Power System Analysis Lab (20A02601P)

By PIDT Baladuraikannan
Assistant Professor
VEMU Institute of Technology

VEMU INSTITUTE OF TECHNOLOGY

DEPT.OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION OF THE INSTITUTE

- To be a premier institute for professional education producing dynamic and vibrant force of technocrats with competent skills, innovative ideas and leadership qualities to serve the society with ethical and benevolent approach.

MISSION OF THE INSTITUTE

- To create a learning environment with state-of-the art infrastructure, well equipped laboratories, research facilities and qualified senior faculty to impart high quality technical education.
- To facilitate the learners to foster innovative ideas, inculcate competent research and consultancy skills through Industry-Institute Interaction.
- To develop hard work, honesty, leadership qualities and sense of direction in rural youth by providing value based education.

VISION OF THE DEPARTMENT

- To produce professionally deft and intellectually adept Electrical and Electronics Engineers and equip them with the latest technological skills, research & consultancy competencies along with social responsibility, ethics, Lifelong Learning and leadership qualities.

MISSION OF THE DEPARTMENT

- To produce competent Electrical and Electronics Engineers with strong core knowledge, design experience & exposure to research by providing quality teaching and learning environment.
- To train the students in emerging technologies through state - of - the art laboratories and thus bridge the gap between Industry and academia.
- To inculcate learners with interpersonal skills, team work, social values, leadership qualities and professional ethics for a holistic engineering professional practice through value based education.

PROGRAM EDUCATIONAL OBJECTIVES(PEOs)

Programme Educational Objectives (PEOs) of B.Tech (Electrical and Electronics Engineering) **program are:**

Within few years of graduation, the graduates will

PEO 1: Provide sound foundation in mathematics, science and engineering fundamentals to analyze, formulate and solve complex engineering problems.

PEO 2: Have multi-disciplinary Knowledge and innovative skills to design and develop Electrical & Electronics products and allied systems.

PEO 3: Acquire the latest technological skills and motivation to pursue higher studies leading to research.

PEO 4: Possess good communication skills, team spirit, ethics, modern tools usage and the life-long learning needed for a successful professional career.

PROGRAM OUTCOMES (POs)

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

On completion of the B.Tech. (Electrical and Electronics Engineering) degree, the graduates will be able to

PSO-1: Higher Education: Apply the fundamental knowledge of Mathematics, Science, Electrical and Electronics Engineering to pursue higher education in the areas of Electrical Circuits, Electrical Machines, Electrical Drives, Power Electronics, Control Systems and Power Systems.

PSO-2: Employment: Get employed in Public/Private sectors by applying the knowledge in the domains of design and operation of Electronic Systems, Microprocessor based control systems, Power systems, Energy auditing etc.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B. Tech III-II Sem. (EEE)

L	T	P	C
0	0	3	1.5

(20A02601P) POWER SYSTEM ANALYSIS LAB

Course Objectives:

The objectives of this course include

- To do the experiments (in machines lab) on various power system concepts like determination of sequence impedance, fault analysis, finding of sub transient reactance's.
- To draw the equivalent circuit of three winding transformer by conducting a suitable experiment.
- To develop the MATLAB program for formation of Y and Z buses. To develop the MATLAB programs for Gauss-Seidel and fast decoupled load flow studies.
- To develop the SIMULINK model for single area load frequency problem.

List of Experiments

1. Determination of Sequence Impedances of Cylindrical Rotor Synchronous Machine
2. Determination of Sequence Impedances of salient pole Synchronous Machine
3. LG Fault Analysis on an un loaded alternator
4. LL Fault Analysis on conventional phases
5. LLG Fault Analysis
6. LLLG Fault Analysis
7. Determination of Sub transient reactance of salient pole synchronous machine
8. Equivalent circuit of three winding transformer.
9. Y_{Bus} formation using Soft Tools
10. Z_{Bus} formation using Soft Tools
11. Gauss-Seidel load flow analysis using Soft Tools
12. Newton-Raphson load flow analysis using Soft Tools
13. Fast decoupled load flow analysis using Soft Tools
14. Solve the Swing equation and Plot the swing curve
15. Develop a model for a uncontrolled single area load frequency control problem and simulate the same using Soft Tools.
16. Develop a model for PI controlled single area load frequency control problem and simulate the same using Soft Tools.
17. Develop a model for a uncontrolled two area load frequency control problem and simulate the same using Soft Tools.
18. Develop a model for PI controlled two area load frequency control problem and simulate the same using Soft Tools.

Course Outcomes:

- After completion of the course the student will able to
- Get the practical knowledge on calculation of sequence impedance, fault currents, voltages and sub transient reactance's. Get the practical knowledge on how to draw the equivalent circuit of three winding transformer.
- Get the knowledge on development of MATLAB program for formation of Y and Z buses.
- Get the knowledge on development of MATLAB programs for Gauss-Seidel and Fast Decouple Load Flow studies.
- Get the knowledge on development of SIMULINK model for single area load frequency problem.

GENERAL INSTRUCTIONS FOR LABORATORY CLASSES

DO'S

1. Without Prior permission do not enter into the Laboratory.
2. While entering into the LAB students should wear their ID cards.
3. The Students should come with proper uniform.
4. Students should sign in the LOGIN REGISTER before entering into the laboratory.
5. Students should come with observation and record note book to the laboratory.
6. Students should maintain silence inside the laboratory.
7. Circuit connections must be checked by the lab-in charge before switching the supply

DONT'S

8. Students bringing the bags inside the laboratory..
9. Students wearing slippers/shoes insides the laboratory.
10. Students scribbling on the desk and mishandling the chairs.
11. Students using mobile phones inside the laboratory.
12. Students making noise inside the laboratory.
13. Students mishandle the devices.
14. Students write anything on the devices

EXP. No. **DATE:**

SEQUENCE IMPEDANCE MEASUREMENTS OF 3-Ø ALTERNATOR

Aim: To Measure the following sequence impedances of a Cylindrical Rotor Synchronous Machine

i) Positive sequence impedance

ii) Negative sequence impedance

iii) Zero sequence impedance

Apparatus:

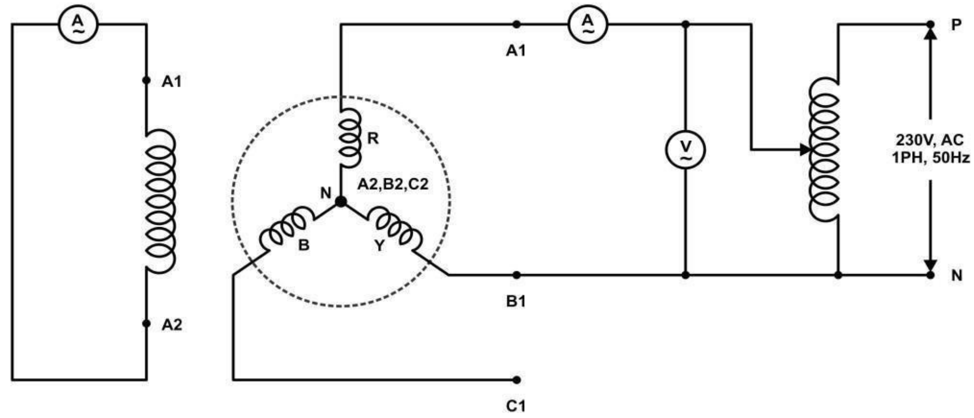
S. No	Apparatus	Range	Quantity
1.	Alternator coupled to motor drive	415V, 1KVA, 1500RPM	1
2.	RPM meter	(1-9999) Digital	1
3.	Variac	1-Ø, 230/0-270V AC	1
4.	Patch chords	-	As per requirement

Name Plate Details:

Alternator **3- Ø Induction Motor**

Measurement of Positive Sequence Impedance:

Circuit Diagram:



Procedure:

i) The machine should be in idle

ii) Alternator Field winding shorted thorough an Ammeter

iii) Apply single phase voltage to A1,B1 (two phases) Terminals of star connected alternator

iv) Switch 'ON' the single phase ac supply and Rotate the Alternator shaft by manually and Note down the ammeter & Voltmeter readings in table - keep the shaft position at the position of Maximum field current value

v) The single phase voltage input to Alternator terminal 'A1 & B1' is assumed as 'X^1'

vi) Repeat the above procedure with single phase ac input to Alternator terminal B1 & C1' is assumed as 'X^{11}'

vii) Repeat the above procedure with single phase ac input to Alternator terminal 'C1 & A1' is assumed as 'X^{111}'.

