POWER SYSTEMS AND SIMULATION LABORATORY

YEAR: III/IV **SEM: II**

STUDENT MANUAL

Department of

ELECTRICAL AND ELECTRONICS ENGINEERING

Prepared by

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DHANEKULA INSTITUE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi, Affliated to JNTUK, KAKINADA)

GANGURU, VIJAYAWADA

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POWER SYSTEMS AND SIMULATION LABORATORY

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA–533003, Andhra Pradesh, India
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III Year – II SEMESTER		**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
POWER SYSTEMS AND SIMULATION LAB					

Course Objectives:

To impart the practical knowledge of functioning of various power system components and determination of various parameters and simulation of load flows, transient stability, LFC and Economic dispatch.

Any of 5 experiments are to be conducted from each section:

Section I: Power Systems Lab:

1. Estimation of sequence impedances of 3-phase Transformer
2. Estimation of sequence impedances of 3-phase Alternator by Fault Analysis
3. Estimation of sequence impedances of 3-phase Alternator by Direct method
4. Estimation of ABCD parameters on transmission line model
5. Performance of long transmission line without compensation
6. Performance of long transmission line with shunt compensation
7. Analyze the Ferranti effect on long transmission line

Section II: Simulation Lab

8. Determination of Y_{bus} using direct inspection method
9. Load flow solution of a power system network using Gauss-Seidel method
10. Load flow solution of a power system network using Newton Raphson method.
11. Formation of Z_{bus} by building algorithm.
12. Economic load dispatch with & without losses
13. Load frequency control of a two area Power System without & with PI controller
14. Transient Stability analysis of single machine connected to an infinite bus (SMIB) using equal area criterion.

Course Outcomes:

After the completion of the course the student should be able to:

- Estimate the sequence impedances of 3-phase Transformer and Alternators
- Evaluate the performance of transmission lines
- Analyse and simulate power flow methods in power systems
- Analyse and simulate the performance of PI controller for load frequency control.
- Analyse and simulate stability studies of power systems

DHANEKULA INSTITUTE OF ENGINEERING & TECHNOLOGY

POWER SYSTEM AND SIMULATION LABORATORY

LIST OF EXPERIMENTS

S No	Name of the Experiment	Cycle No	Connected CO
Experiments as per curriculum			
1	Estimation of sequence impedances of 3-phase Transformer	I	R20C318.1
2	Estimation of sequence impedances of 3-phase Alternator by Fault Analysis	I	R20C318.1
3	Estimation of ABCD parameters on transmission line model	I	R20C318.1
4	Performance of long transmission line with shunt compensation	I	R20C318.1
5	Analyze the Ferranti effect on long transmission line	I	R20C318.1
6	Determination of Ybus using direct inspection method	I	R20C318.1
7	Load flow solution of a power system network using Gauss-Seidel method	I	R20C318.1
8	Load flow solution of a power system network using Newton Raphson method	I	R20C318.1
9	Load frequency control of a two area Power System without & with PI controller	I	R20C318.2
10	Transient Stability analysis of single machine connected to an infinite bus (SMIB) using equal area criterion.	I	R20C318.2

INSTITUTION VISION

Pioneering Professional Education through Quality

INSTITUTION MISSION

- Providing Quality Education through state-of-art infrastructure, laboratories and committed staff.
- Moulding Students as proficient, competent, and socially responsible engineering personnel with ingenious intellect.
- Involving faculty members and students in research and development works for betterment of society.

DEPARTMENT VISION

Emerge as Quality Human Resource Provider for Industry and Society in the field of Electrical & Electronics Engineering

DEPARTMENT MISSION

- Providing Quality Education through State-of-art resources.
- To develop innovative, proficient Electrical engineers.
- Promoting Ethical and moral values among the students so as to make them responsible professionals for the society.

PROGRAM EDUCATIONAL OBJECTIVES(PEO's)

PEO1: Have strong foundation in Electrical Engineering along with Mathematics, Sciences and allied Engineering subjects.

PEO2: Possess good problem solving, design skills, capability to use modern engineering tools, ability to pursue higher education and research.

PEO3: Seek employment in various engineering or technological positions of their interest and continue to achieve their aspirations through lifelong learning.

PEO4: Exhibit professional and ethical attitude, effective communication skills, Teamwork and multidisciplinary approach.

PROGRAM OUTCOMES

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **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.
3. **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.
4. **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.
5. **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.
6. **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.
7. **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.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **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.
11. **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.
12. **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)

PSO 1: Ability to design solutions for identified problems by using latest engineering tools like MATLAB, Simulink, PSPICE, plc etc.

PSO 2: Able to design and develop the Green Electrical systems.

COURSE OBJECTIVES:

At the end of the Course/Subject, the students will:

S.No	Course Objectives (Cobs)
R20Cobj318.1	Impart the practical knowledge of determination of various parameters of power system components
R20Cobj318.2	Impart the practical knowledge of Load Frequency Control and Transient Stability

COURSE OUTCOMES:

At the end of the Course/Subject, the students will be able to:

S. No	Course Outcomes(COs)
R20C318.1	Determine the parameters of various power system components occur in power system studies
R20C318.2	Design the frequency control of a system With and Without Controllers and Transient stability

Course Outcomes vs POs Mapping:

Courses Out Comes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
R20C318.1	-	-	2	-	3	-	-	2	3	-	-	-
R20C318.2	-	2	3	-	3	-	-	2	3	-	-	-
Total	0	2	5	0	6	0	0	4	6	0	0	0
Level of Mapping	-	2	3	-	3	-	-	2	3	-	-	-

Course Outcomes vs PSOs Mapping:

Course Out Comes	PSO1	PSO2
R20C318.1	3	3
R20C318.2	3	3
Total	6	6
Level of Mapping	3	3

Justification of Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

1. R20C318.1 maps highly with PO5, PO9, PSO1, PSO2 as it needs modern tools to determine the parameters of various power system components occur in power system studies and improves Individual and teamwork skills. R20C318.1 maps moderately with PO3, PO8 as it requires design of solutions for determining the parameters of various power systems by applying ethical principles.

2.R20C318.2 maps highly with PO3, PO5, PO9, PSO1 and PSO2 as it requires design by using modern tools and improves Individual and teamwork skills. R20C318.1 maps moderately with PO2, PO8 as it requires problem analysis, ethical principles.

DO'S AND DON'TS IN THE LAB

DO'S:-

1. Proper dress code has to be maintained while entering in to the Lab.

2. Students should carry observation notes and record completed in all aspects.

3. Correct specifications of the equipment have to be mentioned in the circuit diagram.

4. Student should be aware of operating the equipment.

5. Students should be at their concerned experiment table, unnecessary moment is restricted.

6. The readings must be shown to the Lecturer In-Charge for verification.

7. Students must ensure that all switches are in the OFF position, all the connections are removed.

8. All patch cords and stools should be placed at their original positions.

DON'Ts:-

1. Don't come late to the Lab.

2. Don't enter into the Lab with valuable ornaments like Golden rings, bracelets and bangles.

3. Don't make or remove the connections with power ON.

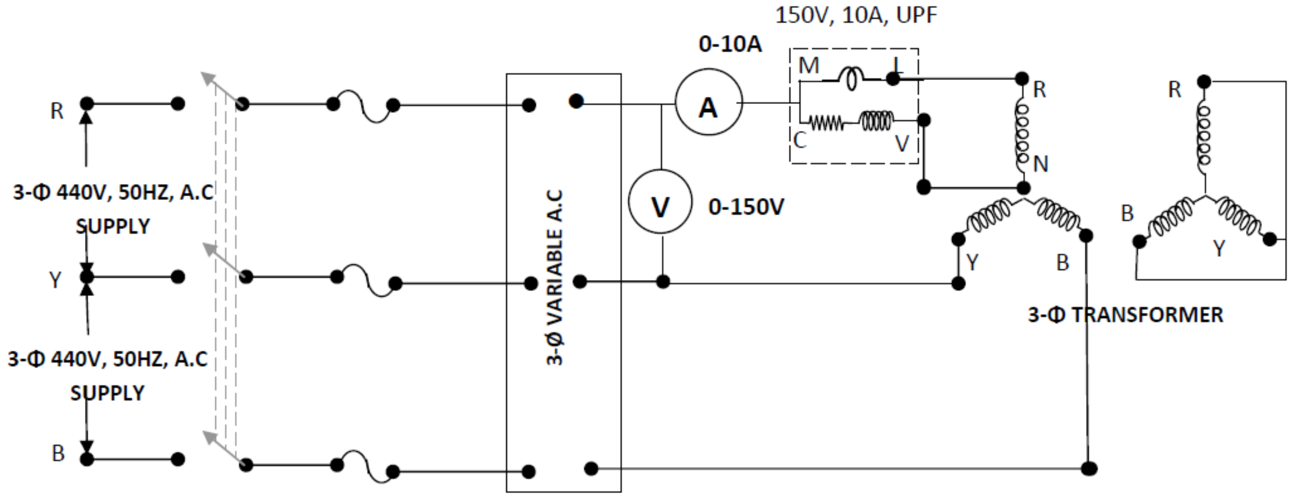
4. Don't switch ON the supply without verifying by the Staff Member.

5. Don't switch OFF the machine with load.

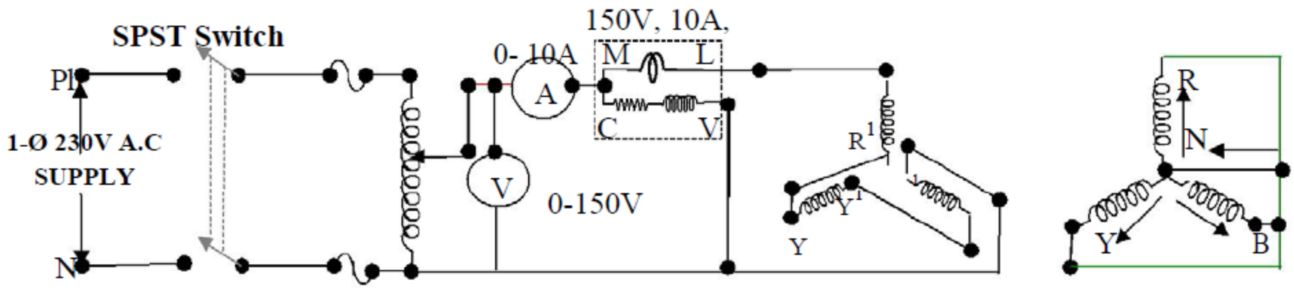
6. Don't leave the lab without the permission of the Lecturer In-Charge.

