DRONACHARYA
Group of Institutions

POWER SYSTEM

LABORATORY MANUAL

B.Tech. Semester

Subject Code: BEE-551

Session: 2024-25, Odd Semester

Name:	
Roll. No.:	
Group/Branch:	

DRONACHARYA GROUP OF INSTITUTIONS
DEPARTMENT OF EEE
#27 KNOWLEDGE PARK 3

GREATER NOIDA

AFFILATED TO Dr. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW

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Vision and Mission of the Institute

Vision:

Instilling core human values and facilitating competence to address global challenges by providing Quality Technical Education.

Mission

- M1 - Enhancing technical expertise through innovative research and education, fostering creativity and excellence in problem-solving.
- M2 - Cultivating a culture of ethical innovation and user-focused design, ensuring technological progress enhances the well-being of society.
- M3 - Equipping individuals with the technical skills and ethical values to lead and innovate responsibly in an ever-evolving digital landscape.

Vision and Mission of the Department

Vision

- To be a Centre of Excellence in Globalizing Education and Research in the field of Electrical and Electronics Engineering.

Mission

- M1: To empower technocrats with state-of-art knowledge to excel as eminent electrical engineers with multi-disciplinary skills.
- M2: To emphasize social values and leadership qualities to meet the industrial needs, societal problems and global challenges.
- M3: To enable the technocrats to accomplish impactful research and innovations.

Programme Educational Objectives (PEOs)

- **PEO1:** To foster strong knowledge in basic sciences and electrical engineering that enable technocrats to have successful careers.
- **PEO2:** Imbibed with the state of art knowledge to adapt ever transforming technical scenario.
- **PEO3:** Inspire engineers to provide innovative solutions to real-world challenging problems by applying electrical and electronics engineering principles.

Programme Outcomes (POs)

Engineering Graduates will be able to:

- **PO1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- **PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

- **PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

- PSO1: Graduates will be capable to gain knowledge in diverse areas of electrical and electronics engineering and apply that to a successful career, entrepreneurship and higher education.
- PSO2: Enhance the competence of graduates to design and analyze systems used in advanced power applications, renewable energy, electrical drives in allied technical fields.
- PSO3. Graduate will use advance tools to analyze, design and develop electrical and electronic systems for feasible operation and meet the industry requirements.

University Syllabus

1. Calculate the parameters of single-phase transmission line
2. Calculate the parameters of three phase single circuit transmission line
3. Calculate the parameters of three phase double circuit transmission line
4. Determine the ABCD constant for transmission line.
5. Simulate the Ferranti effect in transmission line
6. Calculate the corona loss of transmission line
7. Calculation of sag & tension of transmission line
8. Calculation of string efficiency of insulator of transmission line
9. Calculation for grading of underground cables
10. Simulate the skin effect in the transmission line
11. Calculation of ground clearance of transmission line
12. Calculate the parameters for underground cable.
13. Simulation of small PV generation and finding their characteristics.
14. Simulation of small wind generation and finding their characteristics

Course Outcomes (COs)

Upon successful completion of the course, the students will be able to:

CO 1	Use programming tools /Software: Scilab, MATLAB or any C, C++ -Compiler and formulate a program/simulation model for calculation of various parameters related to transmission line.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	1	-	-	-	1	2	-	2
CO 2	3	2	-	-	2	-	-	-	1	2	-	2
CO 3	2	2	2	2	-	-	-	-	1	1	-	1
CO 4	2	-	2	2	2	-	-	-	1	1	-	1
CO 5	1	2	3	2	2	-	-	-	1	1	-	2
Course Correlation mapping	**2.2**	1.2	**1.4**	1.2	**1.4**	-	-	**-**	**1**	**1.4**	**-**	**1.6**

Correlation Levels: High-3, Medium-2, Low-1

CO-PSO Mapping

	PSO1	PSO2	PSO3
CO 1	2	3	1
CO 2	2	3	1
CO 3	2	3	1
CO 4	2	3	1
CO 5	2	3	1

Course Overview

To analyze the performance of power system networks by conducting various experiments. To study different power system protective equipment by conducting suitable experiments. To develop computer programs for analysis of power .

List of Experiments mapped with COs

S. No.	Name of the Experiment	Course Outcome
1	Determination of ABCD parameters of a 400 kV, 300 km transmission line	CO 1
2	To study and compare the performance of a ring and radial distribution systems	CO 1
3	Determination of power angle characteristics of a transmission line	CO 2
4	Improvement of voltage profile at a load bus using a shunt capacitor	CO 2
5	To verify the Ferranti effect in a transmission line	CO 3
6	Study of Surge Impedance Loading of a transmission Line	CO 2
7	To draw the P V characteristics of a transmission line	CO 4
8	To study the characteristics of a series compensated transmission line	CO 2
9	To study operation of oil testing set.	CO 4
10	To obtain formation of Y-bus and perform load flow analysis	CO 3

DOs and DON'Ts

DOs

1. Login-on with your username and password.
2. Log off the computer every time when you leave the Lab.
3. Arrange your chair properly when you are leaving the lab.
4. Put your bags in the designated area.
5. Ask permission to print.

DON'Ts

1. Do not share your username and password.
2. Do not remove or disconnect cables or hardware parts.
3. Do not personalize the computer setting.
4. Do not run programs that continue to execute after you log off.
5. Do not download or install any programs, games or music on computer in Lab.
6. Personal Internet use chat room for Instant Messaging (IM) and Sites is strictly prohibited.
7. No Internet gaming activities allowed.
8. Tea, Coffee, Water & Eatables are not allowed in the Computer Lab.

General Safety Precautions

Precautions (In case of Injury or Electric Shock)

1. To break the victim with live electric source, use an insulator such as fire wood or plastic to break the contact. Do not touch the victim with bare hands to avoid the risk of electrifying yourself.
2. Unplug the risk of faulty equipment. If main circuit breaker is accessible, turn the circuit off.
3. If the victim is unconscious, start resuscitation immediately, use your hands to press the chest in and out to continue breathing function. Use mouth-to-mouth resuscitation if necessary.
4. Immediately call medical emergency and security. Remember! Time is critical; be best.

Precautions (In case of Fire)

1. Turn the equipment off. If power switch is not immediately accessible, take plug off.
2. If fire continues, try to curb the fire, if possible, by using the fire extinguisher or by covering it with a heavy cloth if possible isolate the burning equipment from the other surrounding equipment.
3. Sound the fire alarm by activating the nearest alarm switch located in the hallway.
4. Call security and emergency department immediately:

Emergency : 201 (Reception)

Security : 231 (Gate No.1)

Guidelines to students for report preparation

All students are required to maintain a record of the experiments conducted by them. Guidelines for its preparation are as follows: -

1) All files must contain a title page followed by an index page. ***The files will not be signed by the faculty without an entry in the index page.***

2) Student's Name, Roll number and date of conduction of experiment must be written on all pages.

3) For each experiment, the record must contain the following

(i) Aim/Objective of the experiment
(ii) Pre-experiment work (as given by the faculty)
(iii) Lab assignment questions and their solutions
(iv) Test Cases (if applicable to the course)
(v) Results/ output

Note:

1. Students must bring their lab record along with them whenever they come for the lab.

2. Students must ensure that their lab record is regularly evaluated.

Lab Assessment Criteria

An estimated 10 lab classes are conducted in a semester for each lab course. These lab classes are assessed continuously. Each lab experiment is evaluated based on 5 assessment criteria as shown in following table. Assessed performance in each experiment is used to compute CO attainment as well as internal marks in the lab course.

Grading Criteria	Exemplary (4)	Competent (3)	Needs Improvement (2)	Poor (1)
AC1: Designing experiments	The student chooses the problems to explore.	The student chooses the problems but does not set an appropriate goal for how to explore them.	The student fails to define the problem adequately.	The student does not identify the problem.
AC2: Collecting data through observation and/or experimentation	Develops a clear procedure for investigating the problem	Observations are completed with necessary theoretical calculations and proper identification of required components.	Observations are completed with necessary theoretical calculations but without proper understanding. Obtain the correct values for only a few components after calculations. Followed the given experimental procedures but obtained results with some errors.	Observations are incomplete. Lacks the appropriate knowledge of the lab procedures.
AC3: Interpreting data	Decides what data and observations are to be collected and verified	Can decide what data and observations are to be collected but lacks the knowledge to verify	Student decides what data to gather but not sufficient	Student has no knowledge of what data and observations are to be collected
AC4: Drawing conclusions	Interprets and analyses the data in order to propose viable conclusions and solutions	Incomplete analysis of data hence the quality of conclusions drawn is not up to the mark	Cannot analyse the data or observations for any kind of conclusions.	Lacks the required knowledge to propose viable conclusions and solutions
AC5: Lab record assessment	Well-organized and confident presentation of record & ability to correlate the theoretical concepts with the concerned lab results with appropriate reasons.	Presentation of record is acceptable	Presentation of record lacks clarity and organization	No efforts were exhibited

LAB EXPERIMENTS

Experiment 1

AIM Determination of ABCD parameters of a 400 kV, 300 km transmission line.

SIMULINK BLOCKS REQUIRED:

1. AC voltage source single phase-50 Hz, 326.598 kV peak
2. Series RL element (R=1.85 Ohms, L=0.0486735H)-6 Nos.
3. Capacitors (C=0.2996 μF)-12 Nos.
4. RMS block-3Nos.
5. Display block-3Nos.
6. Voltage and current measurement blocks
7. Powergui

Note: Line considered is a 400 kV, 300 km transmission line. Each pi section represents a length of 50 km. Six such pi sections are cascaded to represent a physical line length of 300 km.

CIRCUIT DIAGRAM:

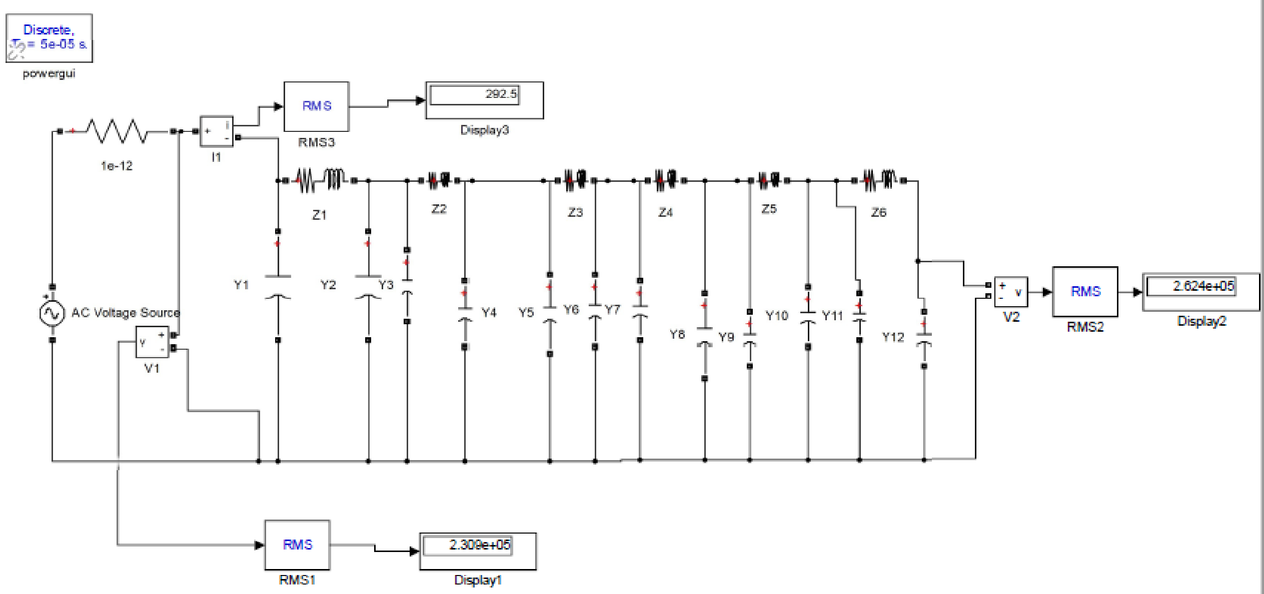


Fig.1 Open circuit

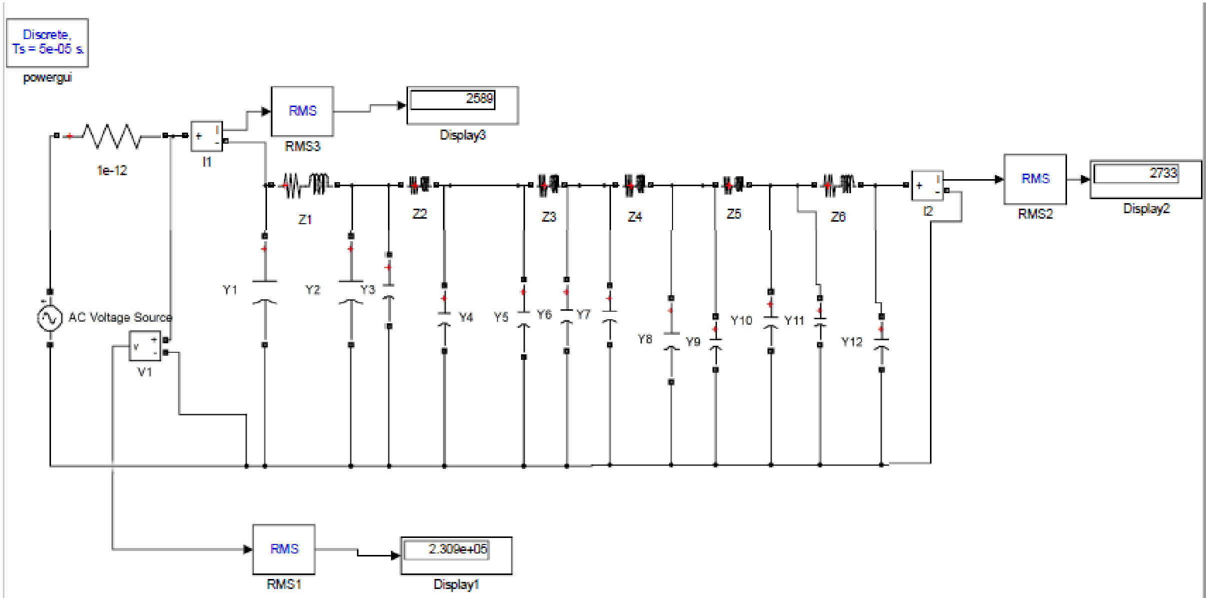


Fig.2 Short Circuit

PROCEDURE:

Short Circuit

1. In Simulink, build the circuit as shown in Fig1. Make sure that in the RMS block, the fundamental frequency is set to 50 HZ, initial RMS value is set to 0, and sampling time is same as that used in the 'powergui' block.
2. Run the simulation and measure the sending end current and voltage, and the receiving end voltage.

Open circuit:

1. In Simulink, build the circuit as shown in Fig1. Make sure that in the RMS block, the fundamental frequency is set to 50 HZ, initial RMS value is set to 0, and sampling time is same as that used in the 'powergui' block.
2. **Run the simulation and measure the sending and receiving end currents and the sending end current.**
3. Repeat same by interchanging the secondary end & receiving end.

<u>OBSERVATION TABLE:</u>

	SENDING END		RECEVING END	
	V_s (V)	I_s (A)	V_s (V)	I_s (A)
OPEN				
SHORT				

CALCULATION

$$A = \left.\frac{V_S}{V_R}\right|_{I_R=0} \quad B = \left.\frac{V_S}{I_R}\right|_{V_R=0} \quad C = \left.\frac{I_S}{V_R}\right|_{I_R=0} \quad D = \left.\frac{I_S}{I_R}\right|_{V_R=0}$$

RESULT- ABCD Parameters of transmission line has been calculated.

Experiment -2

AIM: To study and compare the performance of a ring and radial distribution systems.

SIMULINK BLOCKS REQUIRED:

1. Single phase 325.27 V peak, 50 Hz AC power supply
2. RL element representing distribution lines (Z1=Z3=0.5+j0.26 Ohms, Z2=0.25+j0.13 Ohms)
3. R element representing loads (R=50 Ohms)
4. Voltage and Current measurement blocks
5. RMS block
6. Display block
7. Powergui

CIRCUIT DIAGRAM

Model of 500 m long feeder is divided into three sections of 200m, 100m, and 200m. Feeder is designed for a maximum load of 12A.

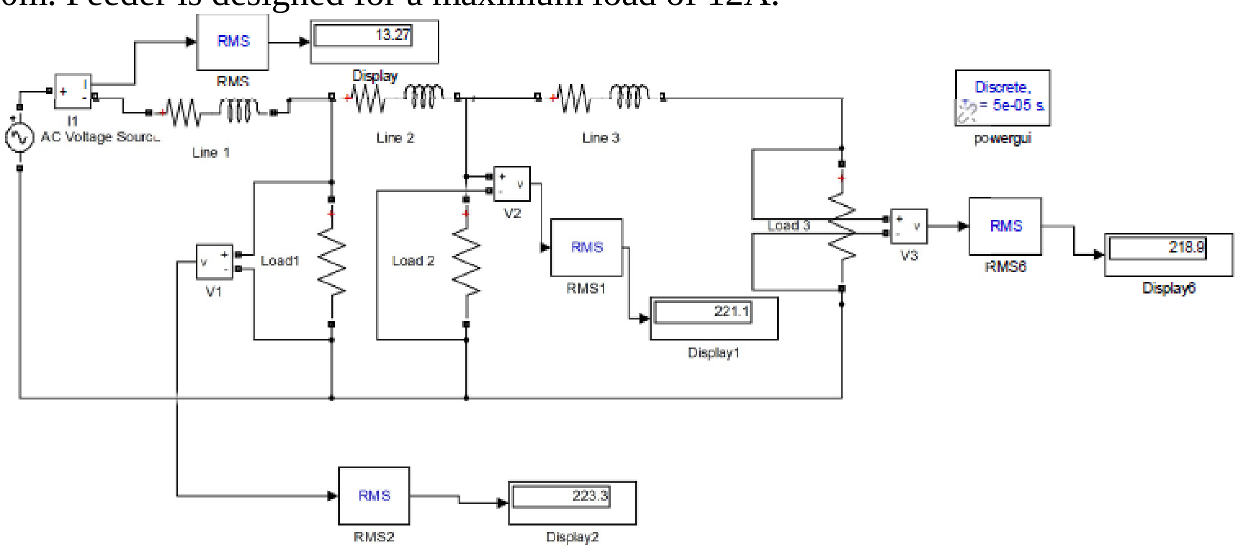


Fig.1 Radial Distribution system

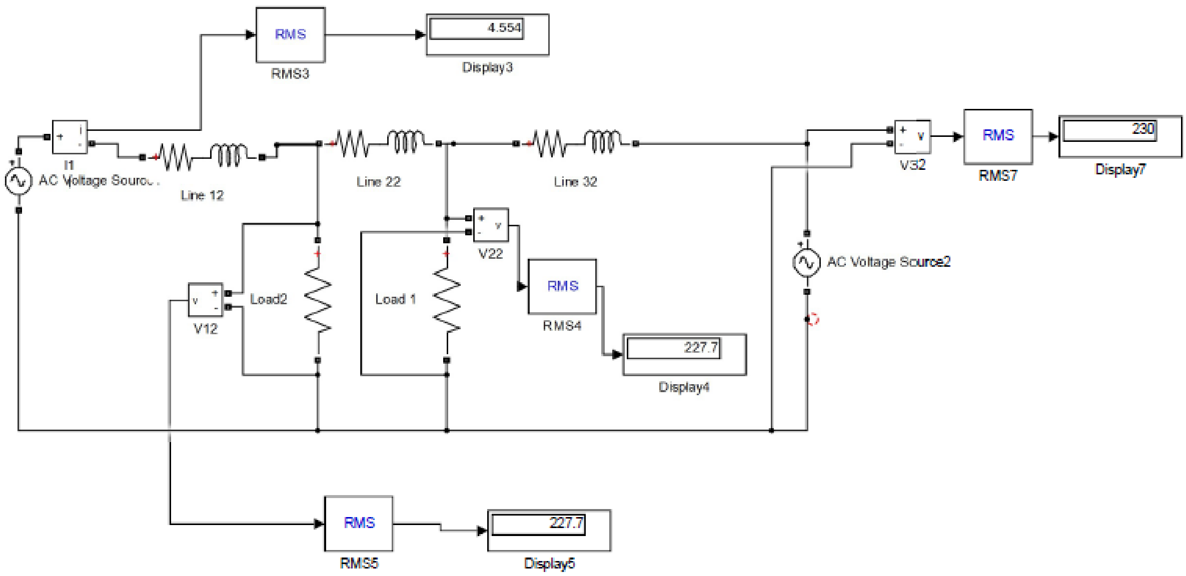


Fig. 2 Ring main distribution system

PROCEDURE:

Radial System

1. Build the SIMULINK model as shown in the figure 1.
2. Make sure that in the RMS block, the fundamental frequency is set to 50 HZ, initial RMS value is set to 0, and sampling time is same as that used in the 'powergui' block.
3. Run the simulation model. Note down the readings of the ammeter (input side) and the three voltages.

Ring Mains System

1. Build the SIMULINK model as shown in the figure 2.
2. Make sure that in the RMS block, the fundamental frequency is set to 50 HZ, initial RMS value is set to 0, and sampling time is same as that used in the 'powergui' block.
3. Run the simulation model. Note down the readings of the ammeter and the three voltages.

OBSERVATION TABLE:

For radial type AC distribution system:

S.No.	Vs (V)	Is (A)	Va (V)	% Voltage Drop	Vb (V)	% Voltage Drop	Vc (V)	% Voltage Drop

For ring type AC distribution system:

S.No.	Vs (V)	Is (A)	Va (V)	Vb (V)	% Voltage Drop

RESULT:

Experiment 3

AIM Determination of power angle characteristics of a transmission line.

SIMULINK BLOCKS REQUIRED

1. Series RL element (R=2.96 Ohms, L=77.8776 mH) representing a short transmission line of 400 kV, 80 km-1No.
2. Controlled voltage sources -2Nos.
3. Sine Wave function (Set 50 Hz, single phase, 326.598 kV peak rating)-2Nos.
4. Current and voltage measurement blocks
5. Power measurement blocks
6. Displays
7. RMS calculation block
8. Powergui

CIRCUIT DIAGRAM

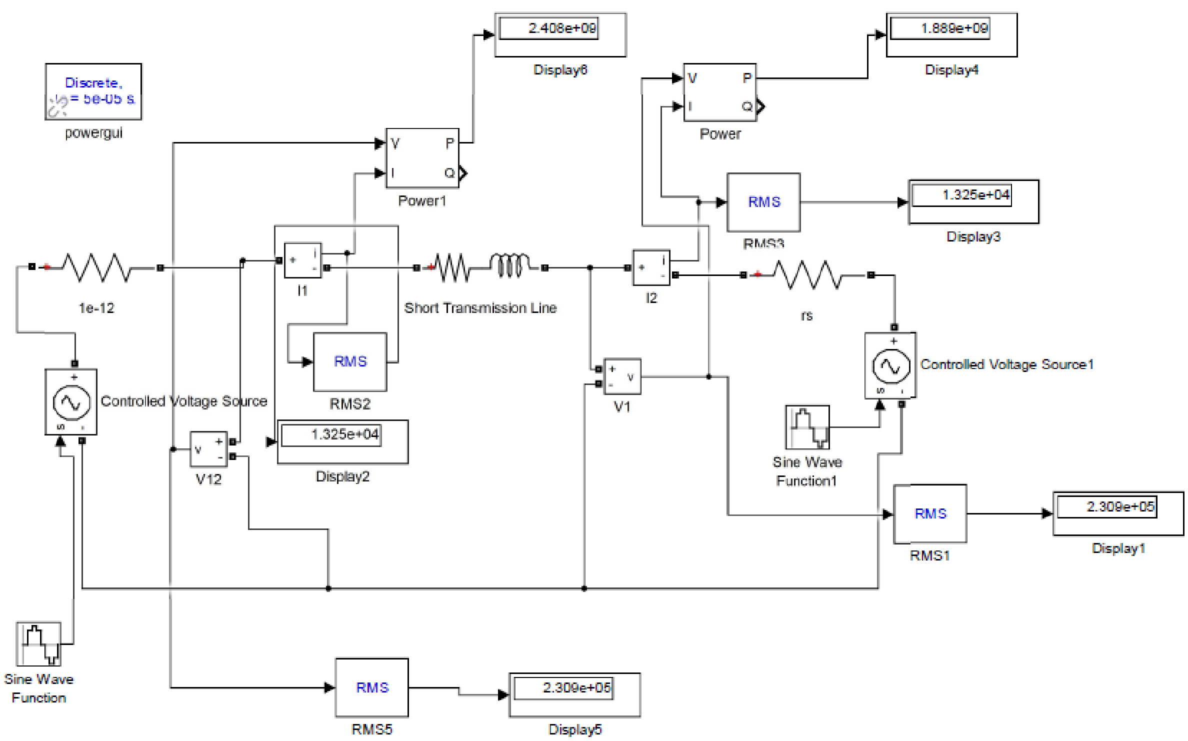


Fig: **Circuit Diagram of Power Angle Characteristics**

PROCEDURE:

1. Build the SIMULINK model according to the diagram.
2. Set the sending end (V_s) and receiving end (V_r) voltages at 326.598 kilovolts (constant) peak.
3. Now start varying the phase angle (δ) of the sending end voltage (V_s) (change in the sine wave function) in the steps of 10^0 and note the readings of power blocks and current measurement blocks after running the model.
4. Vary the phase angle of the sending end voltage (change in the sine wave function) once in leading direction from $0\text{-}70^0$, and then in lagging direction for same range to see the change in direction of power flow from sending end to receiving end and vice versa.
5. Tabulate the reading & draw the power angle characteristic (P Vs δ).

OBSERVATION TABLE:

(i) Sending end voltage (lagging) receiving end voltage

S.NO	δ (DEG.)	I_S	W_S
1.	0		
2.	10		
3.	20		
4.	30		
5.	40		
6.	50		
7.	60		
8.	70		

(ii) Sending end voltage (Leading) Receiving end Voltage

S.NO	δ (DEG.)	I_r	W_r
1.	0		
2.	10		
3.	20		
4.	30		
5.	40		

RESULT:

Plotted the curve between power and Power Angle.

Experiment 4

AIM Improvement of voltage profile at a load bus using a shunt capacitor.

SIMULINK BLOCKS REQUIRED

1. AC voltage source, single phase, 50 Hz
2. Pi section transmission line (R=0.037 Ohms/km, L=0.97347 mH/km, C=11.984 nF/km, total length= 300 km, 6 sections of 50 km each, rated line to line voltage is 400 kV, per phase rating is 230.94 kV)
3. R element representing a load (R=114 Ohms)-1 No.
4. C element for a shunt capacitor- 1No. (C=22.223 μF)
5. Single phase breaker-1No
6. Breaker control block-1No
7. Voltage and current measurement blocks
8. RMS calculation blocks
9. Display block
10. Powergui block

CIRCUIT DIAGRAM

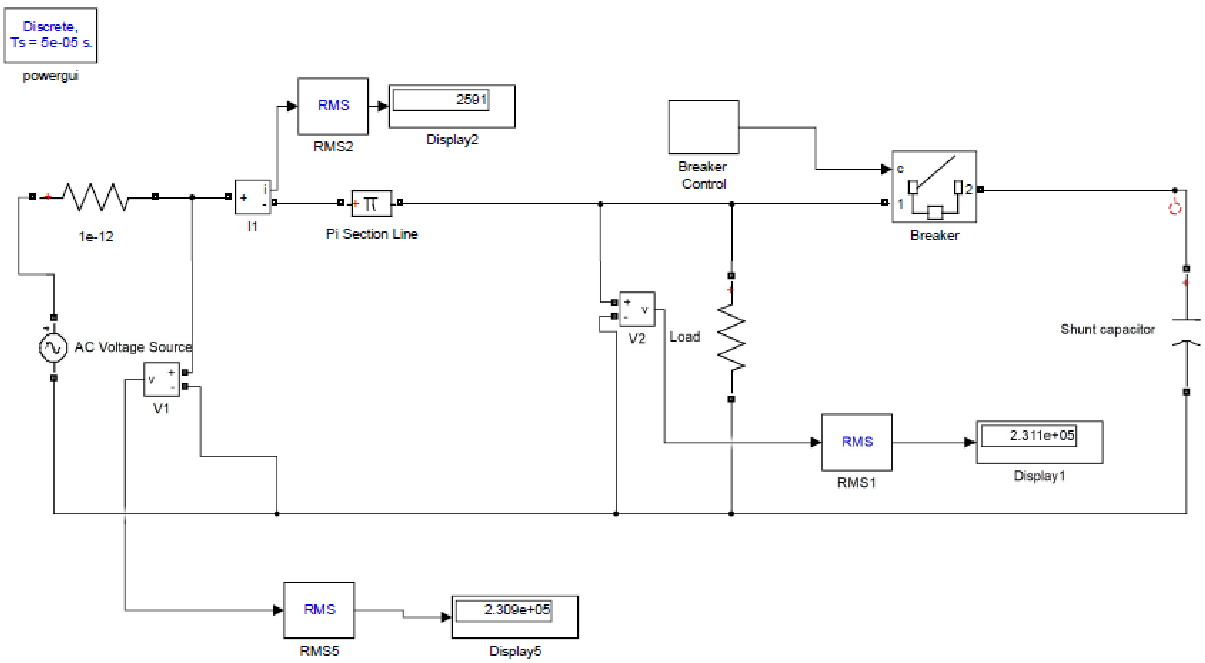


Fig. Circuit diagram

PROCEDURE

1. Build a SIMULINK model as shown in Circuit diagram.
2. Set the value of the ac voltage source to 326.598 kV peak & note down the input and output voltage. The load resistance is taken as 114 Ohms. Take the compensating shunt capacitor value to be 22.223 µF.
3. After about 4 seconds of simulation run time, the breaker will close contacts connecting the shunt capacitance.
4. Note down change in output voltage.
5. Repeat same for other value of voltages.
6. Calculate the Voltage regulation of line with Capacitor and without capacitor.

OBSERVATION TABLE:

S.No.	Vs	Without Capacitor		With Capacitor	
		I_L	V_R	I_L	V_R

RESULT

Voltage profile of transmission line with and without shunt capacitor has been plotted.

Experiment 5

AIM To verify the Ferranti effect in a transmission line.

SIMULINK BLOCKS REQUIRED-

1. AC Voltage source, single-phase, 50 Hz, 326.598 kV peak
2. Series RL element (R=1.85 Ohms, L=0.0486735H)-6 Nos.
3. Capacitors (C=0.2996 µF)-12 Nos.
4. Voltage measurement blocks
5. RMS Calculator block
6. Displays
7. Powergui

Note: We have considered a 400 kV, 300 km transmission line. Each pi section represents a 50 km length. Six such pi sections are cascaded to represent a physical line length of 300 km.

CIRCUIT DIAGRAM

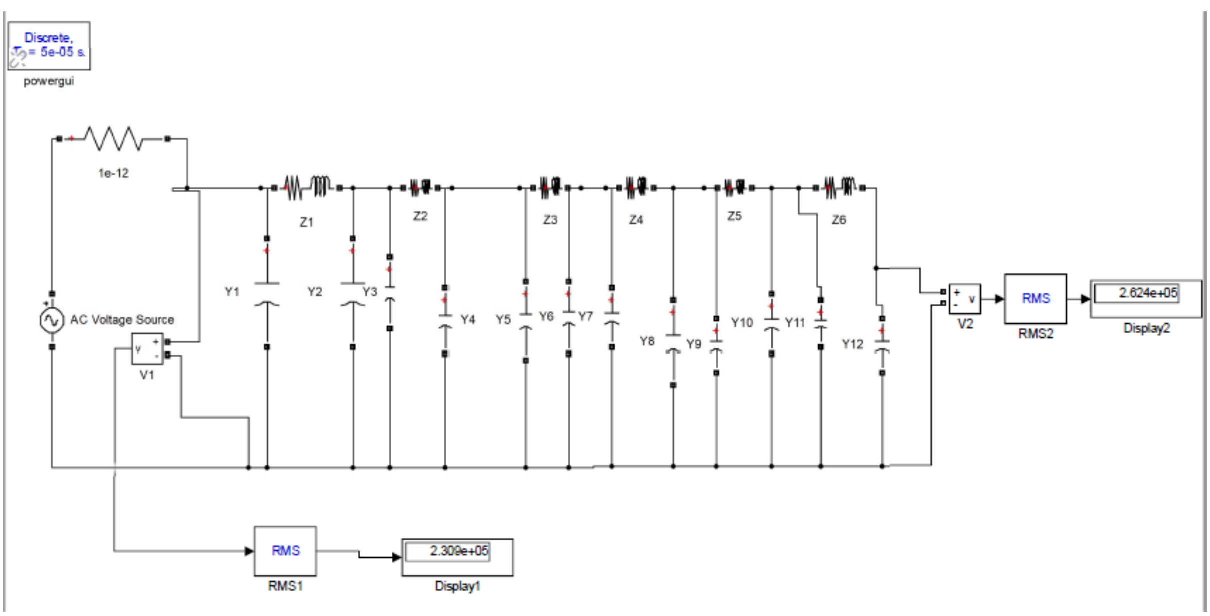


Fig. Circuit diagram

PROCEDURE

1. Build a SIMULINK model as shown in the circuit diagram.
2. Set a voltage in the AC source.
3. Run the simulation and note down the input and output voltage.
4. Measure voltages at the end of different pi sections of the line (to represent voltages at different points in the line).
5. Draw the graph between V_R and distance.
6. Repeat same for other values of voltages.

OBSERVATION TABLE

S.NO.	STEP/DISTANCE	SENDING END VOLTAGE(V_S)	RECEIVING END VOLTAGE(V_R)
1.			
2.			
3.			

RESULT: Ferranti effect has been plotted and observed the graph between receiving end voltage and distance.

Experiment 6

AIM Study of Surge Impedance Loading of a transmission Line

SIMULINK BLOCKS REQUIRED

1. AC voltage source, 1 phase, 50 Hz, 326.598 kV peak
2. Current, power and voltage measurement blocks
3. RMS calculation blocks
4. Display units
5. Pi section transmission line (R=0.037 Ohms/km, L=0.97347 mH/km, C=0.11984 nF/km, total length=300 km, 6 sections of 50 km each, rated line to line voltage is 400 kV, per phase rating is 230.94 kV)
6. R element representing a purely resistive load
7. Powergui block

CIRCUIT DIAGRAM

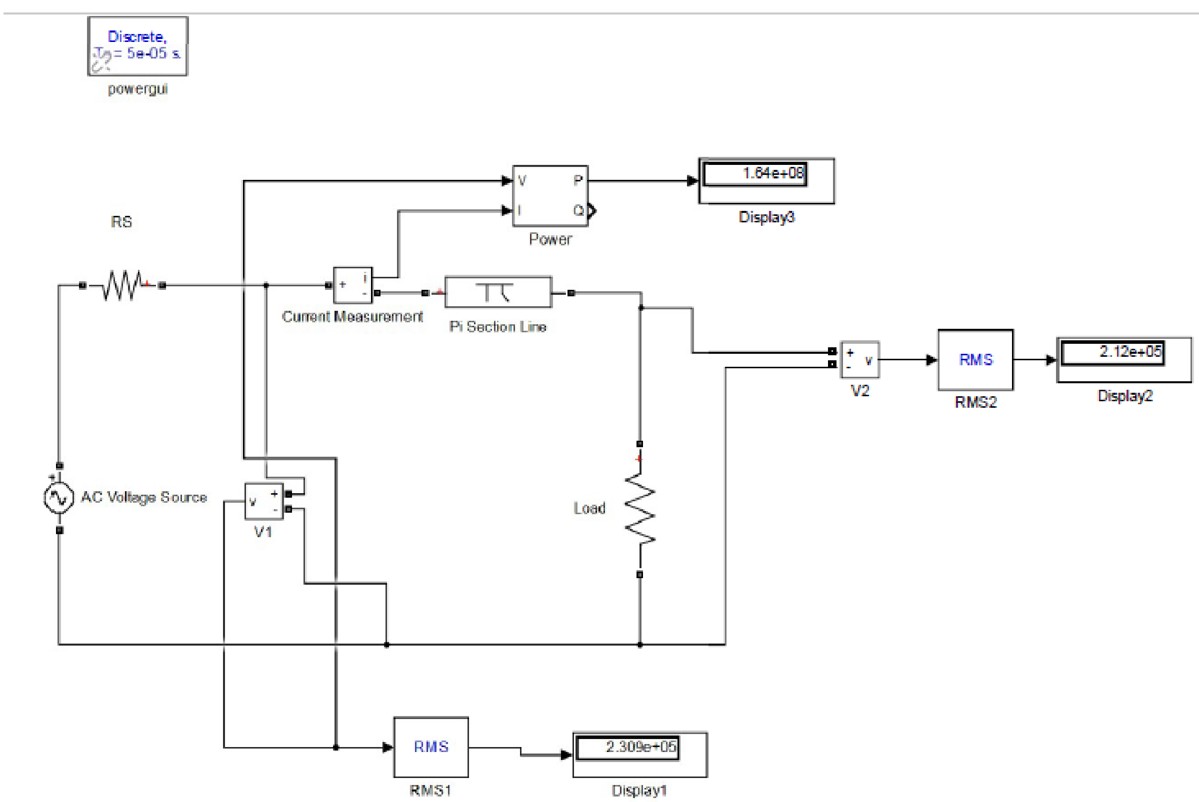


Fig.1 Finding the surge impedance loading

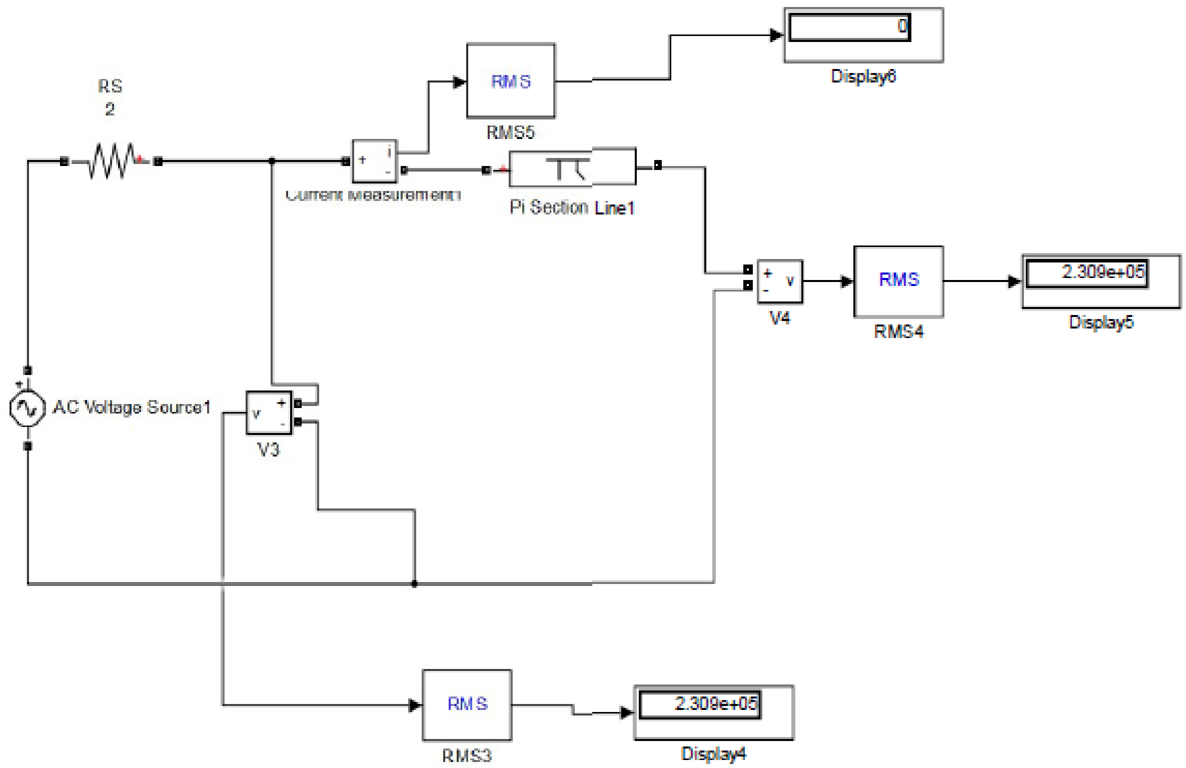


Fig.2 Open circuit measurements

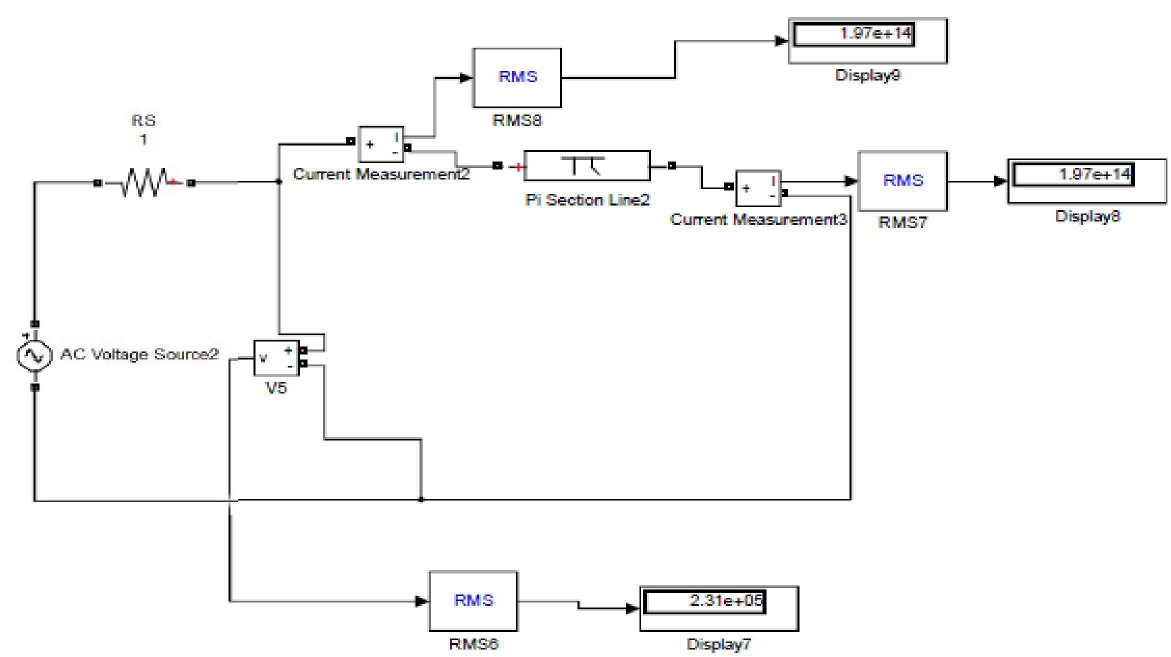


Fig.3 Short circuit measurements

PROCEDURE

1. Build the SIMULINK model as shown in Fig.1.
2. Set the voltage of sending end (in the AC voltage source) to required level, i.e., 326.598 kV peak.
3. Run the simulation by applying load. In different simulation runs, keep on changing the load in suitable steps until the KW of the sending end increases to a certain limit, remains constant and then decreases.
4. Note down the value of maximum KW rating or loading. This value gives the SIL of the line.
5. Remove the load.
6. Build the SIMULINK model given in Fig.2. Note the receiving end is open circuited using a voltage measurement block. To find SIL, run the simulation and note down sending end voltage (Voc) and current (Ioc).
7. Build the SIMULINK model given in Fig.3. Note the receiving end is short circuited using a current measurement block. Run the simulation and note down sending end voltage (Vsc) and current (Isc).
8. Find impedance in open circuit and short circuit condition.

CALCULATION

$Zoc = Voc/Ioc$; $Zsc = Vsc/Isc$

Find core or natural impedance, Zc or $Zn = \sqrt{ZocZsc}$

Surge impedance loading, $P = V^2/Z_c$ in kW

OBSERVATION TABLE-

S.No	V_S	V_R	LOAD POWER

	SENDING END		RECEVING END	
	V_s (V)	I_s (A)	V_s (V)	I_s (A)
OPEN				
SHORT				

RESLULT:

Surge impedance of line =

Surge impedance loading of line =

Experiment 7

AIM To draw the P V characteristics of a transmission line.

SIMULINK BLOCKS REQUIRED

1. AC voltage source, 1 phase, 50 Hz, 326.598 kV peak
2. Current, power and voltage measurement blocks
3. RMS calculation blocks
4. Display units
5. Pi section transmission line (R=0.037 Ohms/km, L=0.97347 mH/km, C=0.11984 nF/km, total length=300 kms, 6 sections of 50 km each, rated line to line voltage is 400 kV, per phase rating is 230.94 kV)
6. R element representing a purely resistive load
7. Powergui block

CIRCUIT DIAGRAM

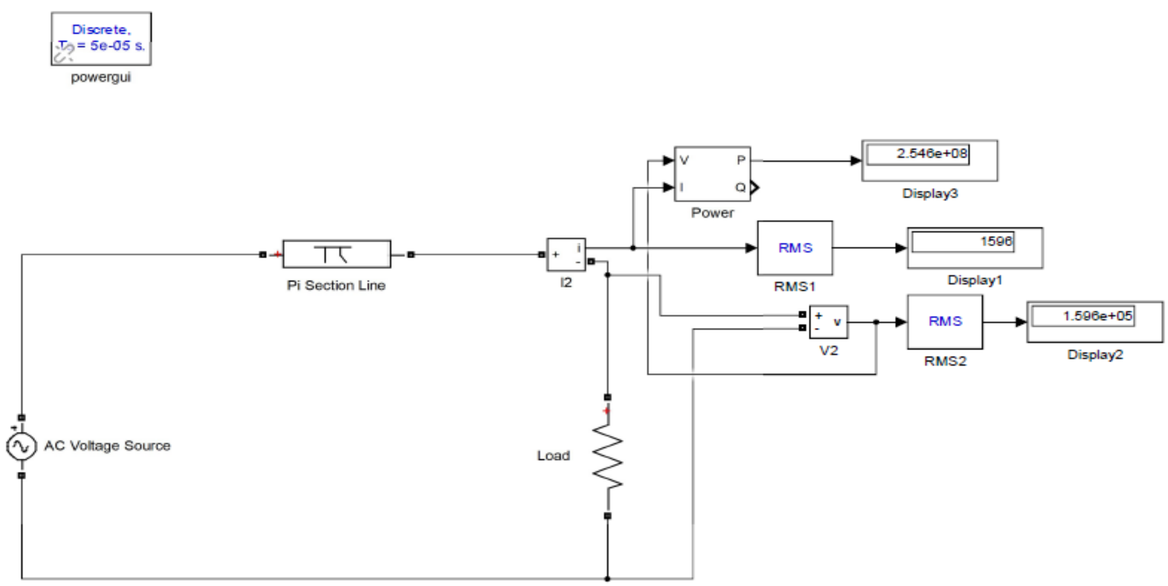


Fig. Circuit connection

PROCEDURE

1. Build a SIMULINK model as per Circuit diagram.
2. Set the load resistance to 100 Ohms.
3. Adjust the input voltage to 326.598 kV peak and run the simulation.
4. Note the readings in table.
5. Now decrease the load resistance and note the readings.
6. Continue taking readings by decreasing resistance till you get the critical point and voltage drops beyond critical value.
7.Plot graph between power and voltage.

OBSERVATION TABLE

S.NO	POWER (P)	LOAD(V_L)	CURRENT(I)
1.			
2.			
3.			
4.			
5.			

RESULT: Power angle characteristics of a transmission line is plotted.

Experiment 8

AIM To study the characteristics of a series compensated transmission line.

SIMULINK BLOCKS REQUIRED-

1. AC voltage source, 1 phase, 50 Hz, 326.598 kV peak
2. Current, power and voltage measurement blocks
3. RMS calculation blocks
4. Display units
5. Pi section transmission line (R=0.037 Ohms/km, L=0.97347 mH/km, C=0.11984 nF/km, total length=300 kms, 6 sections of 50 km each, rated line to line voltage is 400 kV, per phase rating is 230.94 kV)
6. R element representing a purely resistive load
7. C element representing the series capacitor
8. Powergui block

CIRCUIT DIAGRAM

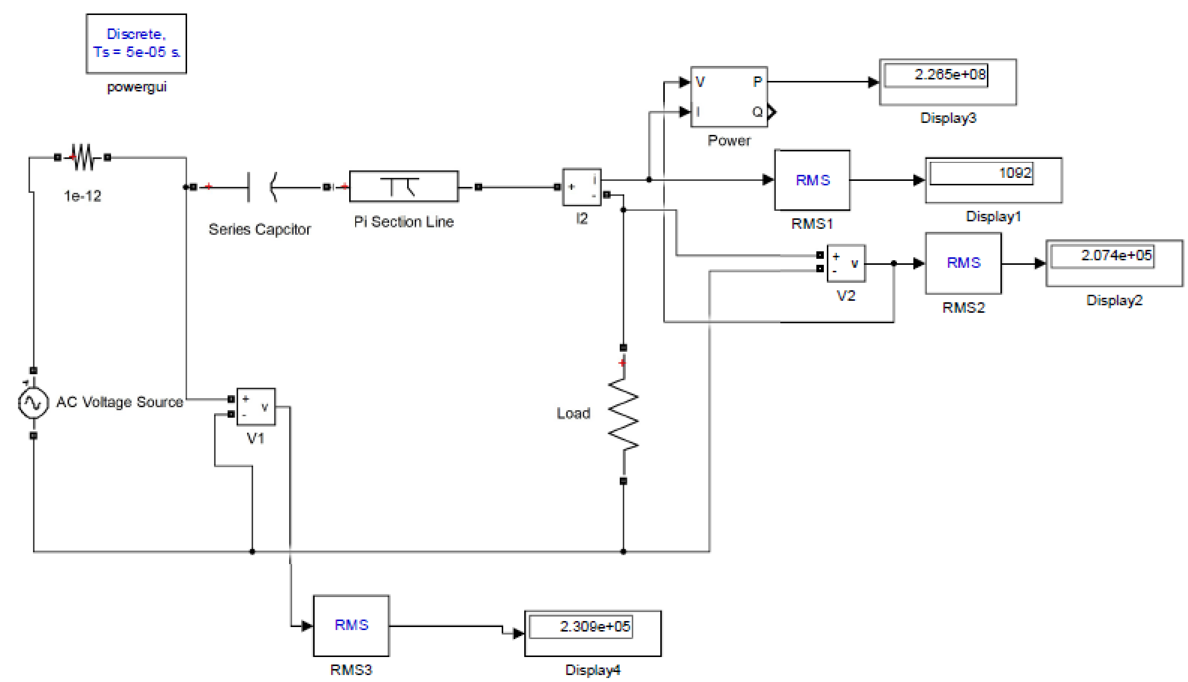


Fig. Circuit diagram

PROCEDURE-

1. Build a SIMULINK model as shown in Circuit diagram.
2. Set the load resistance to 190 Ohms.
3. Run the simulation without connecting a series capacitor. Note down the power, current, and voltages.
4. Connect a series capacitor so as to provide approximately 10 % compensation, simulate and note down the readings.
5. Increase the degree of compensation in steps of 10 %, simulate and tabulate the results for each scenario. Go up to 50 % compensation.
6. Calculate voltage increase at receiving end.
7. Plot graph Compensation vs voltage, power.

OBSERVATION TABLE

S.NO	LOAD	V_S	I	V_R	P
1.	NO CAPACITOR				
2.	C1				
3.	C2				
4.	C3				

RESULT: Plot of power transferred with various levels of compensation is plotted.

EXPERIMENT NO. 9

AIM: To study operation of oil testing set.

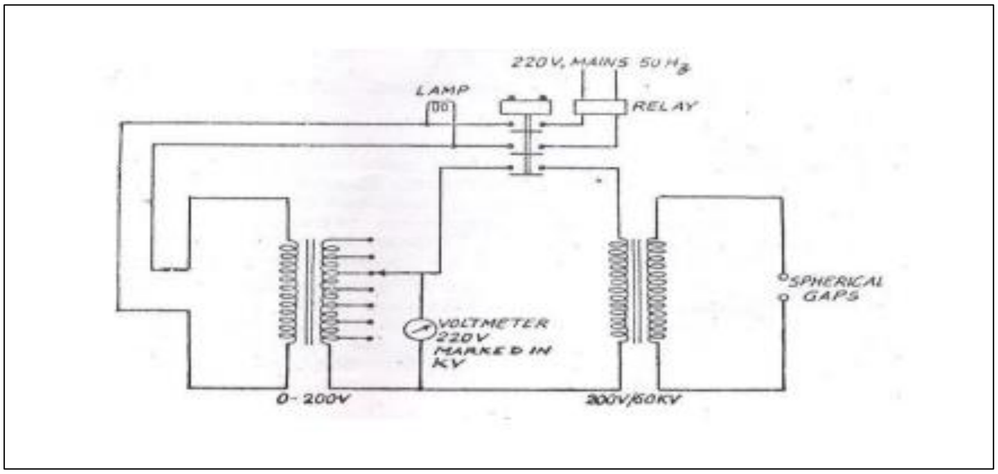
APPARATUS USED: Oil Testing Set

THEORY: When a sample of oil is subjected to dielectric stress in a gap between two spheres the materials of higher conductivity and higher spheres capacity are drawn into the intense field between the spheres and causes a distortion of the field resulting in local high density and disruption begins at these points. When testing transformer oil it is found often that one or more discharge occur across the gap at comparatively low voltages due to the presence of water particles but that the voltage can be raised to a very much higher value before complete rupture occurs. If particles of higher dielectric constant than the oil are drawn into the intense field, they will cause excessive local stress which may result in dissociation or ionization of oil and the gases of ionization may bridge the gap and causes complete rupture. In standard specifications for 'Insulating Oil' the method of applying the testing voltage (which must be alternating or approximately sine waveform of frequency between 25 and 100 Hz and with a peak factor of $\sqrt{2}$ +5% has been laid down. The test has to be carried out under standard conditions. The minimum dimensions of the test cell, diameter of the electrode and the distance between them are specified.

PROCEDURE: When testing oils the set is operated according to a particular method (in compliance with the regulations) i.e. with a fixed spark gap and variable testing voltage. The voltage should be increased gradually under continues observation of the measuring until the breakdown occurs. To test oils of high quality the distance between electrodes should be adjusted to 2 mm. The equipment permit 310 KV/cm to be measured. For testing oils of medium quality or inferior quality the spark gap should be adjusted to 4 mm by means of a distance gauge. The insulating material oil testing cup is equipped normally with two calotte-shaped electrodes of 36 mm dia, radius of each sphere is 25 mm. The oil testing cup is kept as small as possible to do with minimum quantity of oil. Suitable safety contacts are provided to put the set out of operation as soon as the top lid is opened in order to insert or remove the test cup, thus eliminating HT danger.

The set is disconnected automatically as soon as the puncture occurs. No oil tests are possible as long as the lid of the rear of the cabinet is open.

CIRCUIT DIAGRAM:



RESULT:

Distance between electrodes = ____ Breakdown voltage = _____

EXPERIMENT NO. 10

AIM: To obtain formation of Y-bus and perform load flow analysis

```
%   From  To   R    X
z = [ 0    1    0   1.0
      0    2    0   0.8
      1    2    0   0.4
      1    3    0   0.2
      2    3    0   0.2
      3    4    0   0.08];
 Y = ybus(z)                    % bus admittance matrix
Ibus = [-j*1.1; -j*1.25; 0; 0]; % vector of injected bus currents
Zbus = inv(Y)                     % bus impedance matrix
Vbus = Zbus*Ibus
```

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Crosschecked By
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Verified By
Director, DGI Greater Noida

Please spare some time to provide your valuable feedback.