Positive Sequence Combination (A1,B1)

AC Voltmeter Reading (V_L)	AC Ammeter Reading(I_L)	AC Ammeter Reading(I_F)	X^1
Average (X^1)			

Combination (B1, C1)

AC Voltmeter Reading (V_L)	AC Ammeter Reading(I_L)	AC Ammeter Reading(I_F)	X^{11}
Average (X^{11})			

Combination of (C1, A1)

AC Voltmeter Reading (V_L)	AC Ammeter Reading(I_L)	AC Ammeter Reading(I_F)	X^{111}
Average (X^{111})			

Calculations:

$X^1 = V/2I_1$

$X^{11} = V/2I_2$

$X^{111} = V/2I_3$

$K = (X^1 + X^{11} + X^{111}) / 3$

$$M = \sqrt{\frac{(X1-K)^2+(X2-X3)^2}{2}}$$

Positive Sequence Reactance, X1=K - M

Measurement of Negative sequence Impedance:

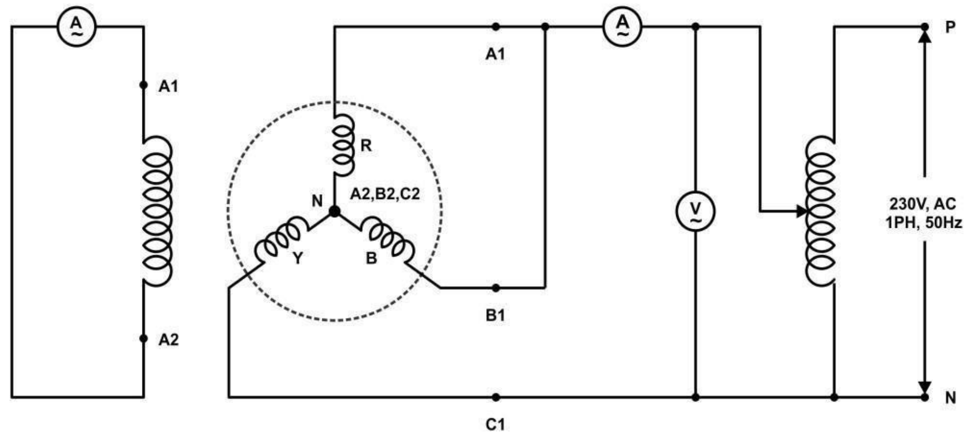


Diagram-2

Procedure:

1. Connections are made as per the above diagram-2
   i. field winding to shorted through an ammeter
   ii. alternator should be connected in star connection
   iii. short any two phase of alternator .Apply single phase voltage to short phases (A1or B1) & open phase (C1)
2. Run the alternator at its rated speed (1500 RPM)
3. Note down the readings & tabulate the values

Tabular Column:

Voltmeter Reading (V)	Ammeter Reading (I)	Z2(Ω)
Average		

$$Z_2 = \frac{V}{\sqrt{3}\, I}$$

$$X_2 = \sqrt{(Z2)^2 - (R2)^2}$$

Note: R2 is the Resistance of Alternator = 2.88 ohm

Measurement of Zero Sequence Impedance:

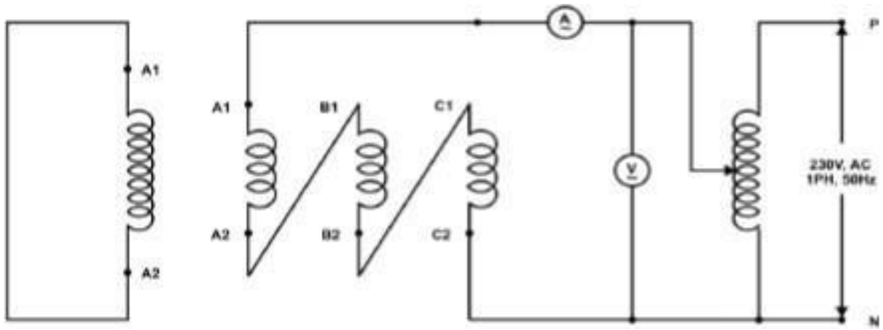


Diagram-3

Procedure:

1. Connections are made as per the abovediagram-3
   i. field winding to shorted
   ii. Connect all 3phase of the armature winding in series and apply a single phase variable voltage
2. Run the alternator at its rated speed (1500 RPM)
3. Note down the readings & tabulate the values

Tabular Column:

Voltmeter Reading (V)	Ammeter Reading (I)	Z0

Z0 (Average) =

$$Z_0 = X_0 = \frac{V}{3I}$$

Result:

Exp. No. Date:

LG FAULT ANALYSIS OF AN UNLOADED ALTERNATOR

Aim: To find the fault currents and fault voltages when a Line to ground fault (L-G) occurs on an unloaded alternator.

Apparatus:

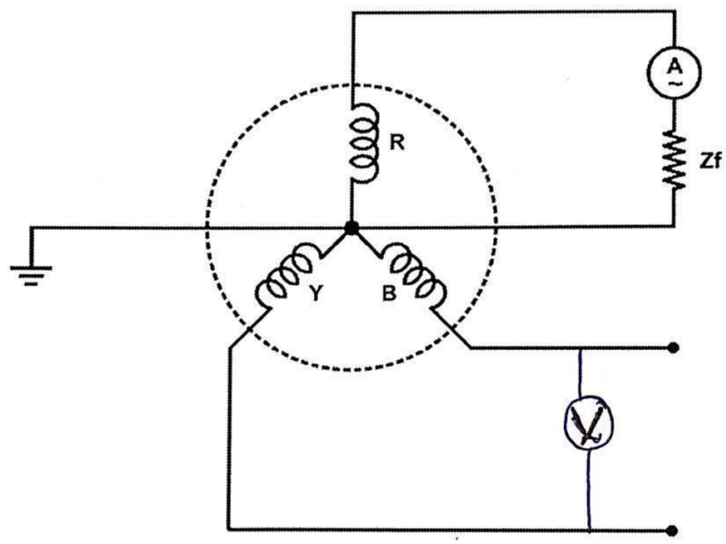
S. No	Apparatus	Range	Quantity
1.	Alternator coupled to motor drive	415V, 1KVA, 1500RPM	1
2.	RPM meter	(1-9999) Digital	1
3.	Variac	1-Ø, 230/0-270V AC	1
4.	Ammeter	0-2A MI	1
5.	Voltmeter	0-600V MI	1
4.	Patch chords	-	As per requirement

Name Plate Details:

Alternator **3- Ø Induction Motor**

Circuit Diagram:

Line to Ground fault



Procedure:

1. Connections are made as per circuit diagram.
2. Initially keep the rheostat at maximum position and switch ON the supply.
3. Run the motor at rated speed using the speed control knob provided.
4. Gradually apply the voltage to alternator using variac up to rated current flows through it.
5. Note down the values of voltage and current and calculate the fault current using the formula.

Tabular Column:

V_{RN} (V)	V_{YN} (V)	V_{BN} (V)	V_{RY} (V)	V_{YB} (V)	V_{BR} (V)	I_R (A)	I_{field} (A)

Theoretical Calculation:

$$\text{Fault Current } (I_F) = \frac{3\,Ea}{Z0+Z1+Z2+3ZF} = 3\,I_0$$

Where $I_0 = E_0 / (Z_1 + Z_2 + Z_0 + 3Z_f)$

Result:

Exp. No. Date:

LL FAULT ANALYSIS ON CONVENTIONAL PHASES

Aim: To find the fault currents and fault voltages when a Line to line faults (L-L) occurs on an unloaded alternator.

Apparatus:

S. No	Apparatus	Range	Quantity
1.	Alternator coupled to motor drive	415V, 1KVA, 1500RPM	1
2.	RPM meter	(1-9999) Digital	1
3.	Variac	1-Ø, 230/0-270V AC	1
4.	Ammeter	0-2A MI	1
5.	Voltmeter	0-600V MI	1
4.	Patch chords	-	As per requirement

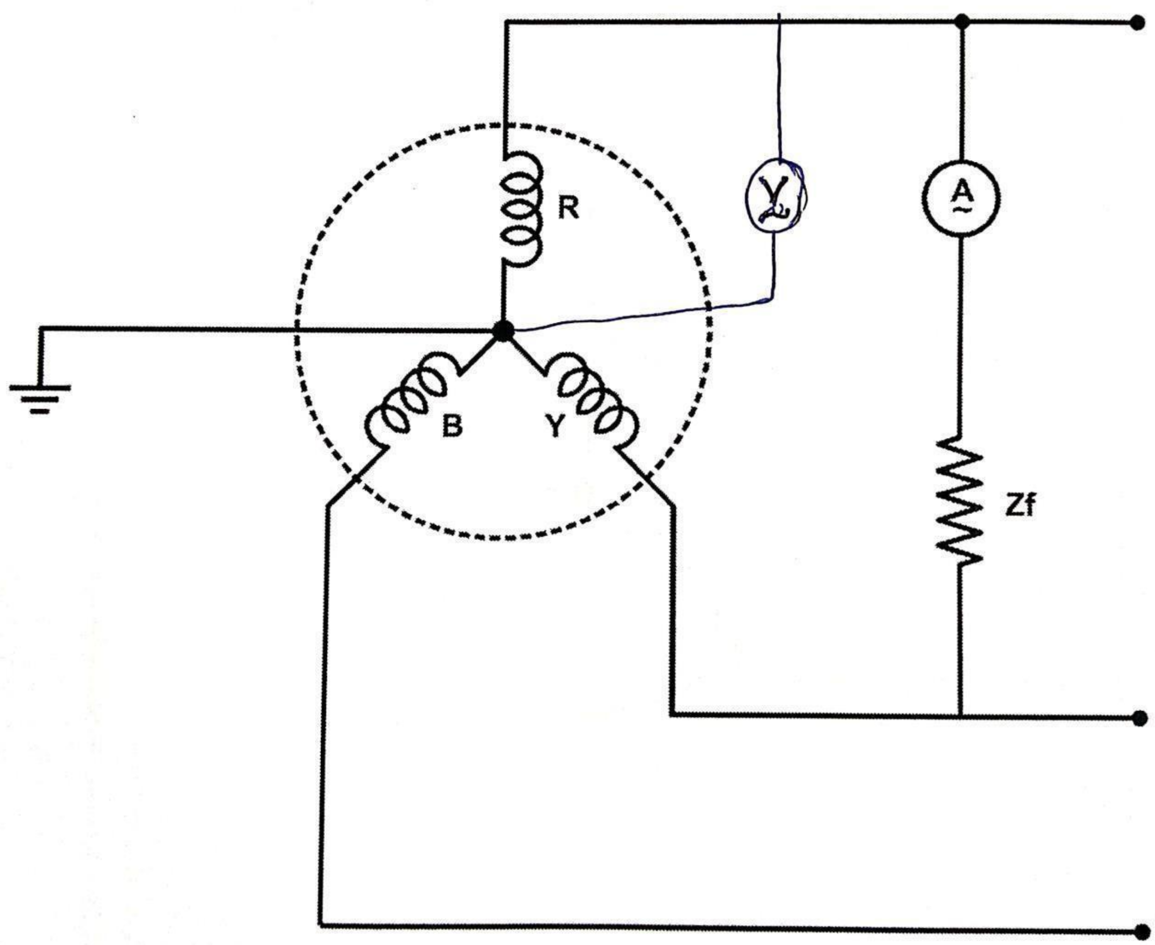
Name Plate Details:

Alternator **3- Ø Induction Motor**

Circuit Diagram:

Line to Line fault (L-L):

Circuit Diagram:



Procedure:

1. Connections are made as per circuit diagram.
2. Initially keep the rheostat at maximum position and switch ON the supply.
3. Run the motor at rated speed using the speed control knob provided.
4. Gradually apply the voltage to alternator using variac up to half of its rated current.
5. Note down the values of voltage and current and calculate the fault current using the formula.

Tabular Column:

V_{RN} (V)	V_{YN} (V)	V_{BN} (V)	V_{RY} (V)	V_{YB} (V)	V_{BR} (V)	I_R (A)	I_{field} (A)

Theoretical Calculation:

Fault Current (I_F) = $\frac{3\,Ea}{Z0+Z1+Z2}$

Result:

Exp. No. Date:

LLG FAULT ANALYSIS

Aim: To find the fault currents and fault voltages when a Line to line and ground fault (LL-G) occurs on an unloaded alternator.

Apparatus:

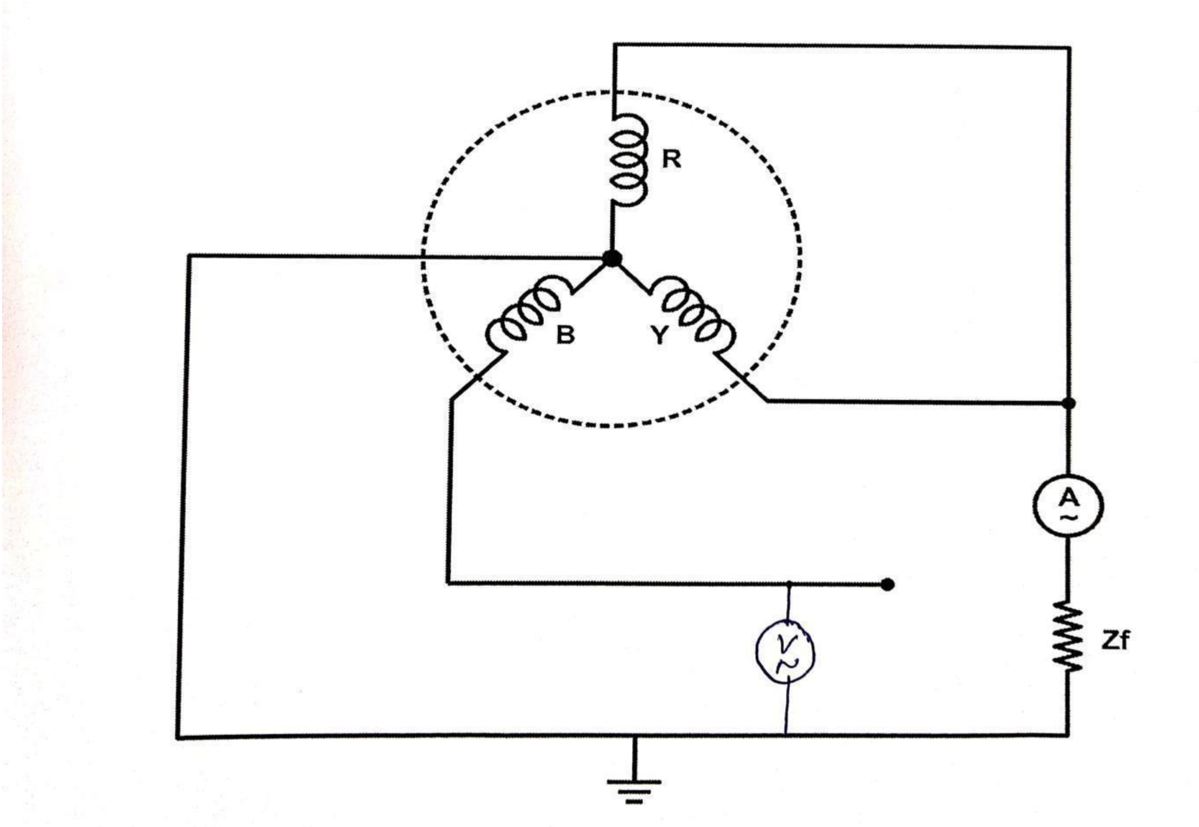
S. No	Apparatus	Range	Quantity
1.	Alternator coupled to motor drive	415V, 1KVA, 1500RPM	1
2.	RPM meter	(1-9999) Digital	1
3.	Variac	1-Ø, 230/0-270V AC	1
4.	Ammeter	0-2A MI	1
5.	Voltmeter	0-600V MI	1
4.	Patch chords	-	As per requirement

Name Plate Details:

Alternator **3- Ø Induction Motor**

Line to line and ground fault (LL-G):

Circuit Diagram



Procedure:

1. Connections are made as per circuit diagram.
2. Initially keep the rheostat at maximum position and switch ON the supply.
3. Run the motor at rated speed using the speed control knob provided.
4. Gradually apply the voltage to alternator using variac up to half of its rated current.
5. Note down the values of voltage and current and calculate the fault current using the formula.

Tabular Column:

V_{RN} (V)	V_{YN} (V)	V_{BN} (V)	V_{RY} (V)	V_{YB} (V)	V_{BR} (V)	I_R (A)	I_{field} (A)

Theoretical Calculation:

Ia1=Ea / {z1+[z2 (z0+3zf)/z0+z2+3zf]}

Ia0= (Ea - z1Ia1) / (z0+3zf)

IF=3Ia0

Exp. No. Date:

LLLG FAULT ANALYSIS

Aim: To find the fault currents and fault voltages when a Three phase to ground fault (LLL-G) occurs on an unloaded alternator.

Apparatus:

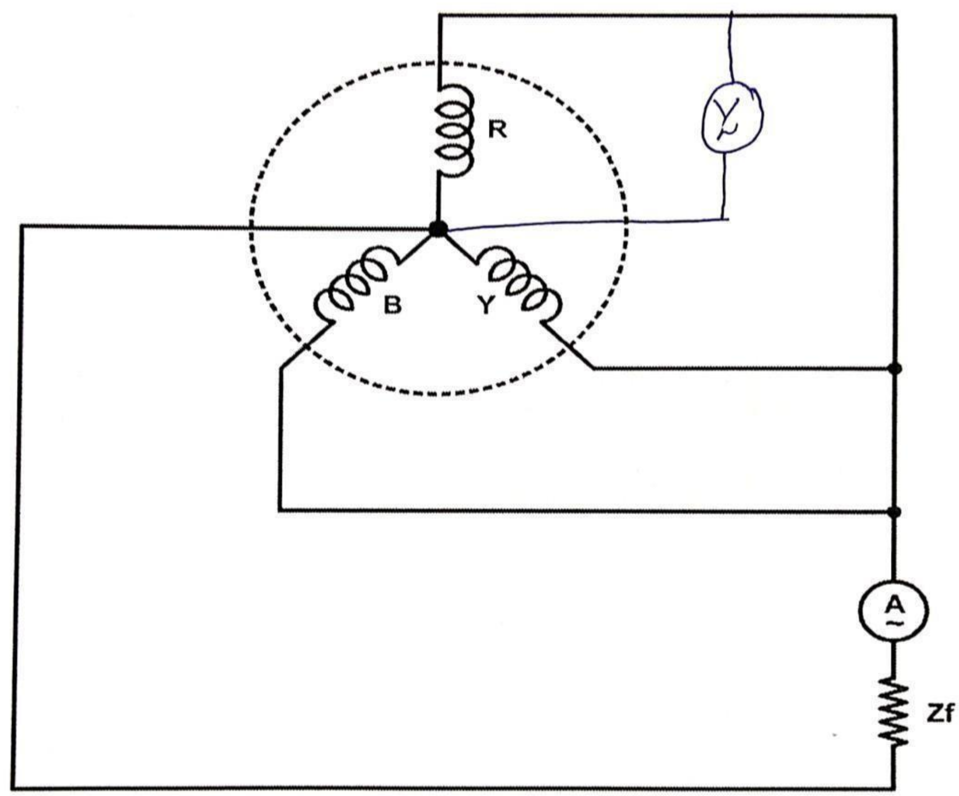
S. No	Apparatus	Range	Quantity
1.	Alternator coupled to motor drive	415V, 1KVA, 1500RPM	1
2.	RPM meter	(1-9999) Digital	1
3.	Variac	1-Ø, 230/0-270V AC	1
4.	Ammeter	0-2A MI	1
5.	Voltmeter	0-600V MI	1
4.	Patch chords	-	As per requirement

Name Plate Details:

Alternator **3- Ø Induction Motor**

Three phase to ground fault (LLL-G):

Circuit Diagram



Procedure:

1. Connections are made as per circuit diagram.
2. Initially keep the rheostat at maximum position and switch ON the supply.
3. Run the motor at rated speed using the speed control knob provided.
4. Gradually apply the voltage to alternator using variac up to half of its rated current.
5. Note down the values of voltage and current and calculate the fault current using the formula.

Tabular Column:

V_{RN} (V)	V_{YN} (V)	V_{BN} (V)	V_{RY} (V)	V_{YB} (V)	V_{BR} (V)	I_R (A)	I_{field} (A)

Theoretical Calculation:

$I_F = \sqrt{3}E_R / (Z1+Zf)$

Result:

SUBTRANSIENT REACTANCE MEASUREMENT OF A 3-Ø ALTERNATOR

Aim: To determine the sub-transient direct axis reactance and quadrature axis reactance of a salient pole alternator.

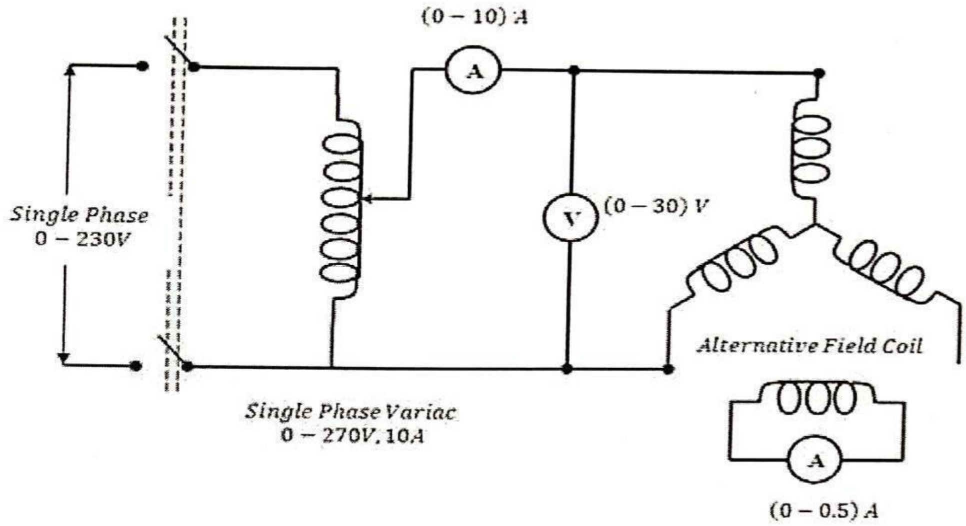
Apparatus:

S. No	Apparatus	Range	Quantity
1.	Alternator coupled to motor drive	415V, 1KVA, 1500RPM	1
2.	RPM meter	(1-9999) Digital	1
3.	Variac	1-Ø, 230/0-270V AC	1
4.	Ammeter	0-2A MI	1
5.	Ammeter	0-2A MC	1
6.	Voltmeter	0-150V MI	1
7.	Patch chords	-	As per requirement

Name Plate Details:

Alternator **3- Ø Induction Motor**

Circuit Diagram:



PROCEDURE:

1. Make the connections as shown in the circuit diagram.
2. Set the variac output to zero.
3. Switch on the supply.
4. Gradually increase the variac output and set armature – current to a suitable value.
5. Slowly rotate the armature and see the field current and armature current readings. Note the values of applied voltage and armature current when field current is maximum and also when it is minimum
6. Repeat the step five for other applied voltage. Take care that armature current does not go beyond its rated value during the experiment.

TABULATION:

S.No	Armature Voltage	Armature voltage phase	Armature Current		Xd''	Avg Xd"	Xq"	Avg Xq"
			If Max	If Min				
01								
02								
03								

CALCULATION:

Direct axis sub transient

Reactance's Xd" = $\frac{Voltage/Phase}{Current/Phese}$ (If Max)

Quadrature axis sub transient

Reactance Xq" = $\frac{Voltage/Phase}{Current/Phese}$ (If Min)

$$Xd''\ (pu) = \frac{Xd''}{Base\ Impedence}$$

$$Xq''\ (pu) = \frac{Xq''}{Base\ Impedence}$$

$$\text{Base Impedance} = \frac{(Base\ Voltage)^2}{Base\ VA}$$

Result:

Exp. No. Date:

EQUIVALENT CIRCUIT OF A THREE WINDING TRANSFORMER

Aim: To draw the Equivalent Circuit of a Three Winding Transformer by conducting Open circuit and Short Circuit Tests.

Apparatus:

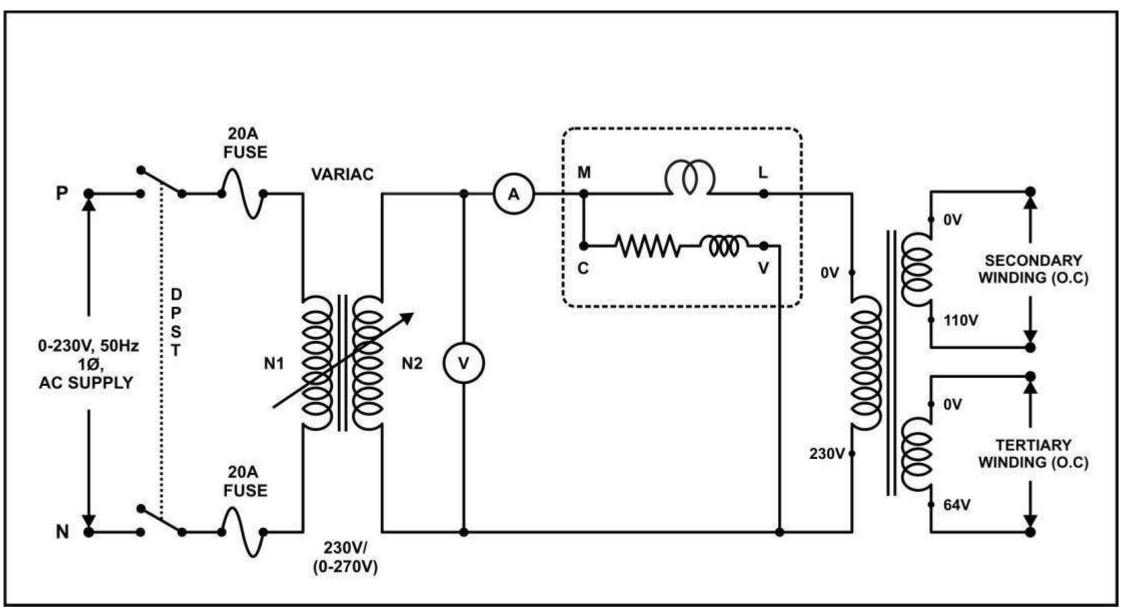
- Three Winding Transformer Trainer Set up
- Patch Chords

Name Plate Details:

Capacity	1 KVA
Primary	0-230VAC
Secondary-1	0-110VAC
Secondary-2	0-64VAC

Circuit Diagram:

For Open Circuit Test (Primary excited & both secondary's are open)



Procedure:

1. Connections are made as per the above Diagram-1, Connect digital Ammeter , Voltmeter & Power meter as per diagram
2. Keep the dimmer stat in zero (minimum) position.
3. Switch ON the main MCB.
4. Slowly apply the rated input voltage i.e., 220V to the primary of the transformer by varying the dimmer stat.
5. Note down the readings of Voltmeter, Ammeter and Wattmeter.

Tabular Column:

Voltage (V)	Current (A)	Power (W)

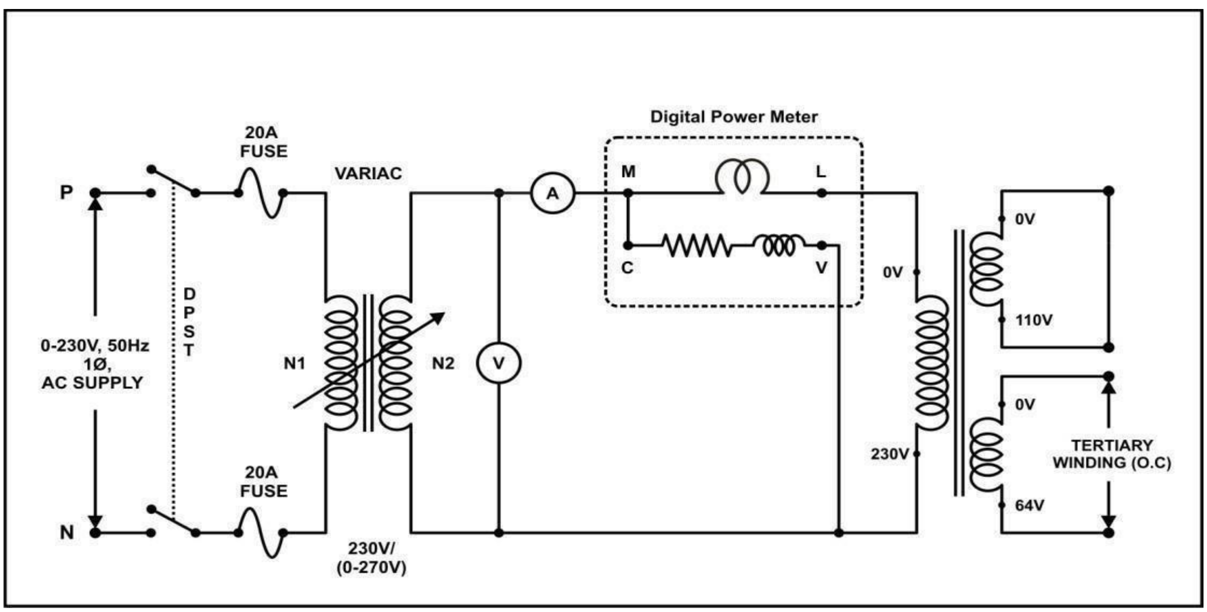
Theoretical Calculations:

Power factor, $COSØ_0 = W_0 / V_0 * I_0$

Core loss resistance, $R_0 = V_0 / I_0 * COSØ_0$

Magnetizing Reactance, $X_0 = V_0 / I_0 * SinØ_0$

For Short Circuit Test-1 (Primary excited & Secondary Shorted & tertiary winding Open)



Procedure:

1. Connections are made as per the above connection diagram
2. Short Circuit the Secondary winding of the transformer .
3. Keep the dimmer stat in zero (minimum) position.
4. Switch ON the main MCB.
5. Gradually increase the voltage up to the transformer rated current (5A) by varying the dimmer stat.
6. Note down the readings of Voltmeter, Ammeter and Wattmeter.

Tabular Column:

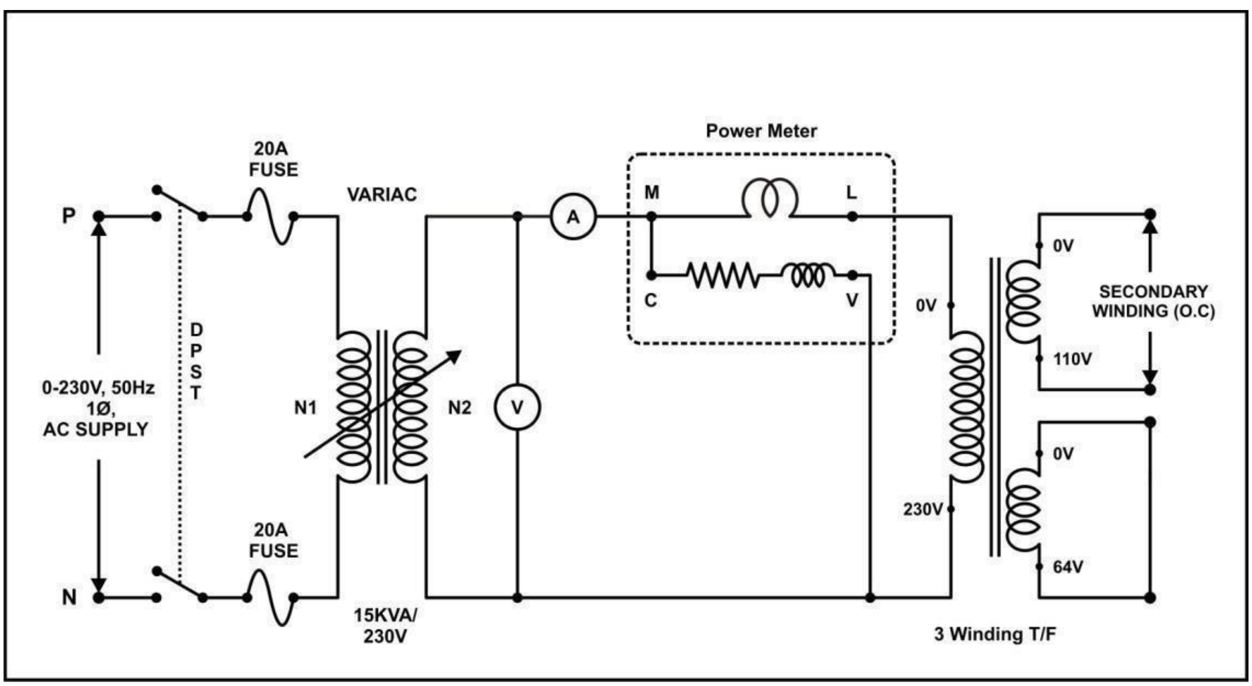
Voltage (V)	Current (A)	Power (W)

Theoretical Calculations:

$$Z_{12} = V_1 / I_1 =$$

$$r_{12} = P_1 / I_1^2 =$$

Short Circuit Test-2 (Primary excited & Secondary (110V) open & tertiary winding (64V) Shorted



Procedure:

1. Connections are made as per the above connection diagram
2. Short Circuit the Secondary winding (64v) of the transformer .
3. Keep the dimmer stat in zero (minimum) position.
4. Switch ON the main MCB.
5. Gradually increase the voltage up to the transformer rated current (5A) by varying the dimmer stat.
6. Note down the readings of Voltmeter, Ammeter and Wattmeter

Tabular Column:

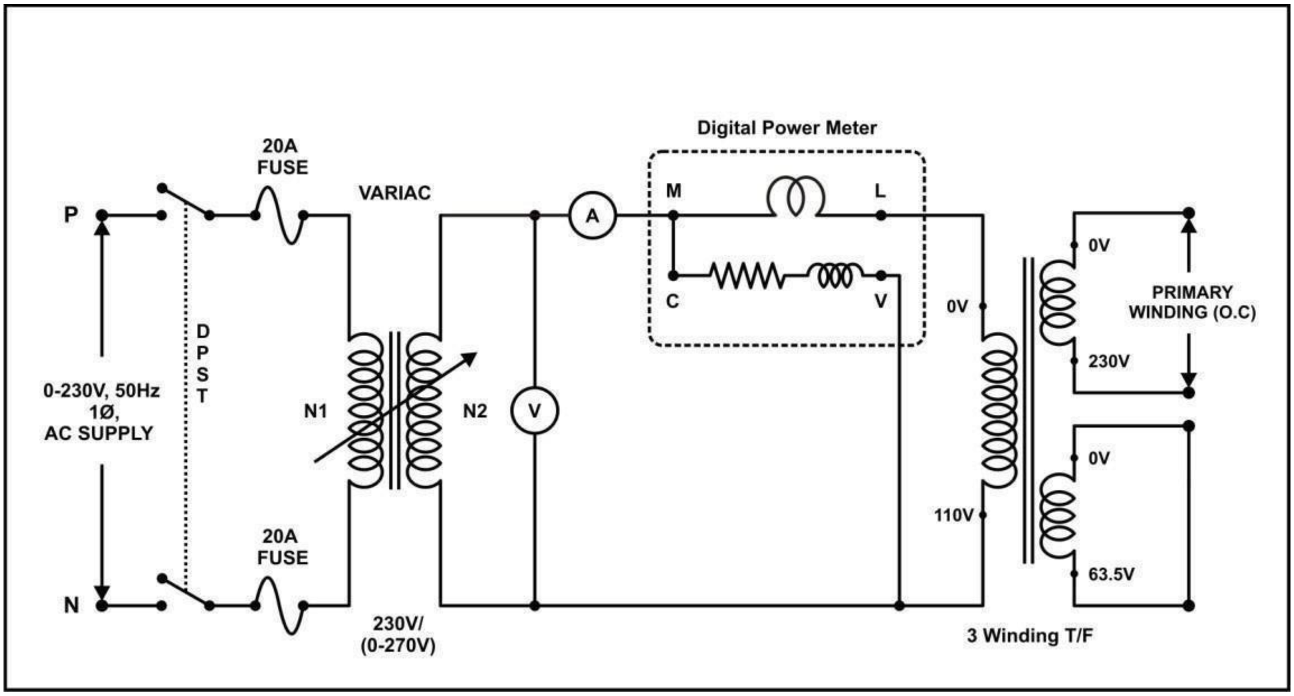
Voltage (V)	Current (A)	Power (W)

Theoretical Calculations:

$$Z_{13} = V_2 / I_2 =$$

$$r_{13} = P_2 / I_2^2 =$$

Short Circuit Test-3 (Secondary (110v) excited & Primary open & tertiary winding (64V) Shorted



Procedure:

1. Connections are made as per the above connection diagram
2. Short Circuit the Secondary winding (64v) of the transformer .
3. Keep the dimmer stat in zero (minimum) position.
4. Switch ON the main MCB.
5. Gradually increase the voltage up to the transformer rated current (5A) by varying the dimmer stat. (note do not apply more than 110VAC)
6. Note down the readings of Voltmeter, Ammeter and Wattmeter

Tabular Column:

Voltage (V)	Current (A)	Power (W)

Theoretical Calculations:

$$Z_{23} = V_3 / I_3 =$$

$$R_{23} = P_3 / I_3^2 =$$

Transferring both values to primary side

$$Z^1_{23} = Z_{23} \times \left(\frac{N_1}{N_2}\right)^2 =$$

$$\gamma^1_{23} = \gamma_{23} \times \left(\frac{N_1}{N_2}\right)^2 =$$

The equivalent circuit resistance r_1, r_2, r_3 are

$$r_1 = \frac{1}{2}(r_{12} + r_{13} - r^1_{23})$$

$$=$$

$$r_2 = \frac{1}{2}(r_{12} + r^1_{23} - r_{13})$$

$$=$$

$$r_3 = \frac{1}{2}(r^1_{23} + r_{13} - r_{12})$$

$$=$$

Leakage impedance referred to primary side,

$$Z_1 = \frac{1}{2}(Z_{12} + Z_{13} - Z^1_{23})$$

$$=$$

$$Z_2 = \frac{1}{2}(Z_{12} + Z^1_{23} + Z_{13})$$

$$=$$

$$Z_3 = \frac{1}{2}(Z_{13} + Z^1_{23} - Z_{12})$$

$$=$$

Leakage Reactances referred to primary side,

$$X_1 = \sqrt{z_1^2 - r_1^2}$$

$$=$$

$$X_2 = \sqrt{z_2^2 - r_2^2}$$

$$=$$

$$X_3 = \sqrt{z_3^2 - r_3^2}$$

$$=$$

Leakage impedance referred to primary winding,

$$X_1 = r_1 + j\, x_1 =$$

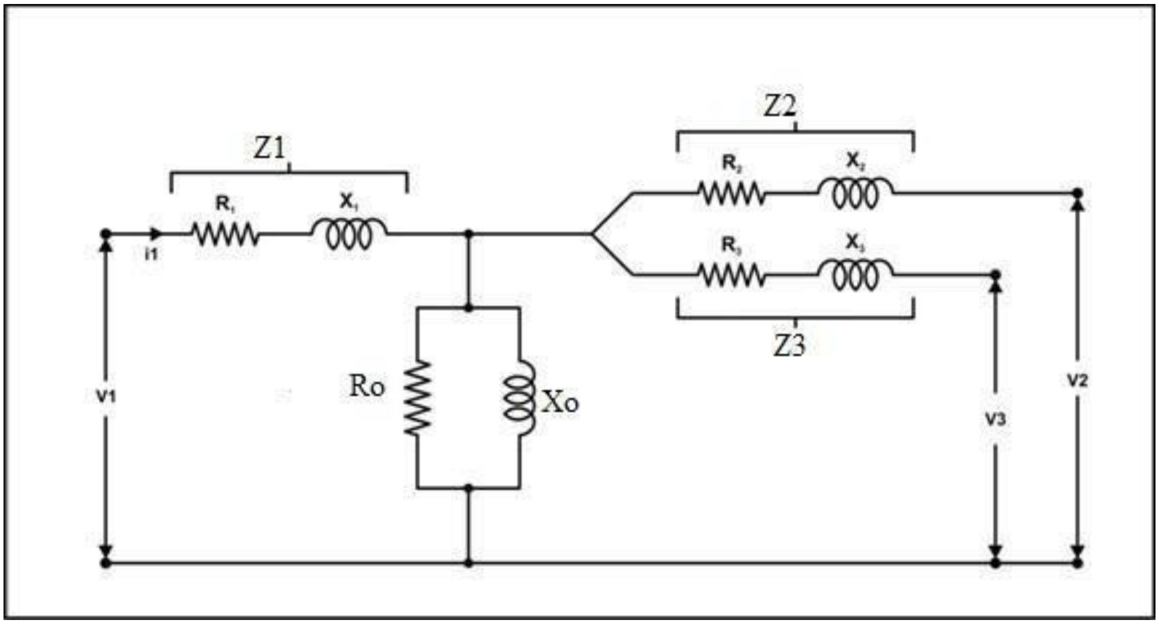
Leakage impedance of secondary winding referred to primary side,

$$Z_2 = r_2 + j\, x_2 \left(\frac{N_2}{N_1}\right)^2$$

Leakage impedance of tertiary winding referred to primary side,

$$Z_3 = r_3 + j\,x_3\,\left(\frac{N_2}{N_1}\right)^2$$

From the above values draw the Equivalent circuit, as below



Result:

EXP.NO: **DATE:**

Y_{BUS} FORMATION USING SOFT TOOLS

Aim: To form bus admittance matrix by using MATLAB and verify the output with theoretical output.

Apparatus Required:

S.No	Apparatus	Quantity
1.	Personal Computer	1
2.	Keyboard	1
3.	Mouse	1
4.	MATLAB Software	1

Procedure:

1. Turn on your personal computer.
2. Click on the MATLAB icon of your personal computer.
3. Click the file button and select the new Blank M-file.
4. Type the program on the new M-file for corresponding bus system.
5. After completion of the program, save and run.
6. Note down the bus admittance matrix.
7. Close the MATLAB tool and turnoff your pc .

Program:

```
clc
clear
zdata = [    From To    R     X ];
nl=zdata(:,1);
nr=zdata(:,2);
R=zdata(:,3);
X=zdata(:,4);
nbr=length(zdata(:,1));
```

```
nbus=max(max(nl),max(nr));
Z=R+j*X;                 % Branch Impedance
y=ones(nbr,1)./Z;   %   Branch   Admittance
Y=zeros(nbus,nbus);
for k=1: nbr;            % Formation of the off diagonalelements
if nl(k)>0 & nr(k)>0
Y(nl(k), nr(k)) = Y(nl(k), nr(k)) - y(k);
Y(nr(k), nl(k)) = Y(nl(k), nr(k));
end
end
for n=1: nbr             % Formation of the diagonal elements
for k=1: nbr
if nl(k) == n|nr(k) == n
Y(n,n) = Y(n,n) + y(k);
else
 end
end
end
Y
```

Theoretical Calculations:

Precautions:

1. Check and write the program without errors.
2. Properly turn on and turn off your pc

Result:

Z_{BUS} FORMATION USING SOFT TOOLS

Aim: To form bus impedance matrix by using MATLAB and verify the output with theoretical output.

Apparatus Required:

S.No	Apparatus	Quantity
1.	Personal Computer	1
2.	Keyboard	1
3.	Mouse	1
4.	MATLAB Software	1

Procedure:

1. Turn on your personal computer.
2. Click on the MATLAB icon of your personal computer.
3. Click the file button and select the new Blank M-file.
4. Type the program on the new M-file for corresponding bus system.
5. After completion of the program, save and run.
6. Note down the bus admittance matrix.
7. Close the MATLAB tool and turnoff your pc.

Program:

```
clc
clear
zdata = [    From To    R     X ];
nl=zdata(:,1);
nr=zdata(:,2);
R=zdata(:,3);
X=zdata(:,4);
nbr=length(zdata(:,1));
```

```
nbus=max(max(nl),max(nr));
Z=R+j*X;                % Branch Impedance
y=ones(nbr,1)./Z;   %   Branch   Admittance
Y=zeros(nbus,nbus);
for k=1: nbr;           % Formation of the off diagonalelements
if nl(k)>0 & nr(k)>0
Y(nl(k), nr(k)) = Y(nl(k), nr(k)) - y(k);
Y(nr(k), nl(k)) = Y(nl(k), nr(k));
end
end
for n=1: nbr            % Formation of the diagonal elements
for k=1: nbr
if nl(k) == n|nr(k) == n
Y(n,n) = Y(n,n) + y(k);
else
 end
end
end
zbus=inv(Y)
```

Theoretical Calculations:

Precautions:

1. Check and write the program without err ors .
2. Properly turn on and turn off your pc

Result:

EXP.NO: **DATE:**

GAUSS-SEIDEL LOAD FLOW ANALYSIS USING SOFT TOOLS

Aim:-To solve power flow problems by the method of Gauss-Seidel using MATLAB.

Apparatus Required:

S.No	Apparatus	Quantity
1.	Personal Computer	1
2.	Keyboard	1
3.	Mouse	1
4.	MATLAB Software	1

Procedure:

1. Turn on your personal computer.
2. Click on the MATLAB icon of your personal computer.
3. Click the file button and select the new Blank M-file.
4. Type the program on the new M-file for corresponding bus system.
5. After completion of the program, save and run.
6. Note down the bus admittance matrix.
7. Close the MATLAB tool and turnoff your pc.

Program:

```
Clear
basemva=100; accuracy=0.001; accel=1.8; maxiter=100;

% IEEE TEST SYSTEM BUS DATA

Busdata = [
          Bus   Bus    Voltage     Voltage       Load          Generation      Reactive          Static
          No.   Code   Magnitude   Angle                                       Power Limits      MVAR

                                             MW   MVAR      MW    MVAR       Qmin    Qmax      +     -
                                                                                               Qc    QL
                                                                                                           ];
Linedata = [

             Bus   Bus   R      X      1/2B   Line code
             nl    nr    p.u.   p.u.   p.u.   = 1 for T.L.
                                              >1 or <1 for Transformer tap setting   ];

lfybus          % form the bus admittance matrix
lfgauss         % Load flow solution by  Gauss-seidel method
busout          % Prints the power flow solution on  the screen
lineflow        % Computes and displays the line flow and losses
```

Theoretical Calculations:

Precautions:

1. Check and write the program without errors.
2. Properly turn on and turn off your pc

Result:

EXP.NO: **DATE:**

FAST DECOUPLED LOAD FLOW ANALYSIS USING MATLAB

Aim: To solve power flow problems by the method of fast decoupled using MATLAB.

Apparatus Required:

S.No	Apparatus	Quantity
1.	Personal Computer	1
2.	Keyboard	1
3.	Mouse	1
4.	MATLAB Software	1

Procedure:

1. Turn on your personal computer.
2. Click on the MATLAB icon of your personal computer.
3. Click the file button and select the new Blank M-file.
4. Type the program on the new M-file for corresponding bus system.
5. After completion of the program, save and run.
6. Note down the bus admittance matrix.
7. Close the MATLAB tool and turnoff your pc.

Program:

```
Clear
basemva=100; accuracy=0.001; accel=1.8; maxiter=100;

% IEEE TEST SYSTEM BUS DATA

busdata = [
          Bus   Bus    Voltage     Voltage       Load          Generation      Reactive        Static
          No.   Code   Magnitude   Angle                                     Power Limits    MVAR

                                            MW   MVAR      MW    MVAR       Qmin   Qmax     +     -
                                                                                            Qc    QL
                                                                                                   ];

% IEEE TEST SYSTEM LINE DATA

linedata = [
           Bus   Bus   R      X      1/2B   Line code
           nl    nr    p.u.   p.u.   p.u.   = 1 for T.L.
                                            >1 or <1 for Transformer tap setting    ];

lfybus          % form the bus admittance matrix
decouple        % Load flow solution by fast decouple method
busout          % Prints the power flow solution on the screen
lineflow        % Computes and displays the line flow and losses
```

Theoretical Calculations:

Precautions:

1. Check and write the program without errors.
2. Properly turn on and turn off your pc

Result:

EXP.NO: **DATE:**

SIMULINK MODEL FOR A SINGLE AREA POWER SYSTEM

Aim: Develop a Simulink model for a single area load frequency problem and simulate the same by using MATLAB.

Apparatus Required:

S.No	Apparatus	Quantity
1.	Personal Computer	1
2.	Keyboard	1
3.	Mouse	1
4.	MATLAB Software	1

Procedure:

1. Turn on your personal computer.
2. Click on the MATLAB icon of your personal computer.
3. Click the file button and select the new Blank M-file.
4. Type the program on the new M-file for corresponding bus system.
5. After completion of the program, save and run.
6. Note down the bus admittance matrix.
7. Close the MATLAB tool and turnoff your pc.

Simulation Diagram:

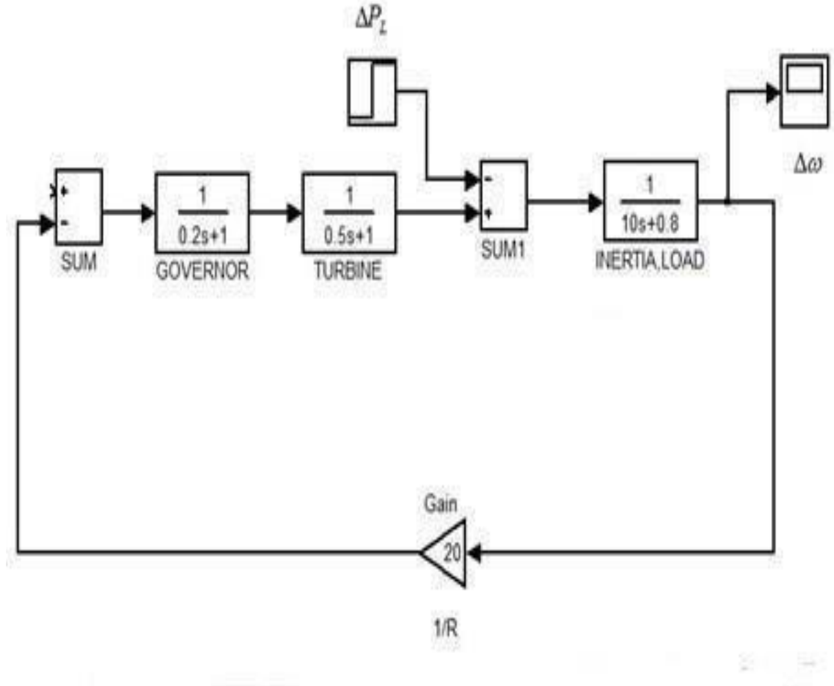


Fig: Simulink model for a single area power system without controller

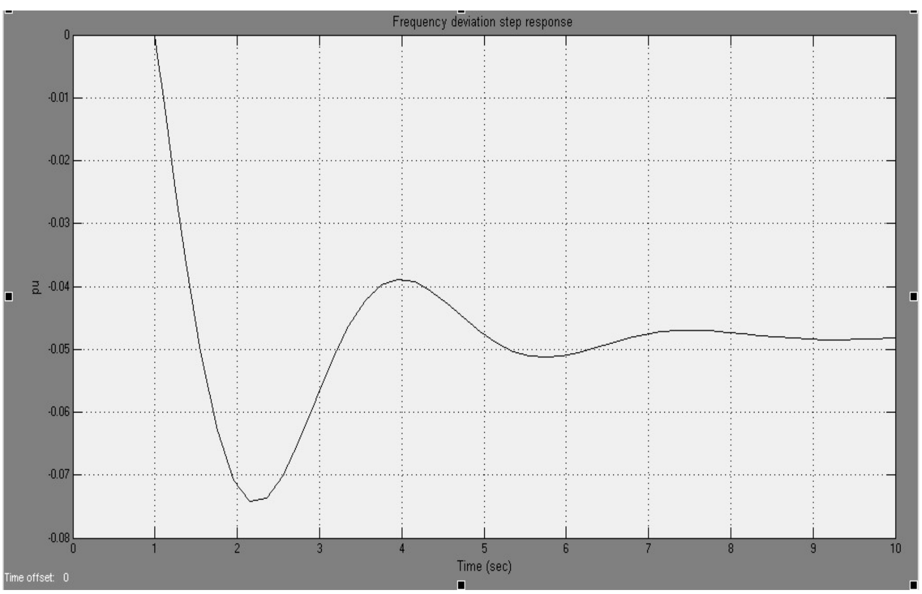


Fig: Frequency deviation step response with controller

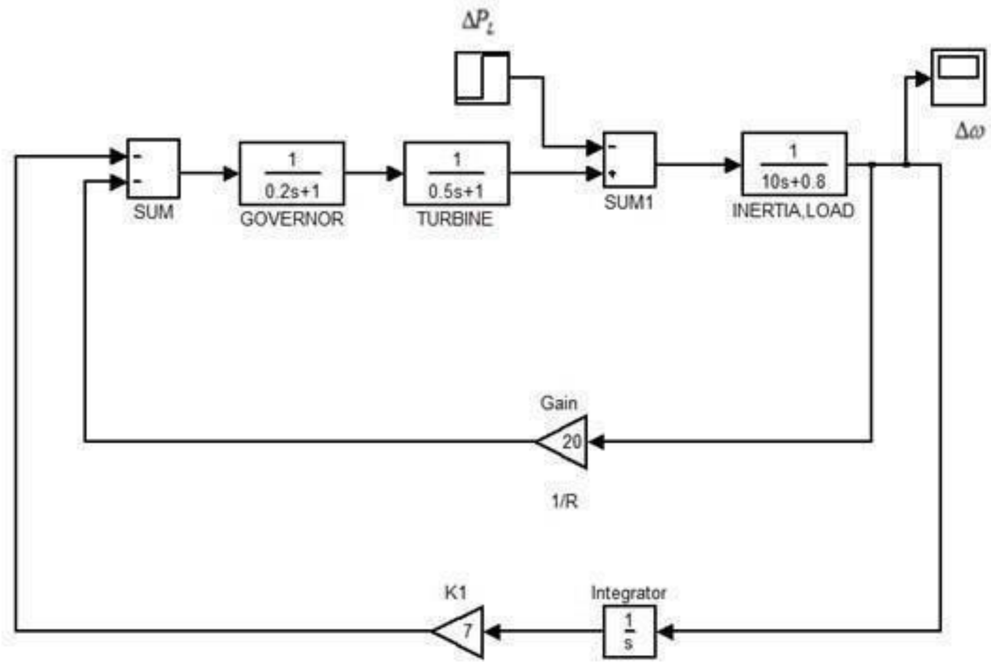


Fig: Simulink model for a single area power system with controller

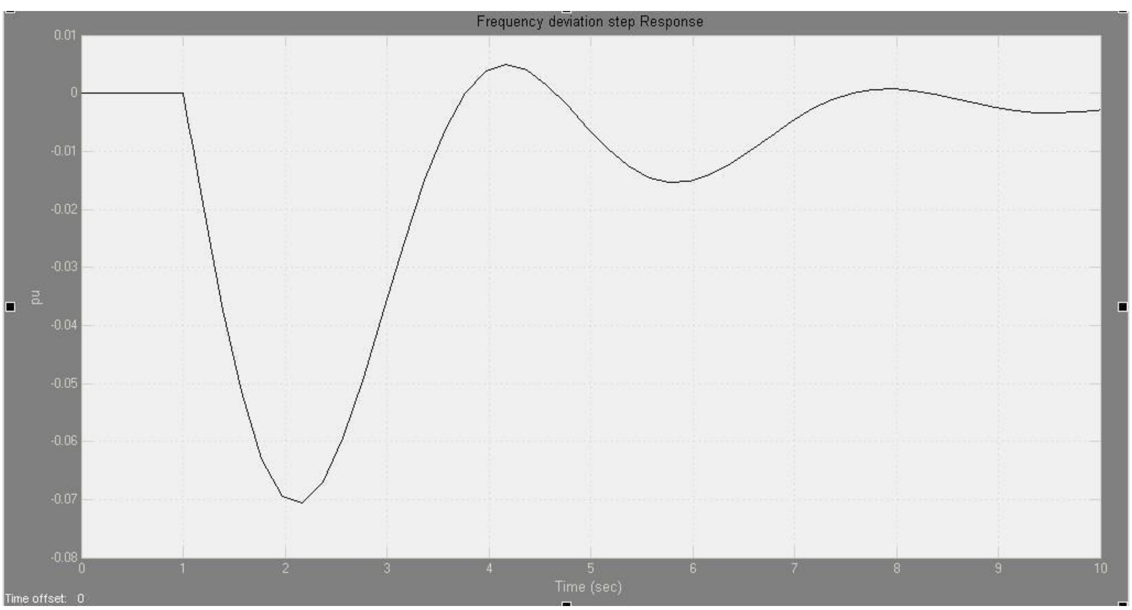


Fig.10.4: Frequency deviation step response with controller

Result: