constants ,sending end voltage,current ,power factor and power when the line is delivering full load of 50MW at 132kV ,0.8 pf lagging , transmission efficiency , receiving end voltage and regulation.

## PROGRAM :

```
ab=input('value of ab');
bc=input('value of bc');
ca=input('value of ca');
pr=input('receiving end power in mw');
vr=input('receiving end voltage in kv');
pfr=input('receiving end powerfactor');
l=input('length of the line in km');
r=input('resistance/ph/km');
f=input('frequency');
D=input('diameter in m');
rad=D/2;
newrad=(0.7788*rad);
deq=(ab*bc*ca)^(1/3);
L=2*10^(-7)*log(deq/newrad);
c=(2*pi*8.854*10^-12)/log(deq/rad);
XL=2*pi*f*L*l*1000;
rnew=r*l;
Z=rnew+i*(XL);
Y=i*(2*pi*f*C*l*1000);
A=1+((Y*Z)/2);
D=A;
```



# SRI SAI RAM INSTITUTE OF TECHNOLOGY

An Autonomous Institution | Affiliated to Anna University & Approved by AICTE, New Delhi

Accredited by NBA and NAAC "A+" | An ISO 9001:2015 Certified and MHRD NIRF ranked institution

Sai Leo Nagar, West Tambaram, Chennai - 600 044. [www.sairamit.edu.in](http://www.sairamit.edu.in)



B=Z;

C=Y\*(1+(Y\*Z)/4);

vrph=(vr\*10^3)/1.732;

irold=(pr\*10^6)/(1.732\*vr\*10^3\*.8);

k=sin(acos(pfr));

ir=irold\*(pfr-(j\*k));

vs=((A\*vrph)+(B\*ir));

is=((C\*vrph)+(D\*ir)); angle(vs);

angle(is);

f=angle(vs);

u=angle(is);

PFS=cos(f-u);

eff=((pr\*10^6)/(3\*abs(vs)\*abs(is)\*PFS))\*100;

reg(((abs(vs)/abs(A))-abs(vrph))/abs(vrph))\*100;

L

c

rnew

A

B

C

abs(vs)

abs(is)

angle(vs)\*180/pi

angle(is)\*180/pi

PFS

eff

reg

## RESULT :

Thus the positive sequence line parameters L and C per phase per kM, of a transmission line for different conductor arrangement was determined. Thus the modeling and performance of transmission line was understood.