CIRCUIT DIAGRAM:

Positive or Negative Sequence Impedance:



Zero Sequence Impedance:



Experiment No: Date:

SEQUENCE IMPEDANCE OF 3 PHASE TRANSFORMER

AIM:

To determine the Positive, Negative and Zero sequence (sequence impedance) of given three phase transformer

NAME PLATE DETAILS:

S.No	3 Phase Transformer	
	Specifications	Ratings

APPARATUS:

Sl. No	Name of Apparatus	Range	Type	Quantity

THEORY:

Need to be written by Students by referring Text Books

PROCEDURE:

1. Connect the given three phase transformer as shown in the Circuit Diagram Fig1
2. After short-circuiting the low voltage side adjusts the voltage on high voltage side with the help of the autotransformer such that the rated current flows in the windings.
3. Note down the voltage and current.
4. From these readings determine the transformer positive sequence Impedance which is also equal to negative sequence impedance.
5. Determine the zero sequence impedance of the transformer by making connections as shown in Circuit DiagramFig2.
6. Note down the voltage and current.

THEORITICAL CALCULATIONS:

Positive and Negative Sequence Impedance,

$Z_1 = Z_2 = V/(\sqrt{3}*I)$

Zero Sequence Impedance,

$Z_0 = V/(3*I)$

$R_1 = W / I^2$

$X_1 = X_2 = \sqrt{(Z^2_1 - R^2_1)}$

$R_0 = W / (3I^2)$

$X_0 = \sqrt{(Z^2_0 - R^2_0)}$

TABULAR FORM:

Positive Sequence Impedance

S. No	V(volts)	I(Amps)	Z1

Zero Sequence Impedance

S.	V(volts)	I(Amps)	Z0

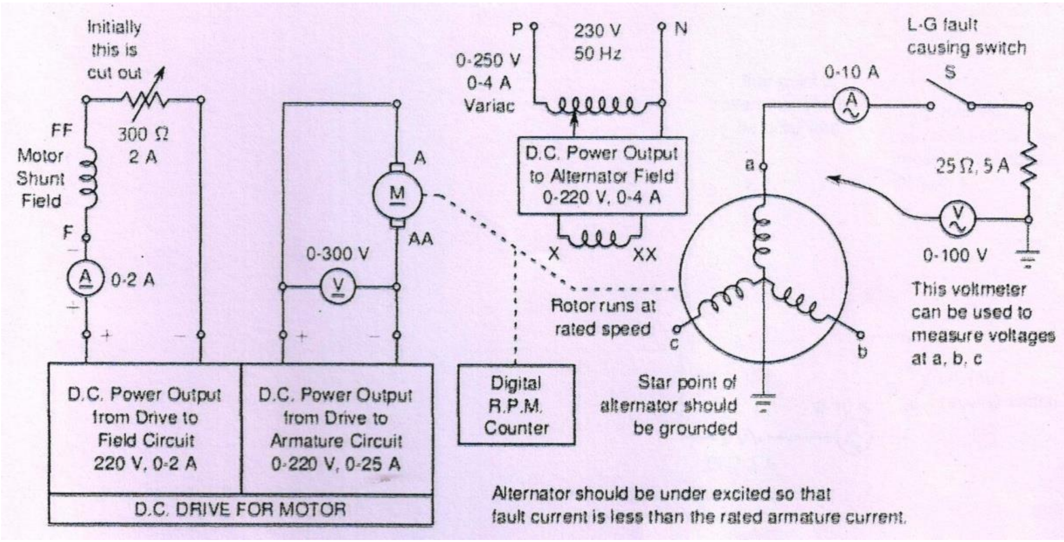
PRECAUTIONS:

1. Connections are to be made tightly and according to the circuit diagram.
2. There should be no parallax error while taking readings.
3. While making or breaking connections supply has to switched OFF.

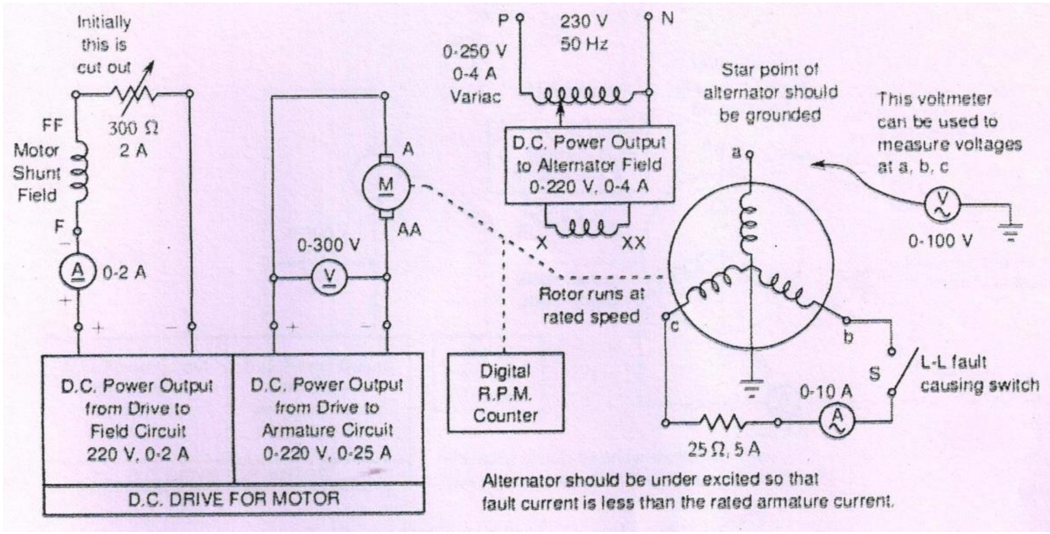
RESULT:

CIRCUIT DIAGRAM:

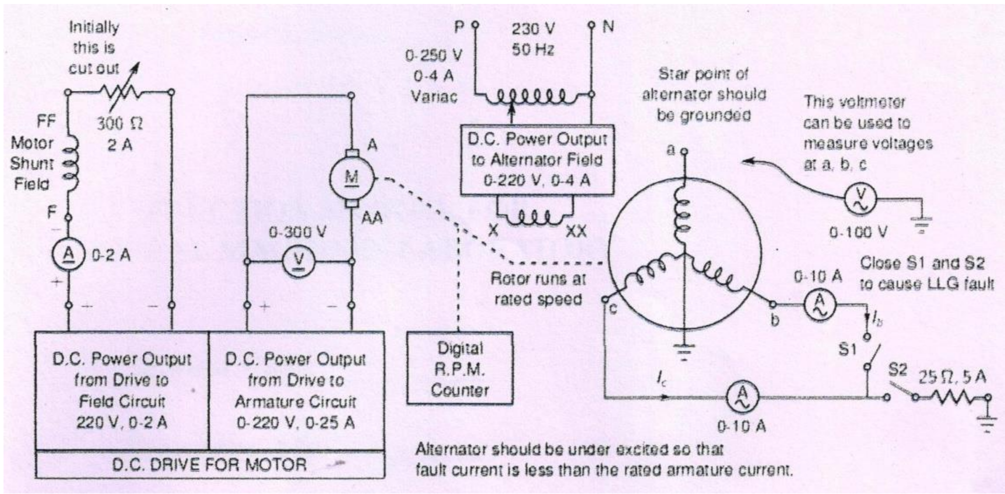
L-G FAULT:



L-L FAULT:



LL-G FAULT



Experiment No: Date:

SEQUENCE IMPEDANCE OF 3 PHASE ALTERNATOR BY FAULT ANALYSIS

AIM:

To determine the fault currents of an unloaded synchronous generator for

(a) Line to ground fault (L-G Fault)

(b) Line to Line fault (L-L fault)

(c) Double Line to ground fault (LL-G Fault)

NAME PLATE DETAILS:

D.C. Shunt Motor		Salient Pole Synchronous Machine	
H.P rating		KVA Rating	
Voltage		Voltage	
Armature Current		Armature Current	
Field Current		Field Current	
Speed		Synchronous Speed	

APPARATUS:

Sl. No	Name of Apparatus	Range	Type	Quantity

Theory:

Need to be written by Students by referring Text Books

PROCEDURE:

(a) **L-G Fault:**

1. Connect the circuit as per the circuit diagram for a line to ground fault on phase R.
2. Calculate the determinate value of the fault current from impedances (Positive, Negative and Zero sequences).
3. Run the generator rated speed.
4. Increase the field current of excitation so that terminal voltage is constant value.
5. Close the switch to create the L-G fault on Phase R.
6. Note the current and voltage in the ammeter and voltmeter.
7. Open the switch and remove the L-G fault on phase R.
8. Reduce the excitation and open the field circuit switch and switch off the prime mover.

Note: This voltage must be such that it does not cause the rated current of the machine to be exceeded.

(b) **L-L Fault:**

1. Connect the circuit as per the circuit diagram for a line to line fault on any two phases.
2. Calculate the determinate value of the fault current from impedances (Positive, Negative and Zero sequences).
3. Run the generator rated speed.
4. Increase the field current of excitation so that terminal voltage is constant value.
5. Close the switch to create the L-L fault on any two phases.
6. Note the current and voltage in the ammeter and voltmeter.
7. Open the switch and remove the L-L fault.
8. Reduce the excitation and open the field circuit switch and switch off the prime mover.

Note: This voltage must be such that it does not cause the rated current of the machine to be exceeded.

(c) **LL-G Fault:**

1. Connect the circuit as per the circuit diagram for a line to line to ground fault.
2. Calculate the determinate value of the fault current from impedances (Positive, Negative and Zero sequences).
3. Run the generator rated speed.
4. Increase the field current of excitation so that terminal voltage is constant value.
5. Close the switch to create the LL-G fault.
6. Note the current and voltage in the ammeter and voltmeter.
7. Open the switch and remove the LL-G fault on phase R.
8. Reduce the excitation and open the field circuit switch and switch off the prime mover.

Note: This voltage must be such that it does not cause the rated current of the machine to be exceeded.

Tabulation:

S.No	$V_{Excitation}$	LG- Fault							
		Before Fault				After Fault			
		I_f	E_R	E_Y	E_B	I_f	E_R	E_Y	E_B

S.No	$V_{Excitation}$	LL- Fault							
		Before Fault				After Fault			
		I_f	E_R	E_Y	E_B	I_f	E_R	E_Y	E_B

S.No	$V_{Excitation}$	LLG- Fault							
		Before Fault				After Fault			
		I_f	E_R	E_Y	E_B	I_f	E_R	E_Y	E_B

PRECAUTIONS:

1. Connections are to be made tightly and according to the circuit diagram.
2. There should be no parallax error while taking readings.
3. While making or breaking connections supply has to switched OFF.

RESULT:

Circuit Diagram:

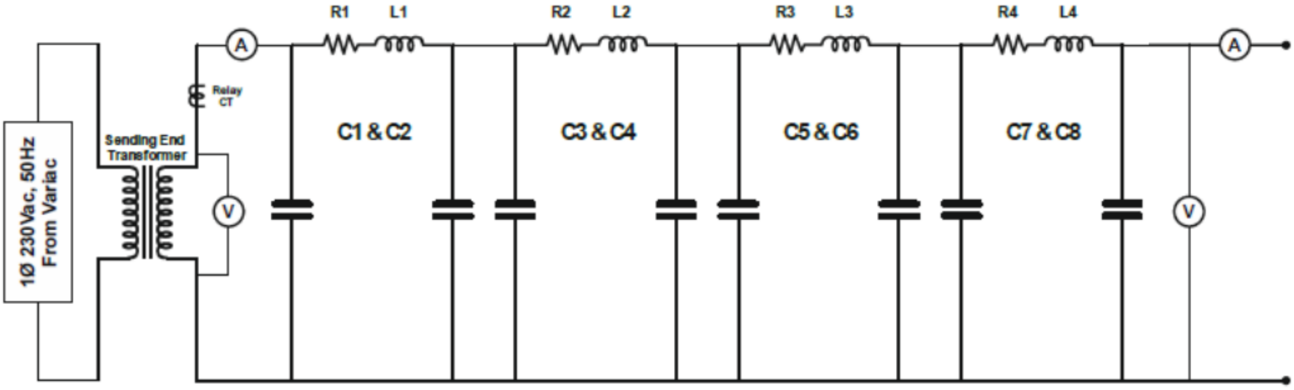


Figure1: Circuit for open circuit test for calculating A and C values

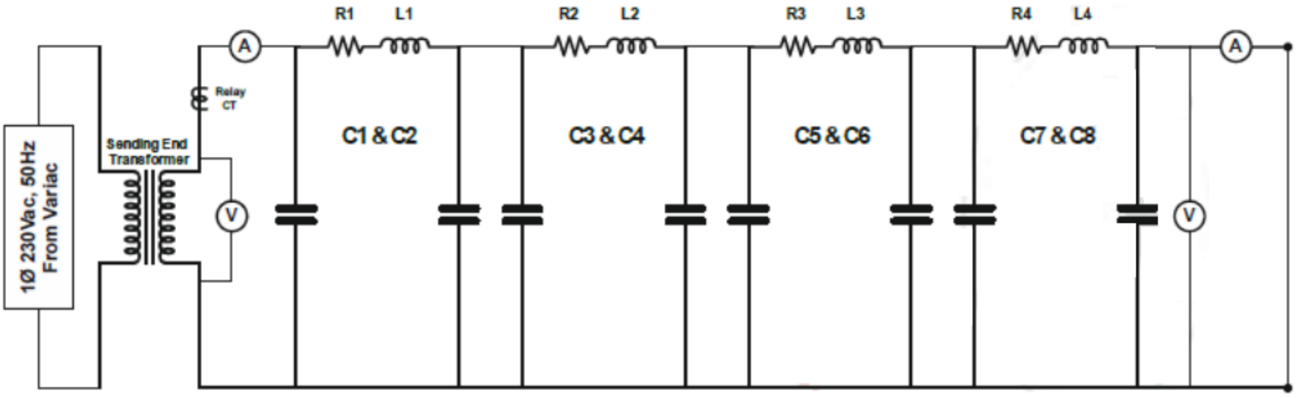


Figure2: Circuit for short circuit test for calculating B and D values

Experiment No: Date:

ABCD PARAMETERS OF TRANSMISSION NETWORK

AIM: -

To determine ABCD constants of 3-phase transmission line with Distributed Connection

APPARATUS:

Sl. No	Name of Apparatus	Range	Type	Quantity

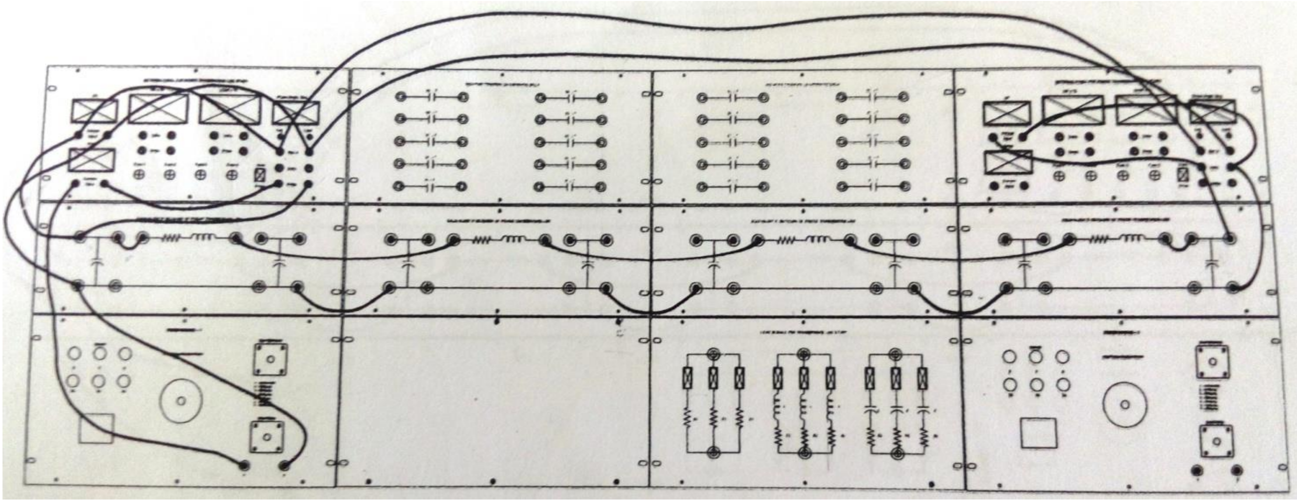
THEORY:

Need to be written by Students by referring Text Books

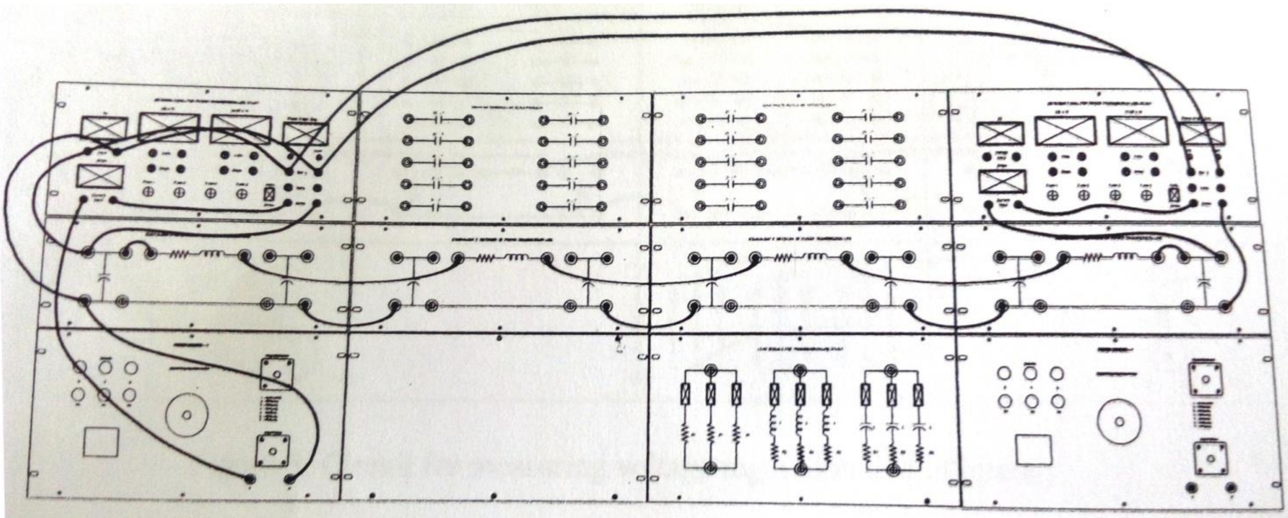
PROCEDURE:

1. Make connections shown in figure-2 below. Now the receiving end terminals are kept open. Turn the phase shift knob in Source-1 to zero.
2. Switch ON power to the module. Slowly turn the variac in Source-1 and apply a voltage of about 100kV. This is indicated by the voltmeter at the sending end. Now observe the voltmeter reading at the receiving end. It reads a value much higher than the input voltage. This effect is known as Ferranti effect. This effect occurs because of high shunt capacitance of the transmission line. This effect is predominant only when the line is not loaded.
3. Now record V_S and V_R. Magnitude of these two are read by the respective voltmeters and their phase angles are read by respective phase angle meters. Since $V_S$is taken as reference phasor, its phase angle will be zero. If V_R is lagging, as indicated by the lag LED at the receiving end, then, its phase angle should be taken as negative. If V_R is leading as indicated by the lead LED at the receiving end, then, its phase angle should be taken as positive.
4. Also record I_S magnitude as read by the ammeter and its phase angle as read by the phase angle meter. Now calculate A and C. Turn variac to zero and switch OFF power supply.
5. Now make connections shown in figure-3. In this case, the receiving end terminals are shorted and we need to measure the receiving end and sending end currents.
6. Switch ON the power supply. Slowly apply about 100kV at the sending by operating the variac in Source-1. Now measure both I_S and I_R. Take care to measure phase angle properly. The phase angle of $V_S$is zero since it is taken as reference phasor. Now Calculate B and D.

For A and C: (figure-2)



For B and D: (figure-3)



Formulae: $A = [V_S/V_R]_{IR=0}$; $C = [I_S/V_R]_{IR=0}$;

$B = [V_S/I_R]_{VR=0}$; $D = [I_S/I_R]_{VR=0}$

Tabular form:

For A and C:

S.No	V_S	I_S	V_R	I_R

For B and D:

S.No	V_S	I_S	V_R	I_R

PRECAUTIONS:

1. Connections are to be made tightly and according to the circuit diagram.
2. There should be no parallax error while taking readings.
3. While making or breaking connections supply has to switched OFF.

RESULT:

Circuit Diagram:

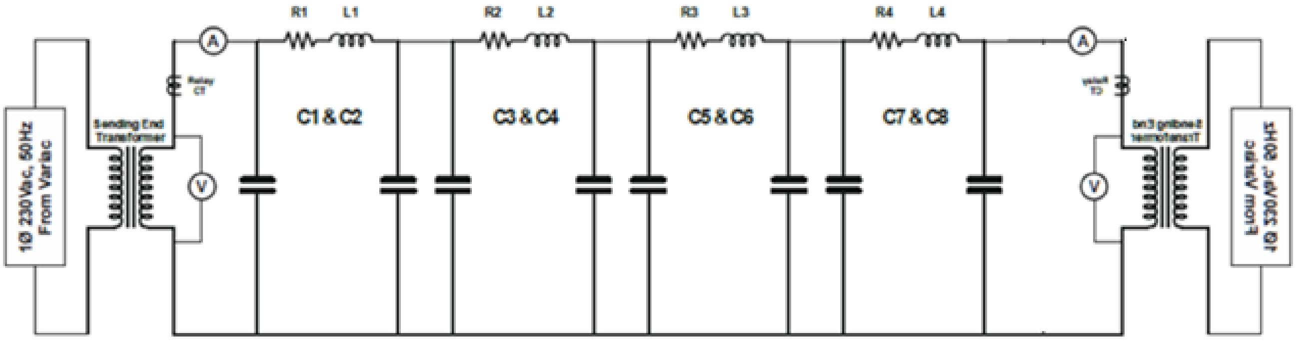


Figure1: Power transfer capability of Transmission line without compensation

Experiment No: Date:

PERFORMANCE OF LONG TRANSMISSION LINE WITHOUT COMPENSATION

AIM: -

To observe the Performance of long transmission line without compensation

APPARATUS:

Sl. No	Name of Apparatus	Range	Type	Quantity

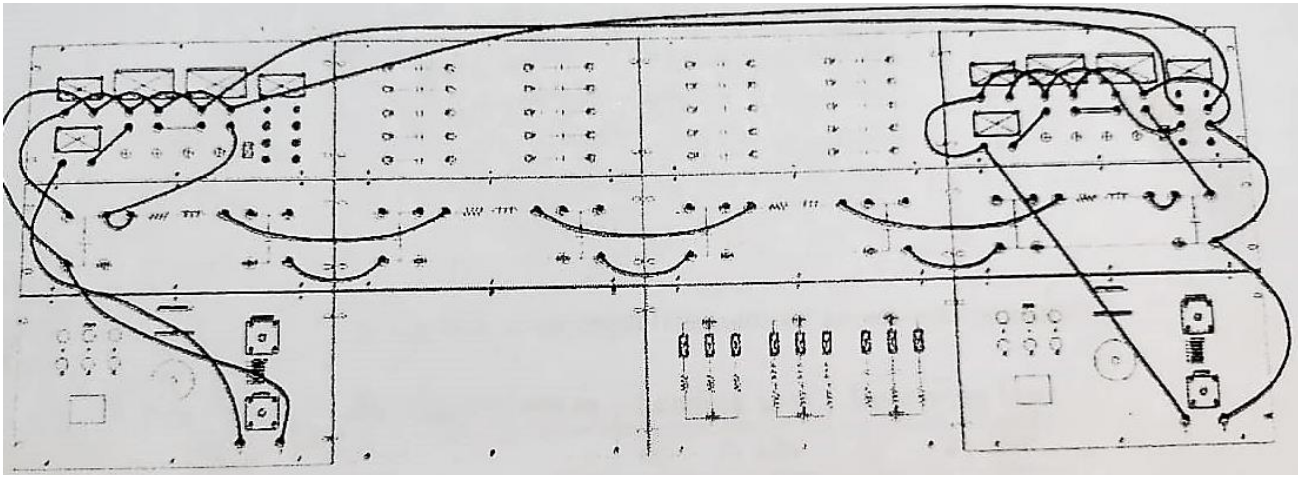
THEORY:

Need to be written by Students by referring Text Books

PROCEDURE:

1. Make connections as shown.
2. Turn the phase shift control knobs to zero in both Source-1 and Source-2.
3. Switch ON Source-1 and slowly increase its output voltage by operating the variac until the sending end voltage is 100 KV as indicated by the voltmeter on the sending end side.
4. Switch ON Source-2 and slowly increase its output voltage to 100 KV by operating its variac. This is indicated by the voltmeter on the receiving end side. The phase angle meter on the receiving side displays the load angle δ. This can be changed by operating the phase shift control knob in Source-2.
5. Turn the phase shift control knob of Source-2 to 1 position and record δ shown by the phase angle meter on the receiving side in Table-1. If the magnitude of receiving end voltage has changed, set it 200 KV by operating the variac in Source-2. Record sending and receiving end active powers in Table-1.
6. Repeat the previous step for each position of phase shift control knob of Source-2 up to 40^0.
7. The maximum power that can be transferred without compensation corresponds to $\delta = 30^0$ which is the practical limit.

Hardware Connection diagram:



Tabular form:

V_S, kV	V_R, kV	δ^0	P_S, MW	P_R, MW

PRECAUTIONS:

1. Connections are to be made tightly and according to the circuit diagram.
2. There should be no parallax error while taking readings.
3. While making or breaking connections supply has to switched OFF.

RESULT:

Circuit Diagram:

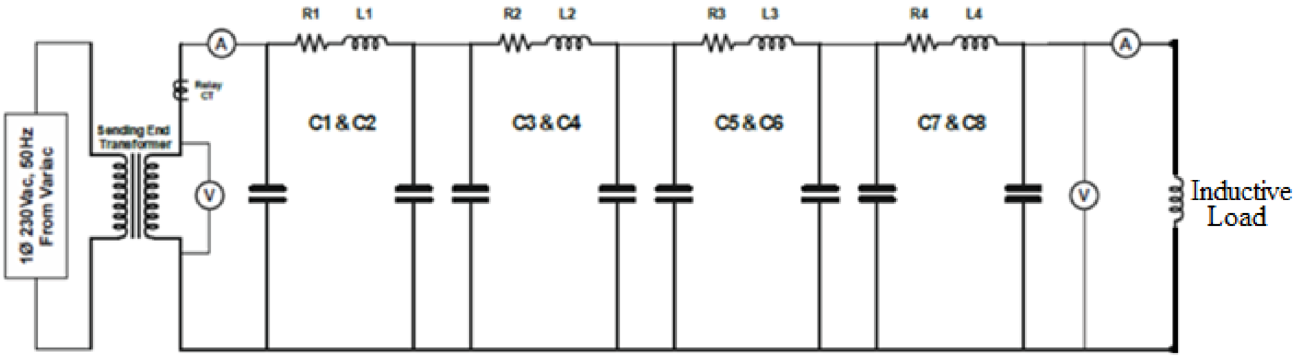


Figure1: Inductive Load connected at the receiving end

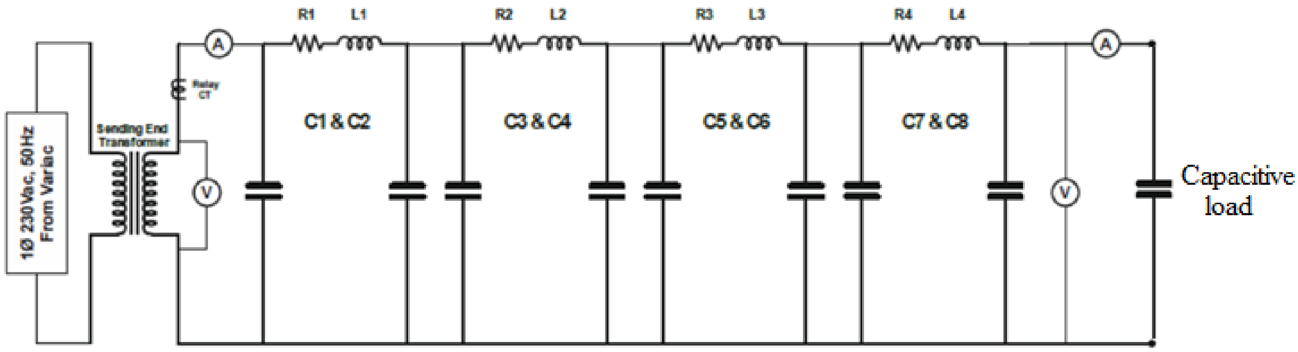


Figure2: Capacitive Load connected at the receiving end

Experiment No: Date:

PERFORMANCE OF LONG TRANSMISSION LINE WITH SHUNT COMPENSATION

AIM: -

To observe the Performance of long transmission line with shunt compensation

APPARATUS:

Sl. No	Name of Apparatus	Range	Type	Quantity

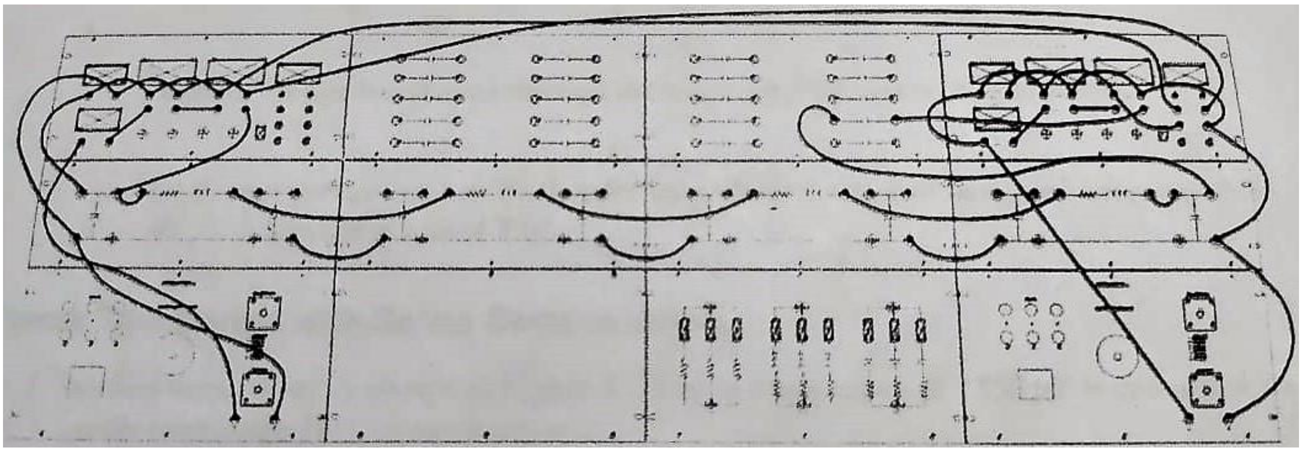
THEORY:

Need to be written by Students by referring Text Books

PROCEDURE:

1. Make connections as shown in above figure but without connecting Source-2 connect inductive load at the receiving end.
2. Switch ON Source-1 and slowly increase its output voltage by operating the variac until the sending end voltage is 100 KV as indicated by the voltmeter on the sending end side. Switch on the inductive load.
3. When the inductive load is switched on, the receiving end voltage decreases. Note down this voltage.
4. Disconnect the load. connect a capacitor in parallel with the load and then switch on power to the load keeping the sending end voltage same as it was earlier. Now, we can see that the receiving end voltage improves.

Hardware Connection diagram:



Tabular form:

With Inductive load:

S.No	L	V_S	I_S	V_R	I_R

With Capacitive load:

S.No	C	V_S	I_S	V_R	I_R

PRECAUTIONS:

1. Connections are to be made tightly and according to the circuit diagram.
2. There should be no parallax error while taking readings.
3. While making or breaking connections supply has to switched OFF.

RESULT:

Circuit Diagram:

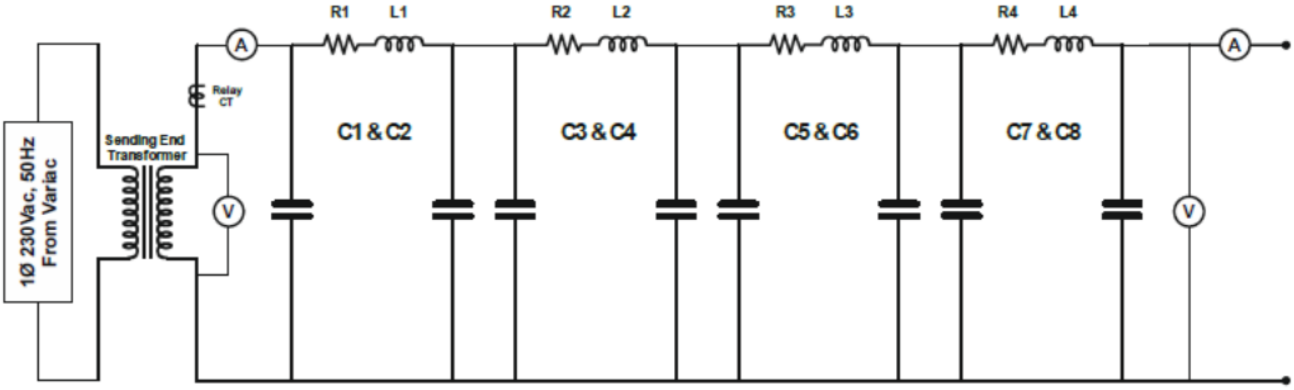


Figure1: Circuit for observing Ferranti Effect

Experiment No: Date:

ANALYZE THE FERRANTI EFFECT ON LONG TRANSMISSION LINE

AIM:

To analyze the Ferranti effect on long transmission line

APPARATUS:

Sl. No	Name of Apparatus	Range	Type	Quantity

THEORY:

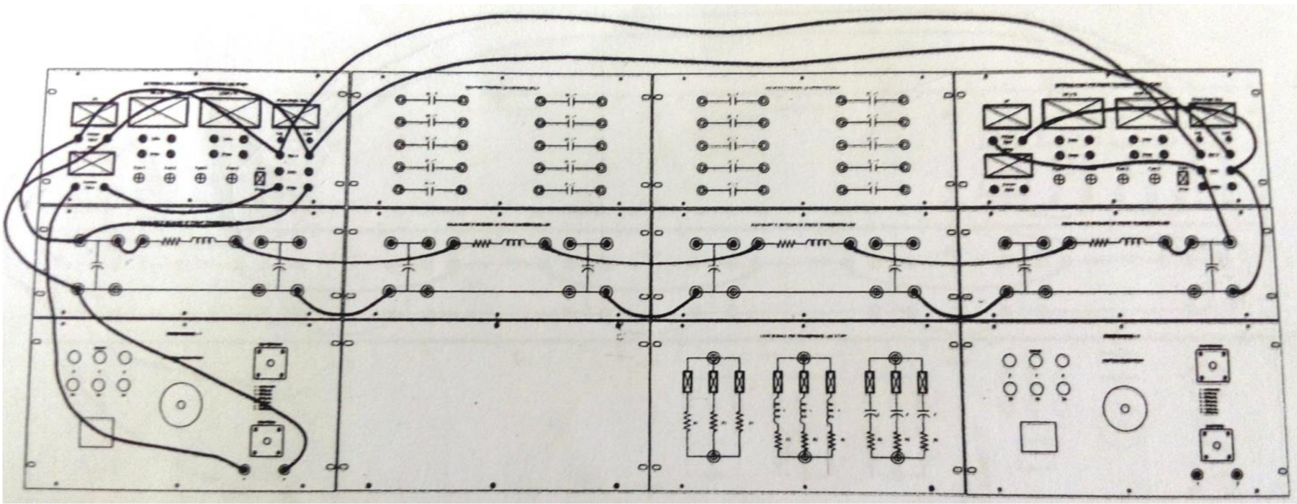
Need to be written by Students by referring Text Books

PROCEDURE:

1. Make connections shown in figure-1 above. Now the receiving end terminals are kept open. Turn the phase shift knob in Source-1 to zero.

2. Switch ON power to the module. Slowly turn the variac in Source-1 and apply a voltage of about 100kV. This is indicated by the voltmeter at the sending end. Now observe the voltmeter reading at the receiving end. It reads a value much higher than the input voltage. This effect is known as Ferranti effect. This effect occurs because of high shunt capacitance of the transmission line. This effect is predominant only when the line is not loaded.

Hardware Connections:



Tabular form:

S.No	V_S	I_S	V_R	I_R

PRECAUTIONS:

1. Connections are to be made tightly and according to the circuit diagram.
2. There should be no parallax error while taking readings.
3. While making or breaking connections supply has to switched OFF.

RESULT:

Experiment No: Date:

YBUS USING DIRECT INSPECTION METHOD

AIM:

To determine the Y_{bus} by using Direct Inspection method.

APPARATUS REQUIRED: Personal Computer with MATLAB software

THEORY:

Need to be written by Students by referring Text Books

Problem:

Form the Y_{bus} by using Direct Inspection method for the data shown below.

Element	Bus code	Self impedance in p.u
1	0 – 1	0.15
2	0 – 2	0.1
3	0 – 3	0.3
4	0 – 4	0.2
5	1 – 2	0.4
6	2 – 3	0.15
7	3 – 4	0.2
8	1 – 4	0.1

PROCEDURE:

1. Switch ON the Personal Computer and open the Start Menu and Open “Matlab Icon”.
2. Click on the New Script on the Main Window.
3. A new window opens, Type the program in the window.
4. After completion, save the file by clicking on Save.
5. Then click on the Run button, which executes the program.
6. Then note down the output displayed on the command window.
7. Then close the window.

PROGRAM:

```
% Ybus by Direct Inspection Method
clc
z01 = 0.15
z02 = 0.1
z03 = 0.3
```

```
z04 = 0.2
z12 = 0.4
z23 = 0.15
z34 = 0.2
z14 = 0.1

disp('Obtain the values of self admittances from self impedances')
y01 = 1/z01
y02 = 1/z02
y03 = 1/z03
y04 = 1/z04
y12 = 1/z12
y23 = 1/z23
y34 = 1/z34
y14 = 1/z14

disp('Formulate Y-Bus Matrix')
Y11 = y01 + y12 + y14;
Y12 = -y12;
Y13 = 0;
Y14 = 0;
Y21 = Y12;
Y22 = y02+y12+y23;
Y23 = -y23;
Y24 = 0;
Y31 = Y13;
Y32 = Y23;
Y33 = y03+y23+y34;
Y34 = -y34;
Y41 = Y14;
Y42 = Y24;
Y43 = Y34;
Y44 = y04+y34+y14;

disp('Ybus matrix is')
YBus = [Y11 Y12 Y13 Y14; Y21 Y22 Y23 Y24; Y31 Y32 Y33 Y34; Y41 Y42 Y43 Y44]
```

RESULT:

Experiment No: 9 Date:

LOAD FLOW STUDIES BY USING GAUSS SEIDEL METHOD

AIM:

To determine the power flow solution using Gauss Seidel method

APPARATUS REQUIRED: Personal Computer with MATLAB software

THEORY:

Need to be written by Students by referring Text Books

Problem:

In the system shown in figure below, bus 1 is slack bus and remaining busses are load busses. By taking a flat voltage profile, determine the bus voltage at the end of iterations.

Bus data:

Bus code	P	Q	V	Remarks
1	-	-	1.04	Slack bus
2	-0.5	-	$1.0 \angle 0^0$	PV bus
3	1.0	-0.55	-	PQ bus
4	-0.3	0.1	-	PQ bus

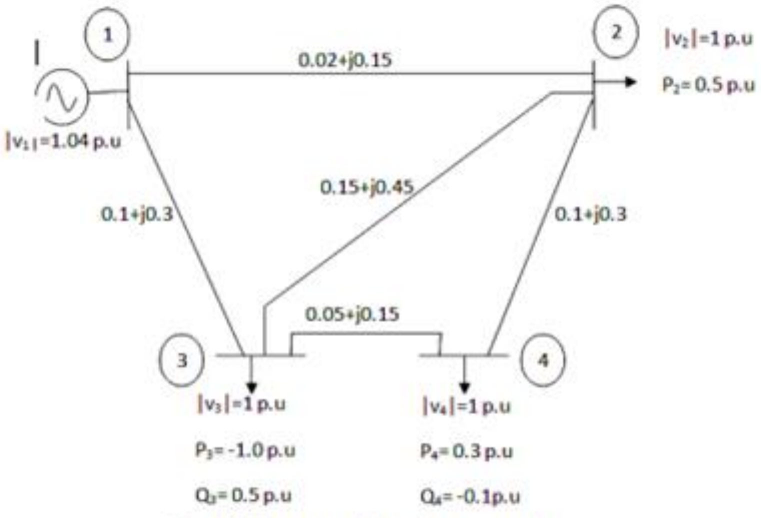


Fig:All elements are impedences per unit.

PROCEDURE:

1. Switch ON the Personal Computer and open the Start Menu and Open “Matlab Icon”.
2. Click on the New Script on the Main Window.
3. A new window opens, Type the program in the window.
4. After completion, save the file by clicking on Save.

5. Then click on the Run button, which executes the program.
6. Then note down the output displayed on the command window.
7. Then close the window.

PROGRAM:

```
%Gauss Seidal Method clc
clc
y12 = 0.873-6.55j;
y13 = 1-3j;
y23 = 0.666-2j;
y24 = 1-3j;
y34 = 2-6j;
p2 = 0.5;
p3 = -1.0;
p4 = 0.3;
q2 = -0.2
q3 = 0.55;
q4 = -0.1;

disp('STEP1: Formulate Y-Bus Matrix')
Y11 = y12+y13;
Y12 = -y12;
Y13 = -y13;
Y14 = 0;
Y21 = -y12;
Y22 = y12+y23+y24;
Y23 = -y23;
Y24 = -y24;
Y31 = -y13;
Y32 = -y23;
Y33 = y13+y23+y34;
Y34 = -y34;
Y41 = 0;
Y42 = -y24;
Y43 = -y34;
Y44 = y24+y34;

YBus = [Y11 Y12 Y13 Y14; Y21 Y22 Y23 Y24; Y31 Y32 Y33 Y34; Y41 Y42 Y43 Y44]

disp('STEP2: Initialize bus voltages')
v1 = 1.04
v2 = 1.04
v3 = 1.0
v4 = 1.0
disp('STEP3: Calculate Q2 value for PV Bus')
Q2 = v2*[(Y21*v1)+(Y22*v2)+(Y23*v3)+(Y24*v4)];
Q2cal = -imag(Q2)
```

```
disp('STEP4: Calculate V2 value')
V2 = (1/Y22)*[((p2-(Q2cal*j))/v2)-(Y21*v1)-(Y23*v3)-(Y24*v4)]
delta2 = angle(V2)

V2new = v2*(cos(delta2)+j*sin(delta2))

V3 = (1/Y33)*[((p3-(q3*j))/v3)-(Y31*v1)-(Y32*V2new)-(Y34*v4)]

V4 = (1/Y44)*[((p4-(q4*j))/v4)-(Y41*v1)-(Y42*V2new)-(Y43*V3)]
```

RESULT:

Experiment No: Date:

LOAD FLOW STUDIES BY USING NEWTON- RAPHSON METHOD

AIM:

To determine the power flow solution using Newton- Raphson method

APPARATUS REQUIRED: Personal Computer with MATLAB software

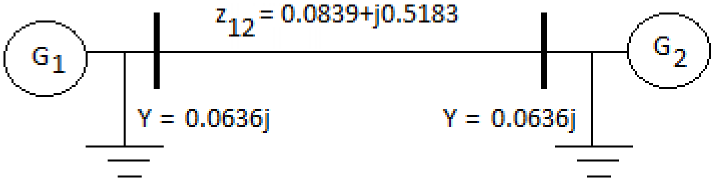
THEORY:

Need to be written by Students by referring Text Books

Problem:

Consider the 2 bus system having series impedance of 0.0839 + j0.5183p.u and a total shunt admittance of 0.0636jpu. The specified quantities at the buses are given below:

Bus	P_D	Q_D	P_G	Q_G	Voltage Specified
1	2	1	-	-	V_1=1.05
2	0	0	0.3	0.1	Unspecified



PROCEDURE:

1. Switch ON the Personal Computer and open the Start Menu and Open "Matlab Icon".
2. Click on the New Script on the Main Window.
3. A new window opens, Type the program in the window.
4. After completion, save the file by clicking on Save.
5. Then click on the Run button, which executes the program.
6. Then note down the output displayed on the command window.
7. Then close the window.

PROGRAM:

```
%Newton Raphson Method
clc
z12 = 0.0839+0.5183j;
hlc = 0.0636j;
```

```
disp('STEP1: Formulate Y-Bus matrix')
Y11 = 1/z12 + hlc;
Y12 = -1/z12;
Y21 = -1/z12;
Y22 = 1/z12 + hlc;

yBus = [Y11 Y12;
 Y21 Y22]

Y11m = abs(Y11);
Y12m = abs(Y12);
Y21m = abs(Y21);
Y22m = abs(Y22);
Y11a = angle(Y11);
Y12a = angle(Y12);
Y21a = angle(Y21);
Y22a = angle(Y22);

disp('STEP2: Initialize bus voltages')
v1 = 1.05
v2 = 1.0
d1 = 0
d2 = 0

X0 = [d2;
 v2]

disp('STEP3: Calculate P2cal, Q2cal, dP2, dQ2')
P2cal = v2*((v1*Y21m*cos(Y12a+d2-d1))+(v2*Y22m*cos(Y22a+d2-d1)))
P2spec = -0.3
dP2 = P2spec-P2cal

Q2cal = -v2*((v1*Y21m*sin(Y12a+d1-d2))+(v2*Y22m*sin(Y22a+d2-d1)))
disp('Check for q limit')
disp('Q2cal < Q2min')
Q2spec = -0.1
dQ2 = Q2spec-Q2cal

disp('STEP4: Form Jacobian matrix')
J11 = (v2*v1*Y21m*sin(Y12a+d1-d2))+(v2*v2*Y22m*0);
J12 = (v1*Y21m*cos(Y12a+d1-d2))+(2*v2*Y22m*cos(Y22a));
J21 = (v2*v1*Y21m*cos(Y12a+d1-d2))-(v2*v2*Y22m*0);
J22 = (-v1*Y21m*sin(Y12a+d1-d2))-(2*v2*Y22m*sin(Y22a));
Jmatrix = [J11 J12;
         J21 J22]

Jinv = inv(Jmatrix)

disp('STEP5: Compute dX')
pq = [dP2;
```

```
dQ2];

dX = Jinv*pq
delta2 = dX(1,1);
dV2 = dX(2,1);
Xnew = X0+dX
v2new = v2+dV2
Delta2new = d2+delta2
```

RESULT:

Experiment No: Date:

(a) LOAD FREQUENCY CONTROL WITHOUT CONTROL

AIM:

To become familiar with modelling and analysis of the frequency and tie-line flow dynamics of a two area power system without control for Load Frequency Control (LFC).

APPARATUS REQUIRED: Personal Computer with MATLAB software

THEORY:

Need to be written by Students by referring Text Books

PROBLEM:

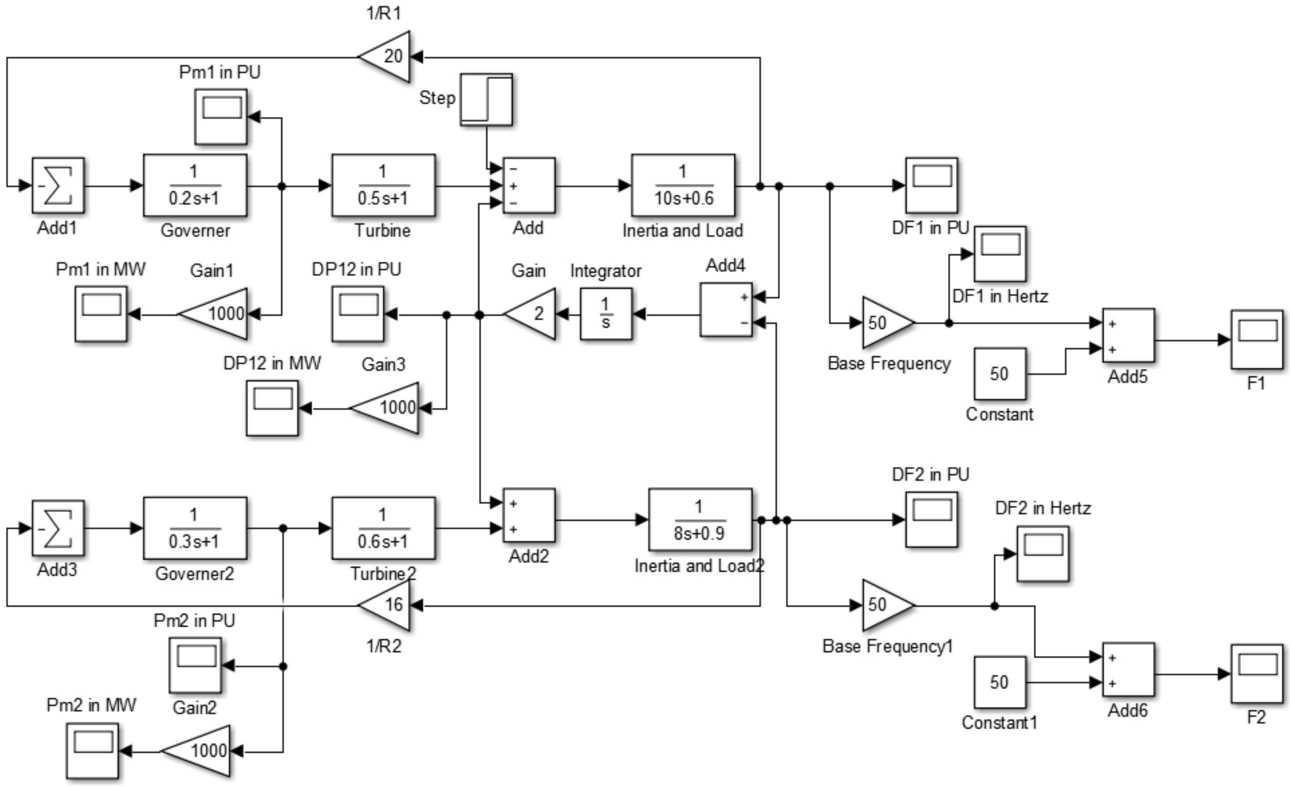
A two area system connected by a tie line has the following parameters on a 1000MVA common base. The unit are operated in parallel at the nominal frequency of 50Hz. The synchronizing power coefficient is computed from the initial operating condition and is given to be Ps = 0.2PU. A load change of 187.5MW occurs in Area1. Construct the Simulink block diagram and obtain the frequency deviation response.

AREA	1	2
Speed regulation	$R_1 = 0.05$	$R_2 = 0.0625$
Frequency sensitive load coefficient	$D_1 = 0.6$	$D_2 = 0.9$
Inertia constant	$H_1 = 5$	$H_2 = 4$
Base Power	1000MVA	1000MVA
Governor Time Constant	$T_{g1} = 0.2$sec	$T_{g2} = 0.3$sec
Turbine Time Constant	$T_{t1} = 0.5$sec	$T_{t2} = 0.6$sec

PROCEDURE:

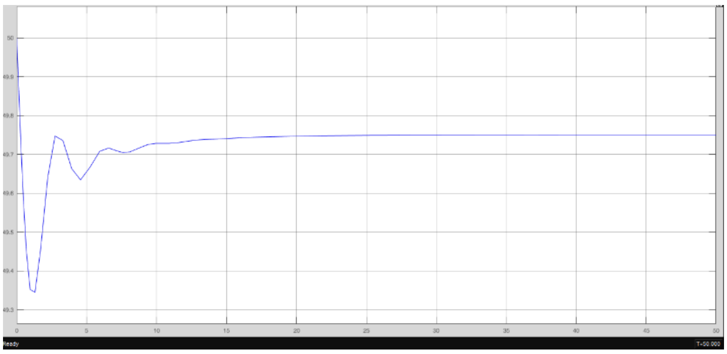
1. Enter the command window of the MATLAB.
2. Create a new Model by selecting File - New – Model
3. Pick up the blocks from the simulink library browser and form a block diagram.
4. After forming the block diagram, save the block diagram.
5. Double click the scope and view the result.

Simulink Model for Single Area with LFC Without Control:

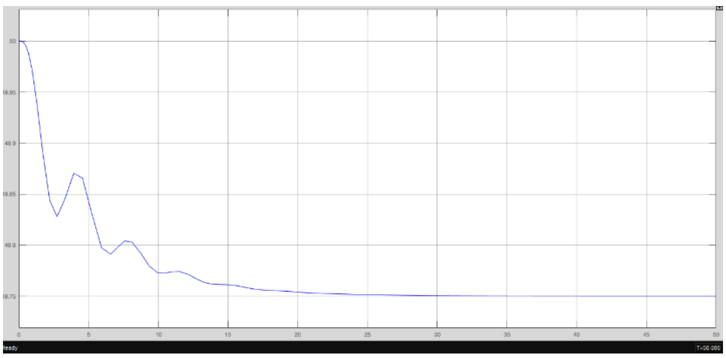


MODEL GRAPH:

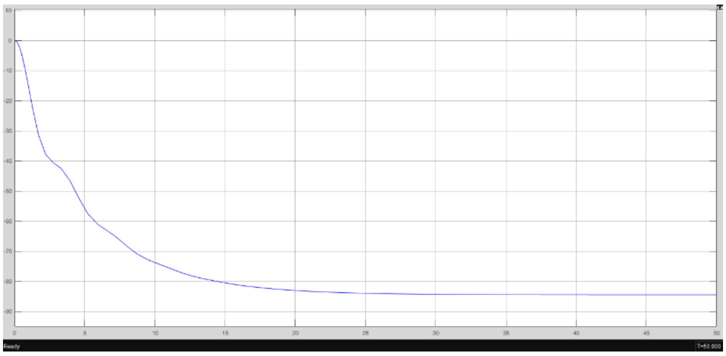
Frequency plot of Area-1:



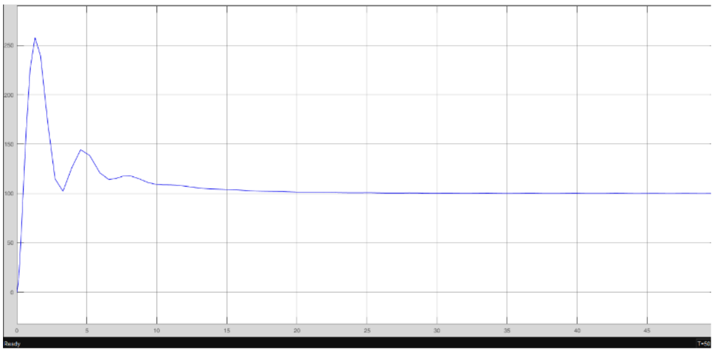
Frequency plot of Area-2:



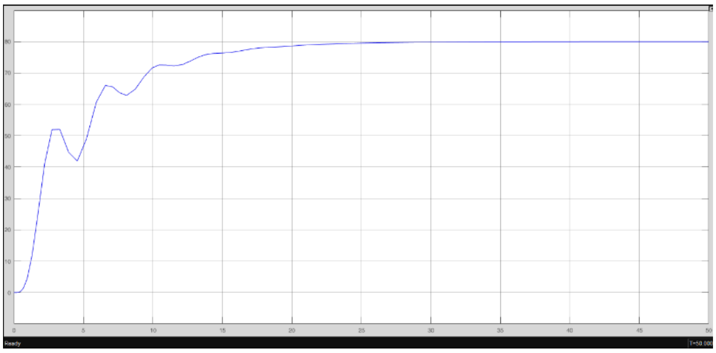
Tie Line Power:



Mechanical Input Power of Area-1:



Mechanical Input Power of Area-2:



RESULT:

Experiment No: Date:

(b) LOAD FREQUENCY CONTROL WITH CONTROL

AIM:

To become familiar with modelling and analysis of the frequency and tie-line flow dynamics of a Two Area Power System with control for Load Frequency Control (LFC).

APPARATUS: Personal Computer with MATLAB software

THEORY :

Need to be written by Students by referring Text Books

PROBLEM:

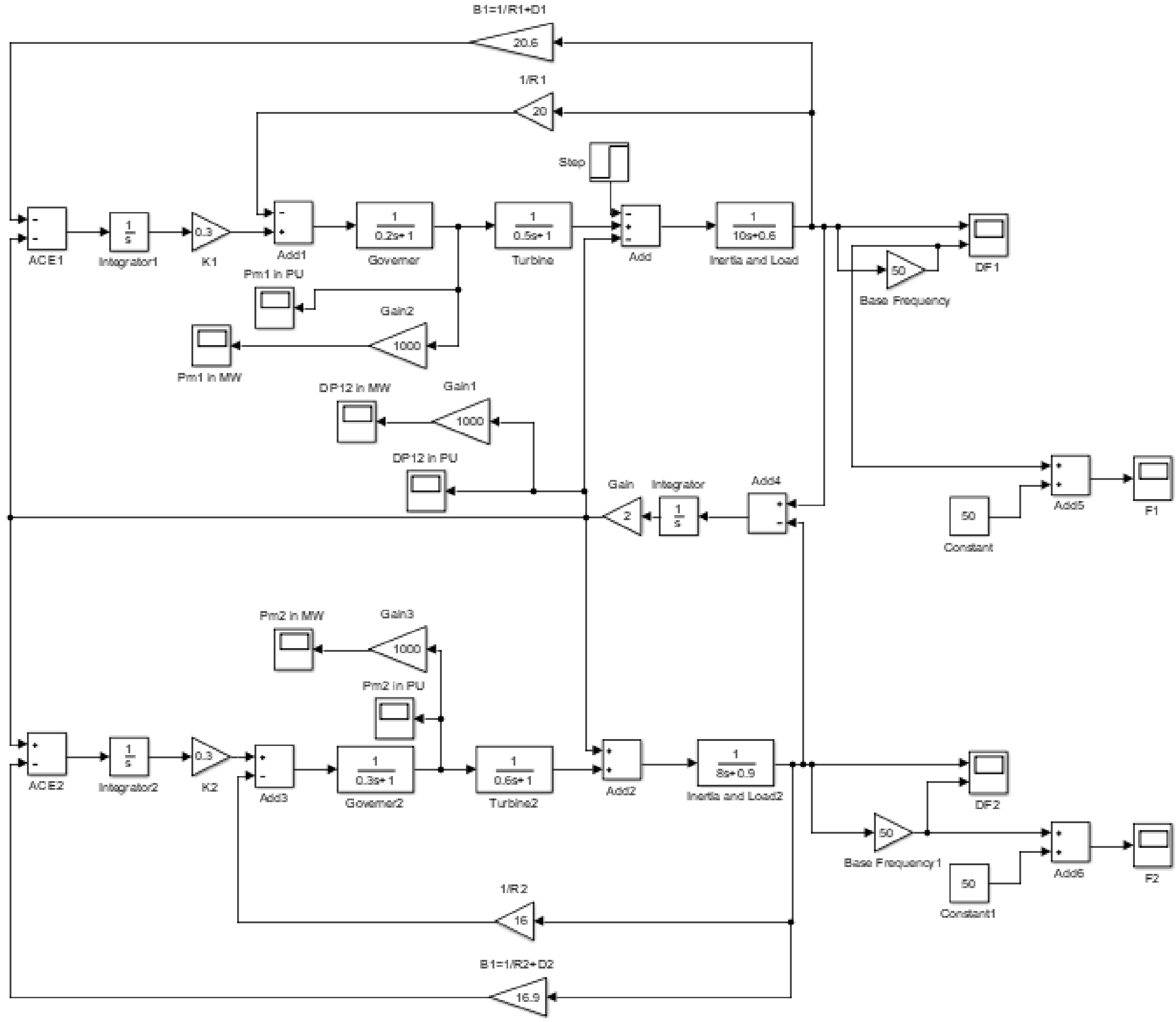
A two area system connected by a tie line has the following parameters on a 1000MVA common base. The unit are operated in parallel at the nominal frequency of 50Hz. The synchronizing power coefficient is computed from the initial operating condition and is given to be Ps = 0.2PU. A load change of 187.5MW occurs in Area1. Construct the Simulink block diagram and obtain the frequency deviation response.

AREA	1	2
Speed regulation	$R_1 = 0.05$	$R_2 = 0.0625$
Frequency sensitive load coefficient	$D_1 = 0.6$	$D_2 = 0.9$
Inertia constant	$H_1 = 5$	$H_2 = 4$
Base Power	1000MVA	1000MVA
Governor Time Constant	$T_{g1} = 0.2$sec	$T_{g2} = 0.3$sec
Turbine Time Constant	$T_{t1} = 0.5$sec	$T_{t2} = 0.6$sec

PROCEDURE:

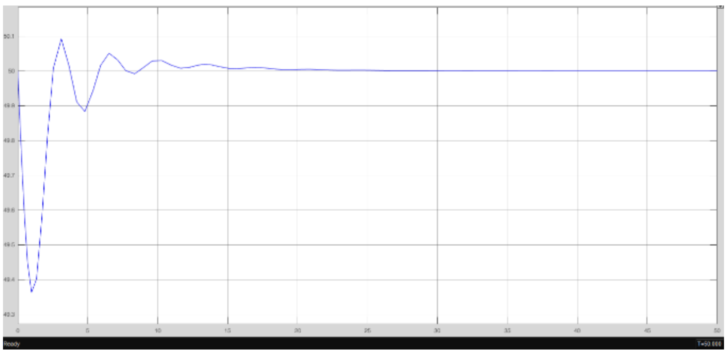
1. Enter the command window of the MATLAB.
2. Create a new Model by selecting File - New – Model
3. Pick up the blocks from the simulink library browser and form a block diagram.
4. After forming the block diagram, save the block diagram and click run.
5. Double click the scope and view the result.

Simulink Model for Two Area LFC With Control:

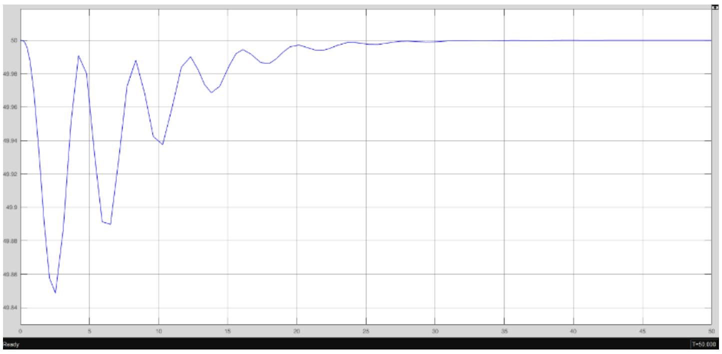


MODEL GRAPH:

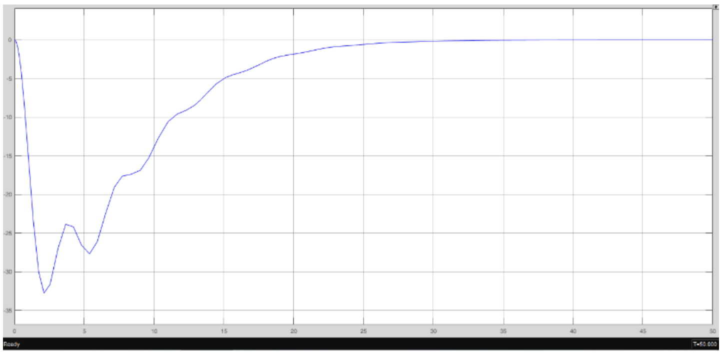
Frequency plot of Area-1:



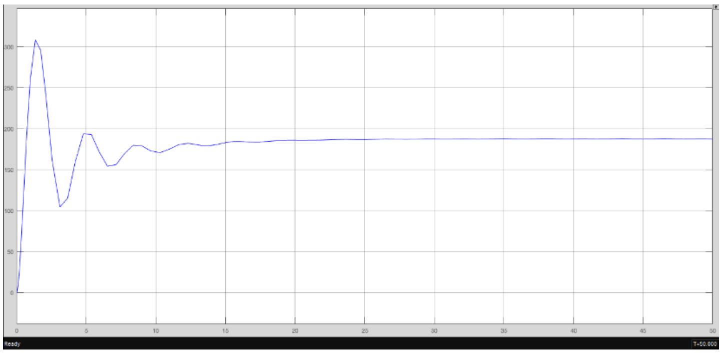
Frequency plot of Area-2:



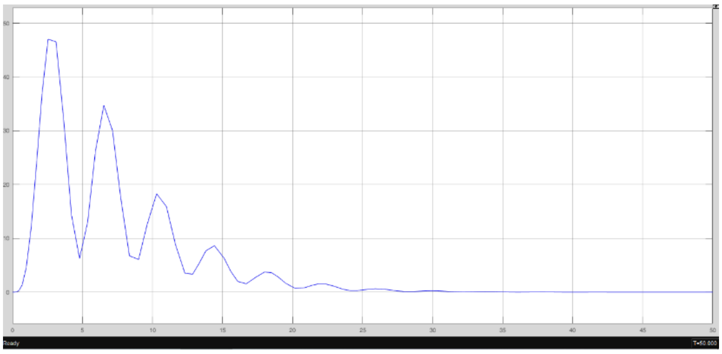
Tie Line Power:



Mechanical Input Power of Area-1:



Mechanical Input Power of Area-2:



RESULT:

Experiment No: Date:

TRANSIENT STABILITY ANALYSIS

AIM:

To determine the transient stability of a single machine connected to infinite bus.

APPARATUS: Personal Computer with MATLAB Software

THEORY:

Need to be written by Students by referring Text Books

PROCEDURE:

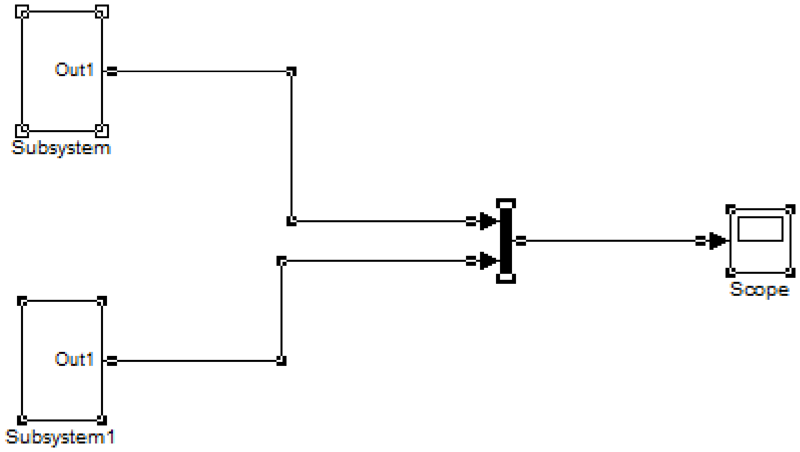
1. Enter the command window of the MATLAB.
2. Create a new Model by selecting File - New – Model
3. Pick up the blocks from the simulink library browser and form a block diagram.
4. After forming the block diagram, save the block diagram and click run.
5. Double click the scope and view the result.

PROBLEM:

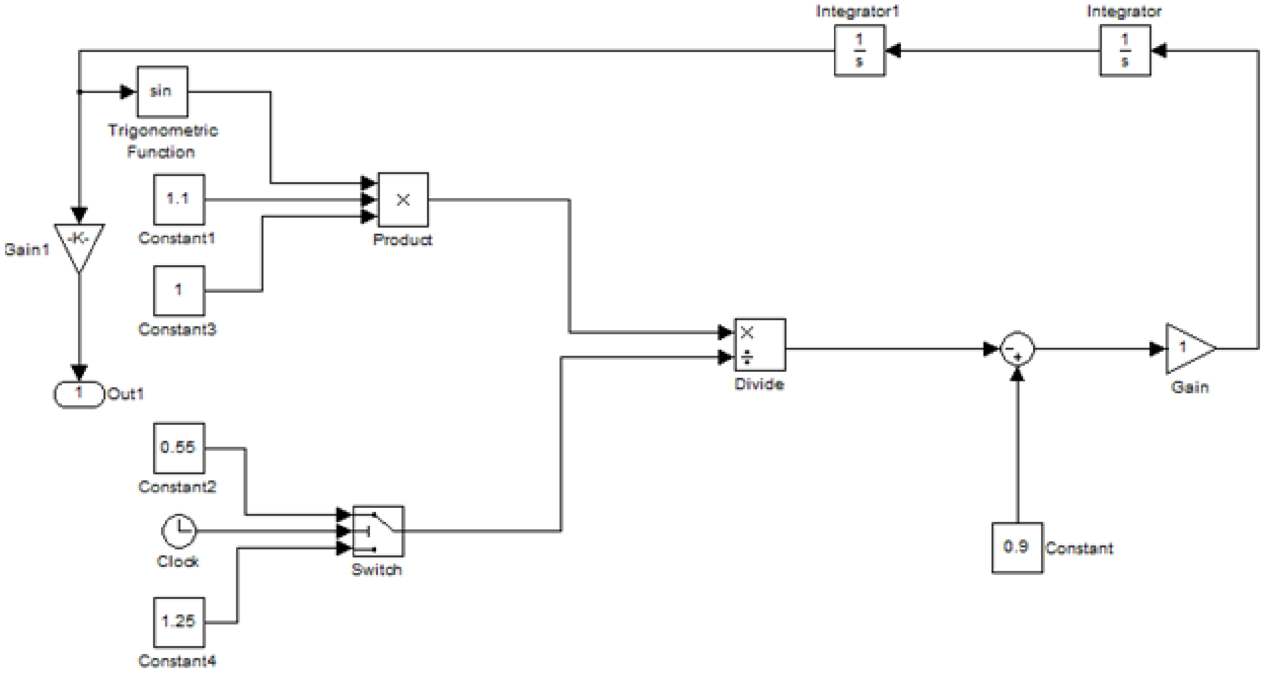
A 20 MVA, 50 Hz generator delivers 18 MW over a double circuit line to an infinite bus. The generator has KE of 2.52 MJ/MVA at rated speed. The generator transient reactance is X'd=0.35 p.u. Each transmission circuit has R=0 and a reactance of 0.2 pu on a 20 MVA base.|E'|=1.1 p u and infinite bus voltage V=1.0/_00.A three-phase short circuit occurs at the mid point of one of the transmission lines. Plot swing curves with fault cleared by simultaneous opening of breakers at both ends of the line at 2.5 cycles and 6.25 cycles after the occurrence of fault. Also plot the swing curve over the period of 0.5s if the fault is sustained.

Note: Before running simulation, integrator 1 has to be initialized to pre fault value of δ, i.e., δ0. This can be done by double-clicking on integrator 1 block and changing the initial value from 0 to δ0 (in radians). Also double click the switch block and change the threshold value from 0 to the fault clearing time (in sec).

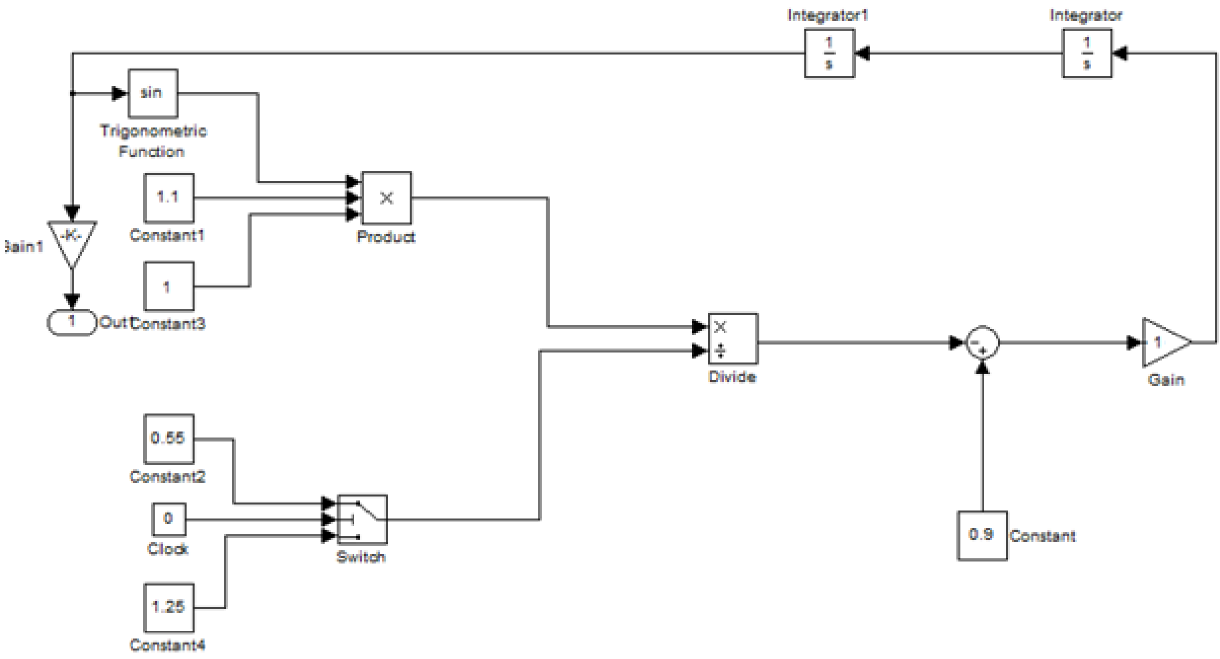
SIMULINK MODEL:



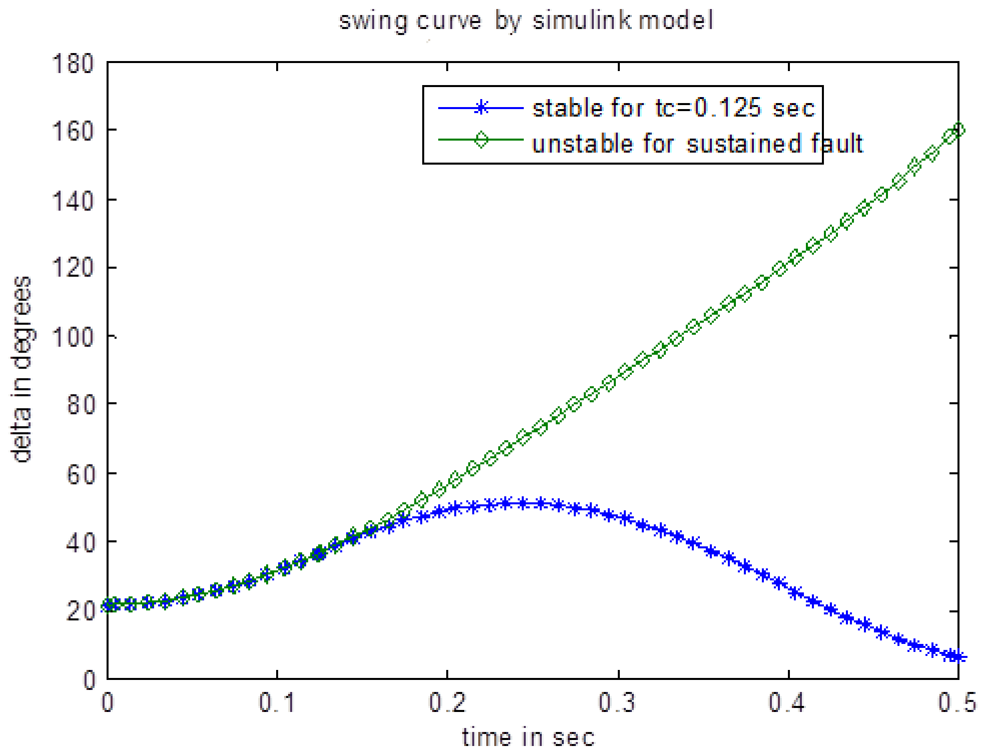
SUBSYSTEM DETAILS:



SUBSYSTEM1 DETAILS:



EXPECTED OUTPUT:



RESULT: