MALLA REDDY COLLEGE OF ENGINEERING AND TECHNOLOGY

(Autonomous Institution – UGC, Govt. of India)
(Affiliated to JNTUH, Hyderabad, Approved by AICTE- Accredited by NBA & NAAC 'A' Grade – ISO 9001:2015 Certified)

Certificate

Department of ***Electrical and Electronics Engineering Certified that in the*** *bonafide Record of the work done by Mr./Miss*----------------------------- *Reg.No*-- ....*of B-Tech EEE*...................*YEAR*..........................*semester for the Academic year 20*.............*to 20*........................*in* ....*Laboratory*.

Date: *Staff Incharge* *HOD*

Internal Examiner *External Examiner*

CONTENTS

S.NO.	NAME OF THE EXPERIMENT	PAGE.NO	MARKS	SIGN

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: PROFESSIONALISM & CITIZENSHIP To create and sustain a community of learning in which students acquire knowledge and learn to apply it professionally with due consideration for ethical, ecological and economic issues.

PEO2: TECHNICAL ACCOMPLISHMENTS To provide knowledge-based services to satisfy the needs of society and the industry by providing hands on experience in various technologies in core field.

PEO3: INVENTION, INNOVATION AND CREATIVITY To make the students to design, experiment, analyze, interpret in the core field with the help of other multi-disciplinary concepts wherever applicable.

PEO4: PROFESSIONAL DEVELOPMENT To educate the students to disseminate research findings with good softs kills and become a successful entrepreneur.

PEO5: HUMAN RESOURCE DEVELOPMENT To graduate the students in building national capabilities in technology, education and research.

PROGRAMME SPECIFIC OBJECTIVES (PSOs)

PSO1 To develop a student community who acquire knowledge by ethical learning and fulfil the societal and industry needs in various technologies of core field.

PSO2 To nurture the students in designing, analyzing and interpreting required in research and development with exposure in multi-disciplinary technologies in order to mould them as successful industry ready engineers/entrepreneurs

PSO3 To empower students with all round capabilities who will be useful in making nation strong in technology, education and research domains.

PROGRAM OUTCOMES (POs)

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 modelling 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 multi-disciplinary 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.

MALLA REDDY COLLEGE OF ENGINEERING AND TECHNOLOGY

IV B. Tech EEE I SEM **L T/P/D**

- / 3 / -1.5

(R20A0288) POWER SYSTEMS LAB

COURSE OBJECTIVES:

- To perform testing of CT, PT's and Insulator strings.
- To determine the load flow analysis on a power system.
- To perform fault analysis on Transmission line models and Generators.
- Formation of Buses using direct inspection method.

List of Experiments

1. Y_{BUS} FORMATION USING MATLAB
2. Z BUS FORMATION USING MATLAB
3. GAUSS-SEIDEL LOAD FLOW ANALYSIS USING MATLAB
4. FAST DECOUPLED LOAD FLOW ANALYSIS USING MATLAB
5. ABCD PARAMETERS OF 3-PH TRANSMISSION MODEL
6. POWER CIRCLE DIAGRAM OF A 3-PH TRANSMISSION MODEL
7. FAULT ANALYSIS – I
8. FAULT ANALYSIS – II
9. CHARACTERISTICS OF OVER VOLTAGE RELAY
10. CHARACTERISTICS OF IDMT OVER CURRENT RELAY

Note: In the above listed experiments, any ten of the experiments are required to be conducted.

COURSE OUTCOMES:

After completion of this lab, the student will be able to

- Perform various load flow techniques
- Understand Different protection methods

EXP.NO: **DATE**:

Y $_{BUS}$ FORMATION USING MATLAB

AIM: To obtain the Y_{bus} matrix for the given power system using Direct inspection method and to verify the same using MATLAB.

APPARATUS REQUIRED: Personal Computer with MATLAB software.

FORMATION OF Y_{bus}:

Find the Y_{bus} matrix for the given power system data using Direct inspection method

Sending end	Receiving end	Reactance values in ohms
1	2	j0.15
2	3	j0.10
1	3	j0.20
1	4	j0.10
4	3	j0.15

PROGRAM FOR YBUS FORMATION:

```
% ***** Matlab code for Ybus formation by direct inspection method********** %
clc;
close all;
clear all;
zdata=[1 2 0 0.15;
1 3 0 0.2;
1 4 0 0.1;
 2 3 0 0.1;
3 4 0 0.15];
nl=zdata(:,1);                          % Sending end bus
nr=zdata(:,2);                          % Receiving end bus
R=zdata(:,3);                           % Resistance
X=zdata(:,4);                           % Reactance
nbr=length(zdata(:,1));
nbus = max(max(nl), max(nr));
Z = R + j*X;                       %branch impedance
y= ones(nbr,1)./Z;                 %branch admittance
```

```
Ybus=zeros(nbus,nbus);          % initialize Ybus to zero
for k = 1:nbr;  % formation of the off diagonal elements
    if nl(k) > 0 & nr(k) > 0
    Ybus(nl(k),nr(k)) = Ybus(nl(k),nr(k)) - y(k);
    Ybus(nr(k),nl(k)) = Ybus(nl(k),nr(k));
    end
end
for n = 1:nbus       % formation of the diagonal elements
    for k = 1:nbr
    if nl(k) == n | nr(k) == n
    Ybus(n,n) = Ybus(n,n) + y(k);
    else
 end
    end
end
Ybus
```

OUTPUT:

Calculation:

Calculation:

EXP.NO: **DATE:**

Z_{BUS} FORMATION USING MATLAB

AIM: To obtain the Z_{bus} matrix for the given power system using Z_{bus} building algorithm and to verify the same using MATLAB.

APPARATUS REQUIRED: Personal Computer with MATLAB software.

FORMATION OF Z_{bus}:

Find the bus impedance matrix using Z_{bus} building algorithm for the given power system whose reactance values are as follows.

Sending end	Receiving end	Reactance values in ohms
1	0	J0.25
2	1	J0.1
3	1	J0.1
2	0	J0.25
2	3	J0.1

PROGRAM FOR ZBUS FORMATION:

```
%%%%% final year EEE %%%%%%
%%%%% power system simulation lab%%%%
%%%% zbus building algorithm%%%%%
clc; % clear command window
Clear all; % clear workspace
Close all; % close all windows
%%% Sending bus receving bus reactance value
z=[   1      0        0.25
      2      1        0.1
      3      1        0.1
      2      0        0.25
      2      3        0.1]; % input data
[m n]=size(z); % selecting size of rows and coloums of z data
zbus=[];       % intailizing of zbus with empty matrix
currentbusno=0; % intailizing currentbusno to zero
for a=1:m
```

```
    [rows cols]=size(zbus); % selecting size of zbus
    fb=z(a,1);              % selecting sending end bus
    tb=z(a,2);              % selecting receving end bus
    value=z(a,3);           % selecting reactance value
    newbus=max(fb,tb);      % selecting new bus value
    ref=min(fb,tb);         % selecting ref value
    %%%% TYPE-1 MODIFICATION
    if newbus>currentbusno && ref==0
    zbus=[zbus zeros(rows,1); zeros(1,cols) value];
    currentbusno=newbus;
    continue
    end
    %%%%  TYPE-2  MODIFICATION
    if  newbus>currentbusno  && ref~=0
    zbus=[zbus zbus(:,ref); zbus(ref,:) value+zbus(ref,ref)];
    currentbusno=newbus;
    continue
    end
    %%%% TYPE-3 MODIFICATION
    if newbus<=currentbusno  & ref==0
    zbus=zbus-1/(zbus(newbus,newbus)+value)*zbus(:,newbus)*zbus(newbus,:);
    continue
    end
     %%%% TYPE-4  MODIFICATION
    if newbus<=currentbusno  & ref~=0
     zbus=zbus-1/(value+zbus(fb,tb)+zbus(tb,tb)-2*zbus(fb,tb))*((zbus(:,fb)-
zbus(:,tb))*(zbus(fb,:)-zbus(tb,:)));
     continue
    end
end
zbus
```

<u>Output:</u>

CALCULATION

CALCULATION

CALCULATION

EXP.NO: **DATE:**

GAUSS-SEIDEL LOAD FLOW ANALYSIS USING MATLAB

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 line flow and losses.
7. Close the MATLAB tool and turnoff your pc.

```
% Program for Gauss - Seidel Load Flow Analysis
% Tripavan  BTech IV Year, EEE Dept., Mrcet, India, Email
:pavannutulapati@gmail.com
clc;
close all;
clear all;
%            From    TO    Resistance Reactance
linedata = [ 1       2        0.10     0.20;
             1       4       0.05     0.20;
             1       5       0.08     0.30;
             2       3       0.05     0.25;
             2       4       0.05     0.10;
             2       5       0.10     0.30;
             2       6       0.07     0.20;
```

```
         3      5       0.12    0.26;
         3      6       0.02    0.10;
         4      5       0.20    0.40;
         5      6       0.10    0.30];
nl=linedata(:,1);                % Sending end bus
nr=linedata(:,2);                % Receiving end bus
R=linedata(:,3);                 % Resistance
X=linedata(:,4);                 % Reactance
nbr=length(linedata(:,1));
nbuses = max(max(nl), max(nr));
Z = R + j*X;                             %branch impedance
y= ones(nbr,1)./Z;                      %branch admittance
Ybus=zeros(nbuses,nbuses);          % initialize Ybus to zero
for k = 1:nbr;    % formation of the off diagonal elements
    if nl(k) > 0 & nr(k) > 0
    Ybus(nl(k),nr(k)) = Ybus(nl(k),nr(k)) - y(k);
    Ybus(nr(k),nl(k)) = Ybus(nl(k),nr(k));
    end
end
for n = 1:nbuses        % formation of the diagonal elements
    for k = 1:nbr
    if nl(k) == n | nr(k) == n
    Ybus(n,n) = Ybus(n,n) + y(k);
    else
 end
    end
end
% |Bus|Type| Vsp |theta |PGi |QGi | PLi | QLi | Qmin | Qmax |
busdata = [ 1     1    1.05     0     0.0    0    0      0      0      0;
            2     2    1.05     0     0.5    0    0      0    -0.5   1.0;
            3     2    1.07     0     0.6    0    0      0    -0.5   1.5;
            4     3    1.0      0     0.0    0    0.7    0.7     0      0;
            5     3    1.0      0     0.0    0    0.7    0.7     0      0;
            6     3    1.0      0     0.0    0    0.7    0.7     0      0 ];
bus = busdata(:,1); % Bus number
type = busdata(:,2); % Type of Bus 1-Slack, 2-PV, 3-PQ.
V = busdata(:,3); % Initial Bus Voltages.
th = busdata(:,4); % Initial Bus Voltage Angles.
GenMW = busdata(:,5); % PGi, Real Power injected into the buses.
GenMVAR = busdata(:,6); % QGi, Reactive Power injected into the buses.
LoadMW = busdata(:,7); % PLi, Real Power Drawn from the buses.
LoadMVAR = busdata(:,8); % QLi, Reactive Power Drawn from the buses.
Qmin = busdata(:,9); % Minimum Reactive Power Limit
Qmax = busdata(:,10); % Maximum Reactive Power Limit
nbus = max(bus); % To get no. of buses
P = GenMW - LoadMW; % Pi = PGi - PLi, Real Power at the buses.
Q = GenMVAR - LoadMVAR; % Qi = QGi - QLi, Reactive Power at the buse
Vprev = V;
toler = 1; % Tolerence.
iteration = 1; % iteration starting
while (toler > 0.00001) % Start of while loop
 for i = 2:nbus
 sumyv  =  0;
 for k = 1:nbus
 if i ~= k
 sumyv = sumyv + Ybus(i,k)* V(k); % Vk * Yik
 end
 end
 if type(i) == 2 % Computing Qi for PV bus
 Q(i) = -imag(conj(V(i))*(sumyv + Ybus(i,i)*V(i)));
 if (Q(i) > Qmax(i)) || (Q(i) < Qmin(i)) % Checking for Qi Violation.
```

```
 if Q(i) < Qmin(i) % Whether violated the lower limit.
 Q(i) = Qmin(i);
 else % No, violated the upper limit.
 Q(i) = Qmax(i);
 end
 type(i) = 3; % If Violated, change PV bus to PQ bus.
 end
 end
 V(i) = (1/Ybus(i,i))*((P(i)-j*Q(i))/conj(V(i)) - sumyv); % Compute Bus
Voltages.
 if type(i) == 2 % For PV Buses, Voltage Magnitude remains same, but Angle
changes.
     r=abs(Vprev(i));
     o=angle(V(i));
 V(i) = r*cos(o) + j*r*sin(o);  % rect = real + j*imag

 end
 end
 iteration = iteration + 1; % Increment iteration count.
 toler = max(abs(abs(V) - abs(Vprev))); % Calculate tolerance.
 Vprev = V; % Vprev is required for next iteration, V(i) =
pol2rect(abs(Vprev(i)), angle(V(i)));
end % End of while loop / Iteration
iteration; % Total iterations.
V; % Bus Voltages in Complex form.
Vmag = abs(V); % Final Bus Voltages.
Ang = 180/pi*angle(V); % Final Bus Voltage Angles in Degree
disp('***************************************** ')
disp('          Gauss Seidel Load-Flow Study    ')
disp('***************************************** ')
disp('      Bus      Voltage     Angle ')
disp('      no       Volts       Degree ')
ywz=[  bus(:,1)      Vmag              Ang ];
disp(ywz)
disp('***************************************** ')
```

Output:

Calculation

Calculation

Calculation

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 line flow and losses.

```
7. % Program for Fast decoupled  Load Flow Analysis
8. clc;
9. close all;
10.   clear all;
11.
12.   %        from to  Resistance Reactance%
13.   line = [1 4      0.0      0.0576;
14.           4 5      0.017    0.092;
15.           5 6      0.039    0.17;
```

```
          3 6     0.0     0.0586;
          6 7     0.0119  0.1008;
          7 8     0.0085  0.072;
          8 2     0.0     0.0625;
          8 9     0.032   0.161;
          9 4     0.01    0.085];
nl=line(:,1);                 % Sending end bus
nr=line(:,2);                 % Receiving end bus
R=line(:,3);                  % Resistance
X=line(:,4);                  % Reactance
nbr=length(line(:,1));
nbuses = max(max(nl), max(nr));
Z = R + j*X;                              %branch impedance
y= ones(nbr,1)./Z;                       %branch admittance
Ybus=zeros(nbuses,nbuses);          % initialize Ybus to zero
for k = 1:nbr;    % formation of the off diagonal elements
    if nl(k) > 0 & nr(k) > 0
    Ybus(nl(k),nr(k)) = Ybus(nl(k),nr(k)) - y(k);
    Ybus(nr(k),nl(k)) = Ybus(nl(k),nr(k));
    end
end
for n = 1:nbuses       % formation of the diagonal elements
    for k = 1:nbr
    if nl(k) == n | nr(k) == n
    Ybus(n,n) = Ybus(n,n) + y(k);
    else
 end
    end
end
b = -imag(Ybus);
%    |Bus| Vsp |theta |PGi |QGi | PLi | QLi | Qmin | Qmax |type
bus = [ 1       1.04     0.00    0.00      0.00  0.00  0.00  0.00  0.00 1;
          2       1.02533 0.00    1.63      0.00  0.00  0.00  0.00  0.00 2;
          3       1.02536 0.00    0.85      0.00  0.00  0.00  0.00  0.00 2;
          4       1.00     0.00    0.00      0.00  0.00  0.00  0.00  0.00 3;
          5       1.00     0.00    0.00      0.00  0.90  0.30  0.00  0.00 3;
          6       1.00     0.00    0.00      0.00  0.00  0.00  0.00  0.00 3;
          7       1.00     0.00    0.00      0.00  1.00  0.35  0.00  0.00 3;
          8       1.00     0.00    0.00      0.00  0.00  0.00  0.00  0.00 3;
          9       1.00     0.00    0.00      0.00  1.25  0.50  0.00  0.00 3];
```

```
%formation of b' matrtix
b1=zeros(nbuses-1,nbuses-1);
for i = 1:nbuses-1
    for j = 1:nbuses-1
        b1(i,j) =b(i+1,j+1);
    end
end
b1;
%formation of b" matrtix
%assuming all the load buses are at last
b2=zeros(nbuses-3,nbuses-3);
for i = 1:nbuses-3
    for j = 1:nbuses-3
        b2(i,j) =b(i+3,j+3);
    end
end
b2;
v = bus(:,2);
del = bus(:,3);
Pg = bus(:,4);
Qg = bus(:,5);
Pd = bus(:,6);
Qd = bus(:,7);
Pspec = Pg-Pd;
Qspec = Qg-Qd;
iter = 1;
slack = 1;
tolerance = .01;
flag=1;
while flag==1;

    m = real(Ybus);
    n = imag(Ybus);
    P = zeros(nbuses,1);
    Q = zeros(nbuses,1);
    iter= iter+1;


for i=1:nbuses     %finding  bus real and reactive power
    for j=1:nbuses
        P(i)  = P(i)+  (v(i)*v(j)*(m(i,j)*cos(del(i)-del(j))+n(i,j)*sin(del(i)-del(j))));
        Q(i)  = Q(i)+  (v(i)*v(j)*(m(i,j)*sin(del(i)-del(j))-n(i,j)*cos(del(i)-del(j))));
    end
end

P
Q
```

```
%finding del P by v
for i=1:(nbuses-1)
    if(i<slack)
        delP(i,1)= Pspec(i)-P(i);
    else
        delP(i,1)=(Pspec(i+1)-P(i+1));

    end
    delPbyv(i,1)=delP(i,1)/v(i,1);
end

%finding del Q by v
c=0;
for i=1:nbuses
    if bus(i,10)==3
        c=c+1;
        delQ(c,1)= (Qspec(i)-Q(i));
        delQbyv(c,1)= delQ(c,1)/v(i,1);
    end
end

if max(abs(delP))>tolerance | max(abs(delQ))>tolerance
    flag=1;    % tolerance check
else
    flag=0;
end

%calc correction vector
deldel = inv(b1)*delPbyv;
delv = inv(b2)*delQbyv;

%updating values
for i=1:(nbuses-1)
    del(i+1,1)= del(i+1,1)+deldel(i,1);
end

c=0;
for i=1:nbuses
    if bus(i,10)==3
        c=c+1;
        v(i,1)=v(i,1)+delv(c,1);
    end
end

iter
v
del
end
```

```
disp('***************************************** ')
disp('        Fast decoupled Load-Flow Study    ')
disp('***************************************** ')
disp('      Bus      Voltage     Angle ')
disp('      no       Volts       Degree ')
ywz=[  bus(:,1)      v            del ];
disp(ywz)
disp('***************************************** ')
```

Output:

CALCULATION

CALCULATION

CALCULATION

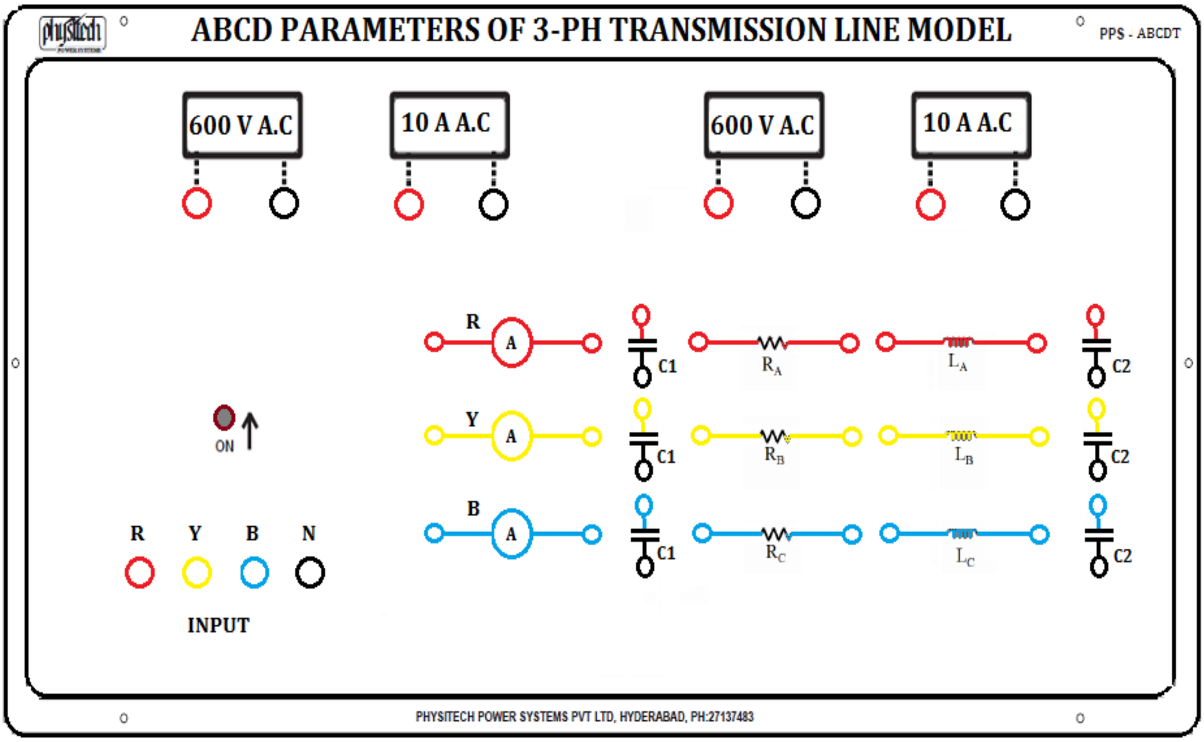
EXP.NO: DATE:

ABCD PARAMETERS OF 3-PH TRANSMISSION MODEL

Aim: To obtain ABCD parameters of a long transmission line model by performing open circuit and short circuit test on both sending and receiving end.

Apparatus:

S.No	Name Of The Equipment	Range	Quantity
1	Built-in Voltmeter	0-600V	1
2	Built-in Ammeter	0-10A	1
3	Auto Transformer	1-Φ, 230V/ 0-270V	1
4	Built-in Transmission line model 3-Φ	500kV, 1000 MW, 250km long	1

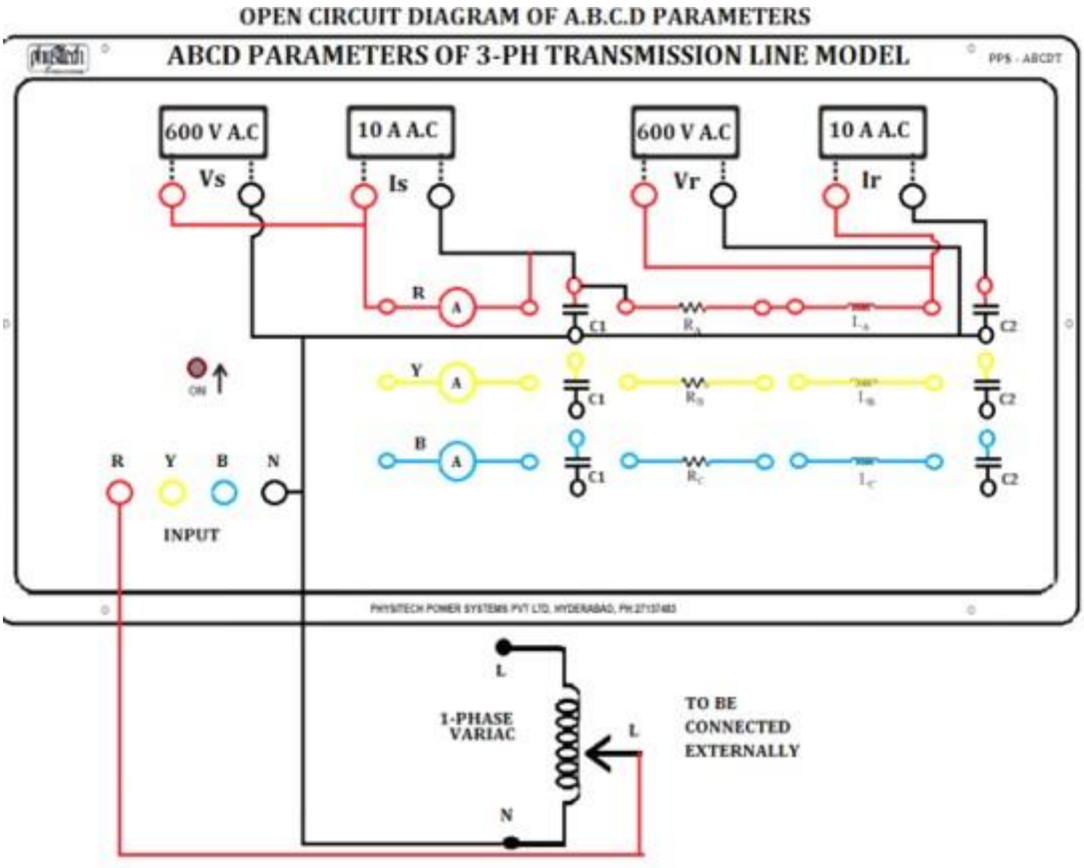


Procedure:

Determination of A and C parameters by conducting open circuit test:

1. Keeping the single-phase autotransformer output at zero volts, switch ON AC power supply on sending end side by closing DPST switch.
2. Now slowly vary the autotransformer till the voltmeter on sending end side reads230V.
3. Note down the ammeter, voltmeter and wattmeter readings.

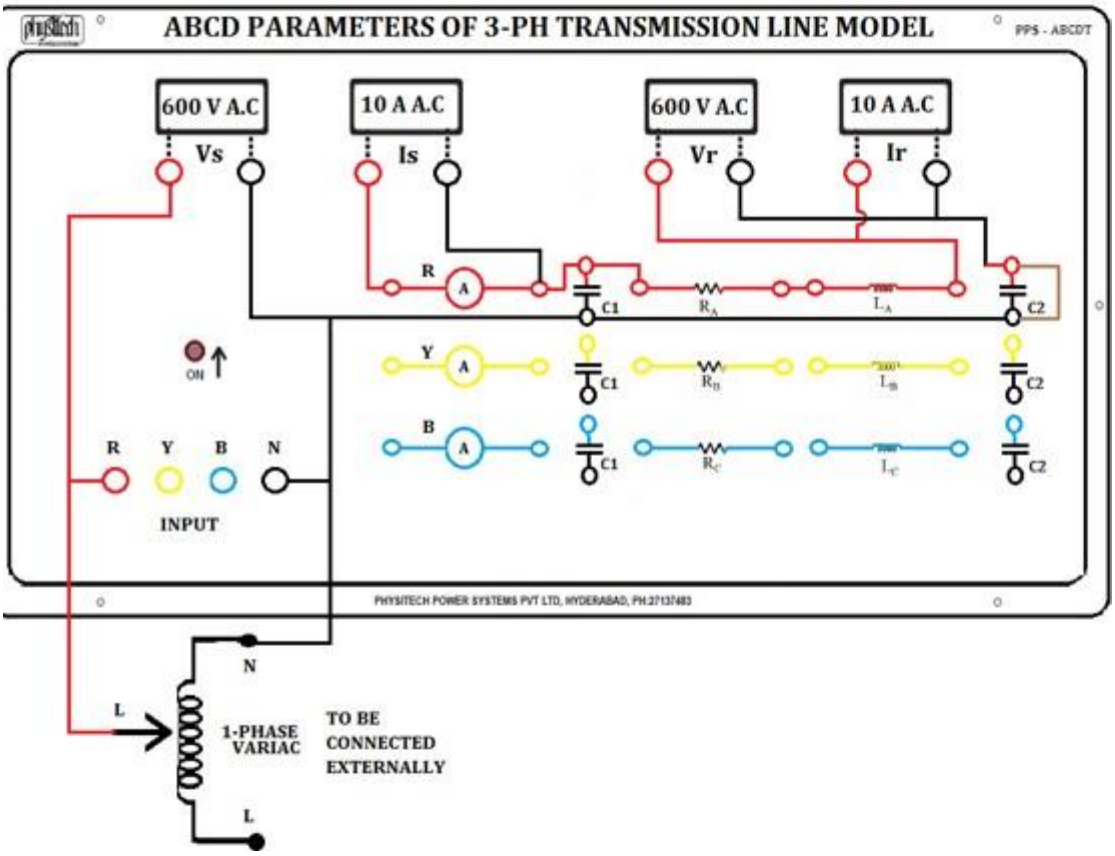
Bring the autotransformer to zero voltage position and switch OFF the DPST.



Determination of B and D parameters by conducting short circuit test:

1. Keeping the single/ three phase autotransformer output at zero volts, switch ON ACpower supply on sending end side by closing DPST switch.
2. Now slowly vary the autotransformer till the ammeter on sending end side reads 5AV.
3. Note down the ammeter, voltmeter and wattmeter readings.
4. Bring the autotransformer to zero voltage position and switch OFF the DPST switch.

SHORT CIRCUIT DIAGRAM OF A.B.C.D PARAMETERS



TABULAR FORM:

S.NO	TYPE	V_S	I_S	V_R	I_R
1	Open circuit				
2	Short circuit				

The Calculated values of A, B, C, D Parameters are:			
A=………;	B= .... Ω;	C=……mho;	D = ... ;

CALCULATIONS:

$A = V_s / V_r$ $(I_r=0)$

$B = V_s/I_r$ $(V_r=0)$

$C = I_s / V_r$ $(I_r=0)$

$D = I_s/I_r$ $(V_r=0)$

Result:

EXP.NO: **DATE:**

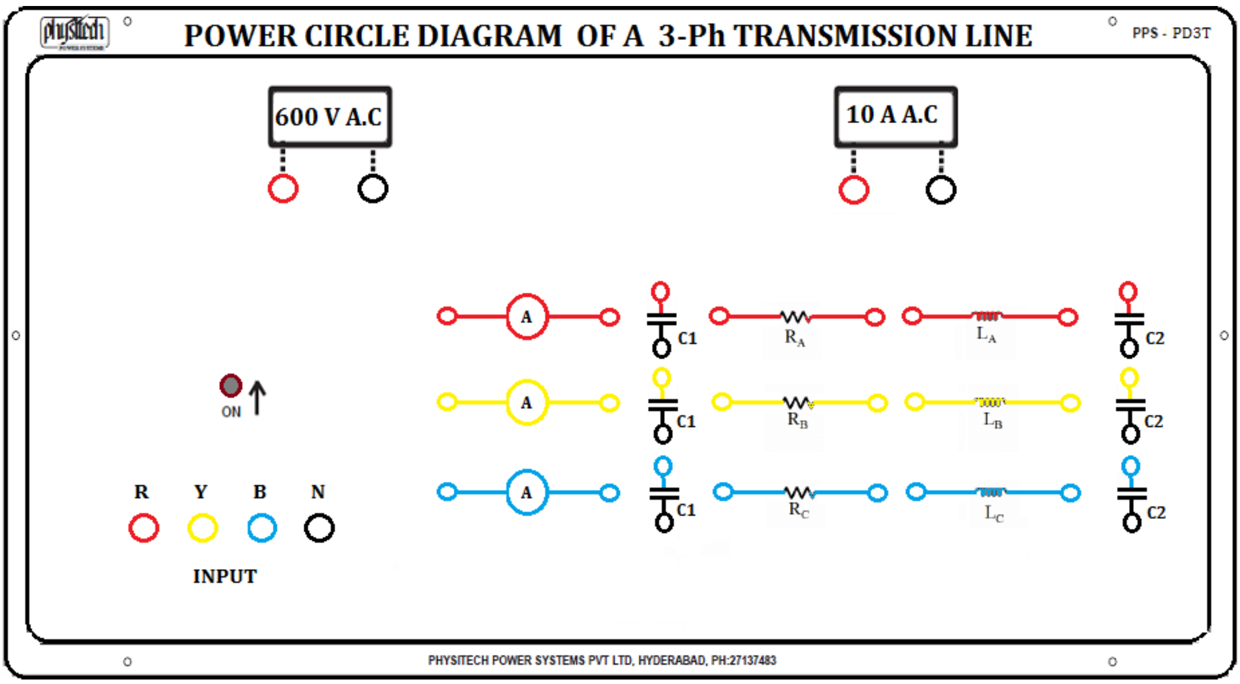
POWER CIRCLE DIAGRAM OF A 3-PH TRANSMISSION MODEL

Aim: To obtain ABCD parameters of a long transmission line model by performing open circuit and short circuit test on both sending and receiving end.

Apparatus:

S.No	Name Of The Equipment	Range	Quantity
1	Built-in Voltmeter	0-600V	1
2	Built-in Ammeter	0-10A	1
3	Auto Transformer	1-Φ, 230V/ 0-270V	1
4	Built-in Transmission line model 3-Φ	500kV, 1000 MW, 250km long	1

Front Panel:



Procedure:

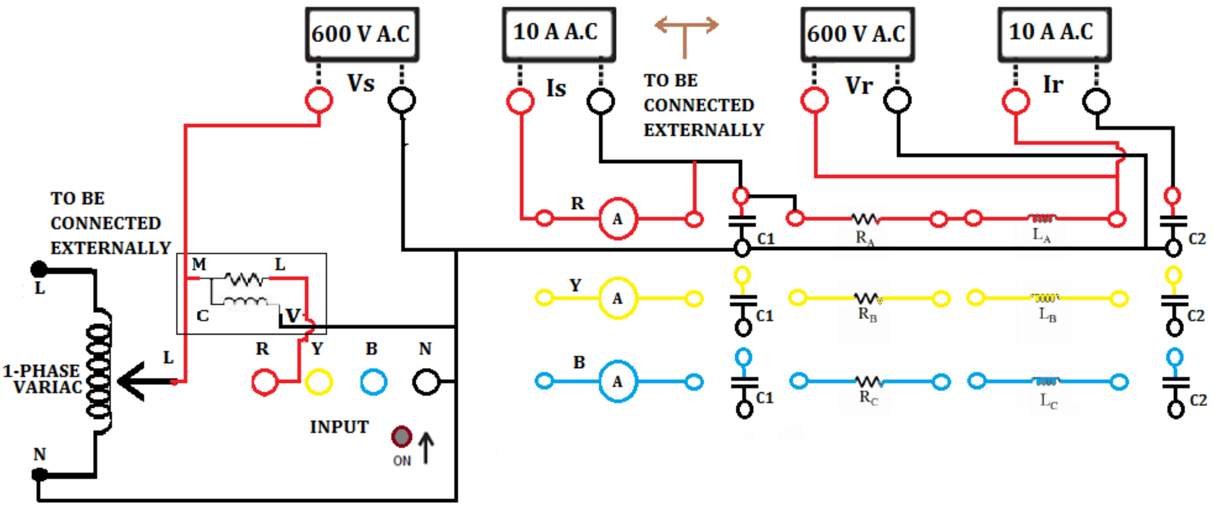
Determination of A and C parameters by conducting open circuit test:

1. Keeping the single-phase autotransformer output at zero volts, switch ON AC power supply on sending end side by closing DPST switch.
2. Now slowly vary the autotransformer till the voltmeter on sending end side reads230V.
3. Note down the ammeter, voltmeter and wattmeter readings.

Bring the autotransformer to zero voltage position and switch OFF the

DPST.

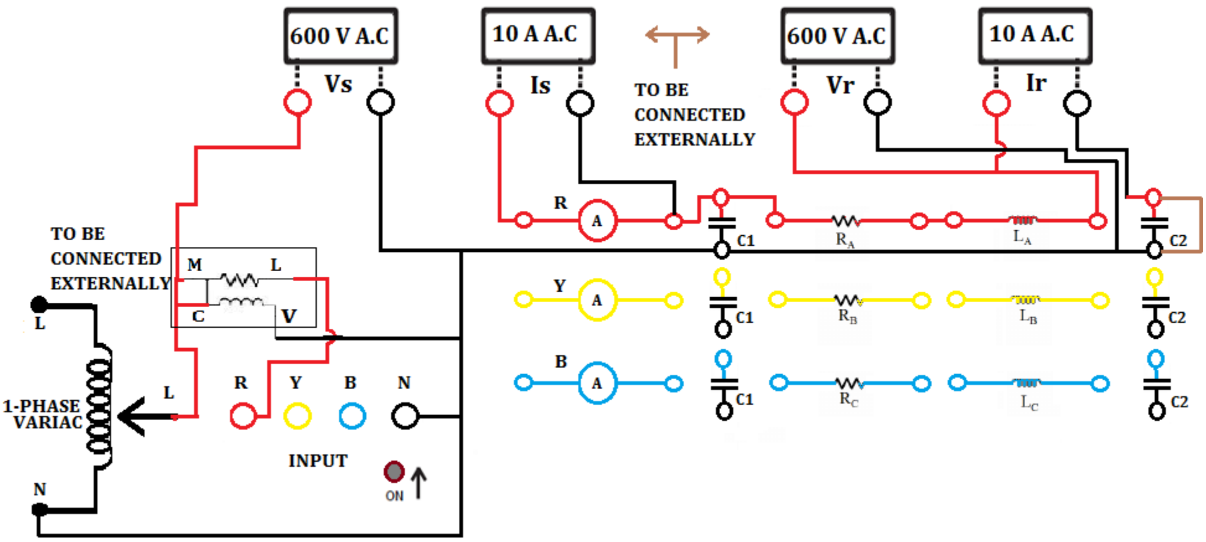
OPEN CIRCUIT WIRING DIAGRAM OF 3 - PHASE TRANSMISSION LINE MODEL



Determination of B and D parameters by conducting short circuit test:

1. Keeping the single/ three phase autotransformer output at zero volts, switch ON ACpower supply on sending end side by closing DPST switch.
2. Now slowly vary the autotransformer till the ammeter on sending end side reads 5AV.
3. Note down the ammeter, voltmeter and wattmeter readings.
4. Bring the autotransformer to zero voltage position and switch OFF the DPST switch.

SHORT CIRCUIT WIRING DIAGRAM OF 3 - PHASE TRANSMISSION LINE MODEL



Observations:

	V_S	I_S	W_S	$Z_{OC} * Z_{SC}$	Calculation
Open Circuit at Receiving End				$cos\theta = \frac{W_S}{V_S I_S}$ $Z_{OC} = \frac{V_S}{I_S}$ $ZOC = ZOC < \theta$	$A = (\frac{Z_{oc}}{Z_{oc} - Z_{sc}})^{\frac{1}{2}}$ $B = A * ZSC\ ohm$
Short Circuit at Receiving End				$cos\phi = \frac{W_S}{V_S I_S}$ $Z_{SC} = \frac{V_S}{I_S}$ $ZSC = ZSC < \phi$	$C = \frac{A}{Z_{OC}}\ mho$ $D = A * Z_{SC\ ohm}$
Capacitance= 2.5 microfarad					

Result:

Calculation:

Calculation:

EXP.NO: **DATE:**

FAULT ANALYSIS – I

Aim: - To find the fault currents and fault voltages when a single line to ground (L-G) faultand line to line (L-L) faults occurred on unloaded alternator.

Name Plate Details:-

S.NO	PARAMETER	ALTERNATOR	MOTOR
1	Rated voltage	415v	220v
2	Rated current	7A	27.2 A
3	speed	1500 RPM	1500 RPM
4	Rating	5KVA	7.5HP

Apparatus Required:-

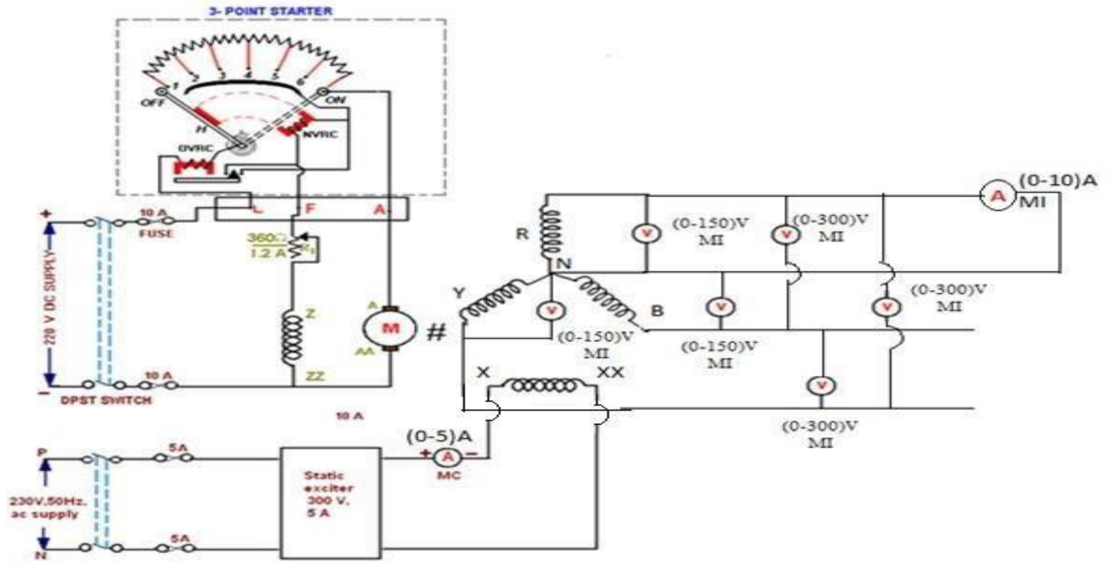
S.N0	Apparatus	Type	Range	Quantity
1.	Ammeter	MI MI	(0-10)A (0-5)A	1 1
2.	Voltmeter	MI MI	(0-150)V (0-150)V	3 3
3.	Rheostat	WWC	360Ω/1.2A	1
4.	Connecting wires	--	---	As per required

Procedure:-

(a) LG Fault:-

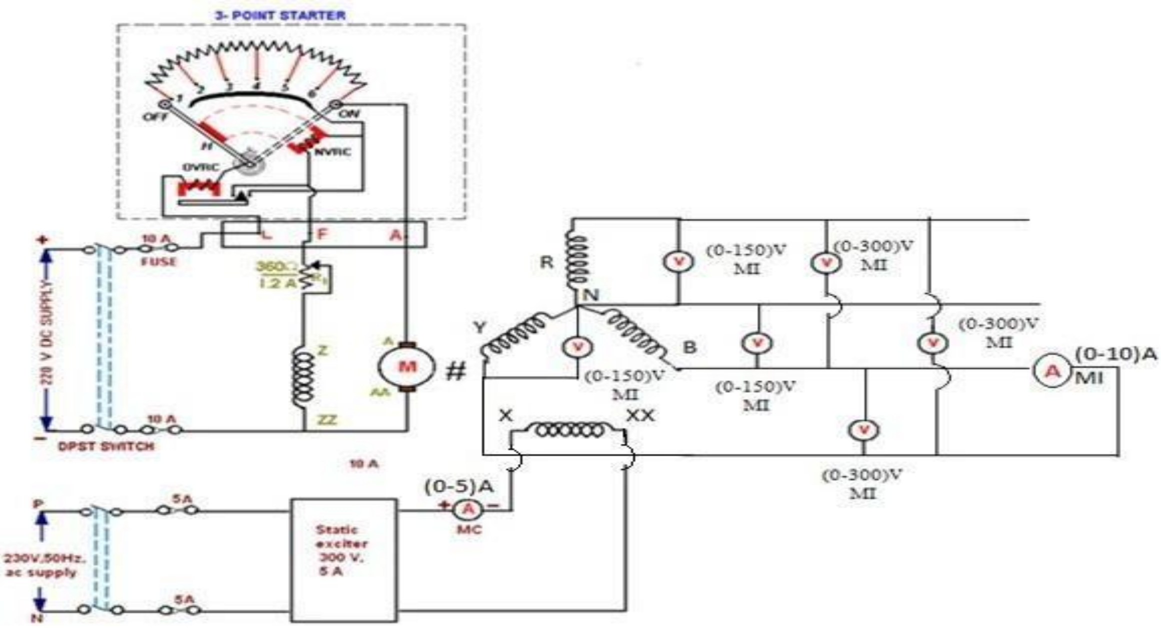
1. Connect the circuit as per the given circuit diagram.
2. Ensure that the filed rheostat is kept in minimum resistance position and DPST switch inoff position.
3. Switch on the supply and close the DPST Switch and then by varying field rheostat, runthe motor at rated speed.
4. By varying the static exciter apply rated current (Fault current) of an alternator.
5. Note down the fault currents and voltmeter readings.

Circuit diagram for L-G Fault:-



(b) LL Fault:-

1. Connect the circuit as per the given circuit diagram.
2. Ensure that the filed rheostat is kept in minimum resistance position and DPST switch inoff position.
3. Switch on the supply and close the DPST Switch and then by varying field rheostat, runthe motor at rated speed.
4. By varying the static exciter apply rated current (Fault current) of an alternator.
5. Note down the fault currents and voltmeter readings.



Tabular Column:-

(a) LG Fault: -

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

(b) LL Fault: -

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

Precautions: -

1. Avoid the loose connections.
2. Note down the readings without parallax error.
3. Keep the field rheostat in maximum resistance position.
4. Keep the variac of the static exciter in minimum voltage output position.

RESULT:

CALCULATION:

CALCULATION:

EXP.NO: **DATE:**

FAULT ANALYSIS – II

Aim: - To find the fault currents and fault voltages when a double line to ground (LLG) faultand Triple line to ground (LLLG) faults occurred on unloaded alternator.

Name Plate Details: -

S.NO	PARAMETER	ALTERNATOR	MOTOR
1	Rated voltage	415v	220v
2	Rated current	7A	27.2 A
3	speed	1500 RPM	1500 RPM
4	Rating	5KVA	7.5HP

Apparatus Required: -

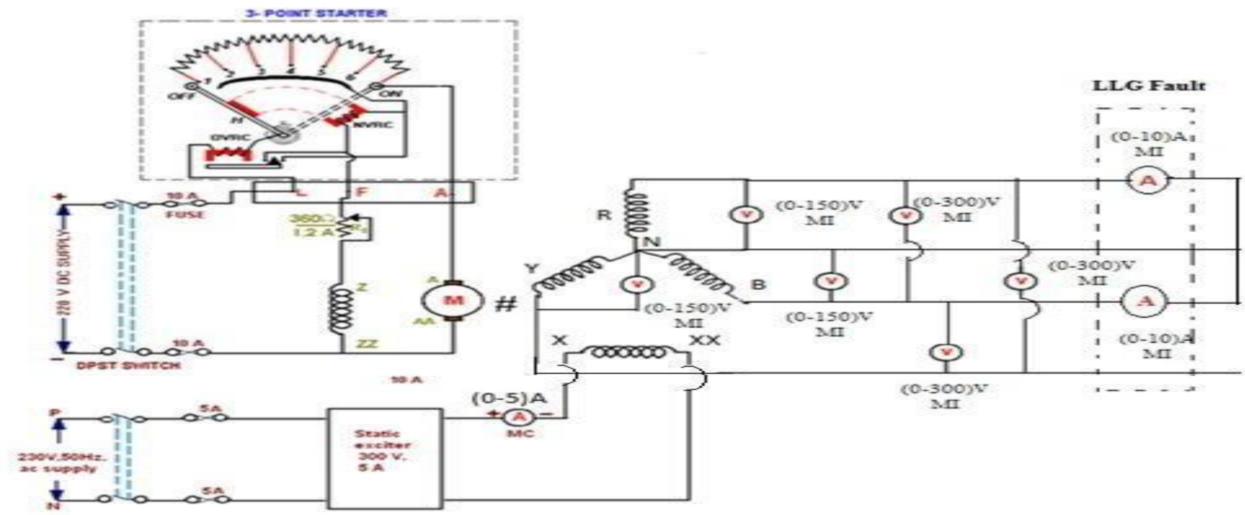
S.N0	Apparatus	Type	Range	Quantity
1.	Ammeter	MI MC	(0-10)A (0-5)A	1 1
2.	Voltmeter	MI MI	(0-150)V (0-150)V	3 3
3.	Rheostat	WWC	360Ω/1.2A	1
4.	Connecting wires	--	---	As per required

Procedure:-

(a) LLG Fault:-

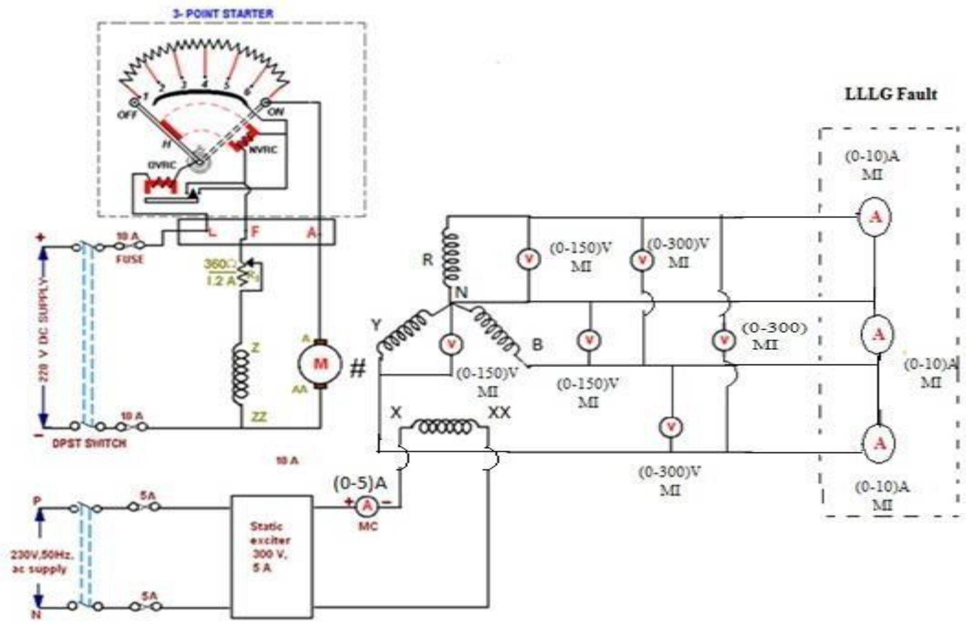
1. Connect the circuit as per the given circuit diagram.
2. Ensure that the filed rheostat is kept in minimum resistance position and DPST switch inoff position.
3. Switch on the supply and close the DPST Switch and then by varying field rheostat, runthe motor at rated speed.
4. By varying the static exciter apply rated current (Fault current) of an alternator.
5. Note down the fault currents and voltmeter readings.

Circuit diagram for LLG Fault:-



(b) LLLG Fault:-

1. Connect the circuit as per the given circuit diagram.
2. Ensure that the filed rheostat is kept in minimum resistance position and DPST switch inoff position.
3. Switch on the supply and close the DPST Switch and then by varying field rheostat, runthe motor at rated speed.
4. By varying the static exciter apply rated current (Fault current) of an alternator.
5. Note down the fault currents and voltmeter readings.



Tabular Column:-

(c) LLG Fault:-

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

(d) LLLG Fault:-

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

Precautions:-

1. Avoid the loose connections.
2. Note down the readings without parallax error.
3. Keep the field rheostat in maximum resistance position.
4. Keep the variac of the static exciter in minimum voltage output position.

RESULT:

CALCULATION:

CALCULATION:

Exp.No.: Date:

CHARACTERISTICS OF OVER VOLTAGE RELAY

Aim: To study the performance of electromechanical over voltage relay and microprocessorover voltage relays and to plot the graph between time vs. plug setting multiplier

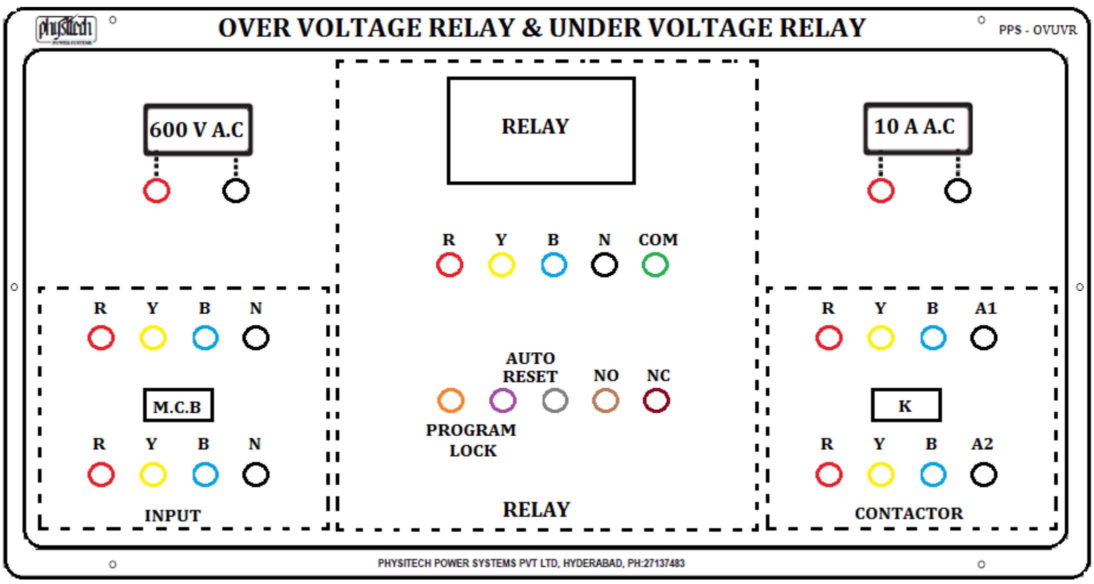
Apparatus required:

1. Over voltage relays
2. 3 - ϕ Auto Transformer
3. Connecting wires

Front Panel Details:

1. Microprocessor Relay 415V, 50Hz, 3 - ϕ, AC
2. Contactor, MCB
3. Voltmeter & Ammeter

Front Panel:



KEY OPERATIONS:

	MENU/ENTER/HOLD/SCROLL KEY **RUN MODE:** used to select scroll/hold the parameters. **PROGRAM MODE:** Used to enter into program mode. **:** Used to select next parameters.
	INC KEY **PROGRAM MODE:** Used to increase the values.

	DEC KEY **PROGRAM MODE:** Used to decrease the values.
●	**MANUAL/ESC KEY** **RUN MODE:** When fault recovery happens, this key shall used to load ON/OFF manually. **PROGRAM MODE:** It is used to view the previous parameters.

RUN Mode:

1. On power application, relay will be in NC condition for approximately 10 sec.
2. During health condition, all the voltage parameters shall be displayed with instantaneous values. Relay and relay LED will be in ON or OFF condition depending upon the relay ‘y’ or relay ‘n’ settings.
3. During fault condition, type of fault shall be displayed with relay OFF or ON status depending on relay ’y’ or ‘n’ setting.

AUTO Mode: (6 & 7 terminals – short)

1. Once the fault is recovered, unit automatically comes back to parameter display mode as mentioned above.

MANUAL Mode: (6 & 7 terminals – open)

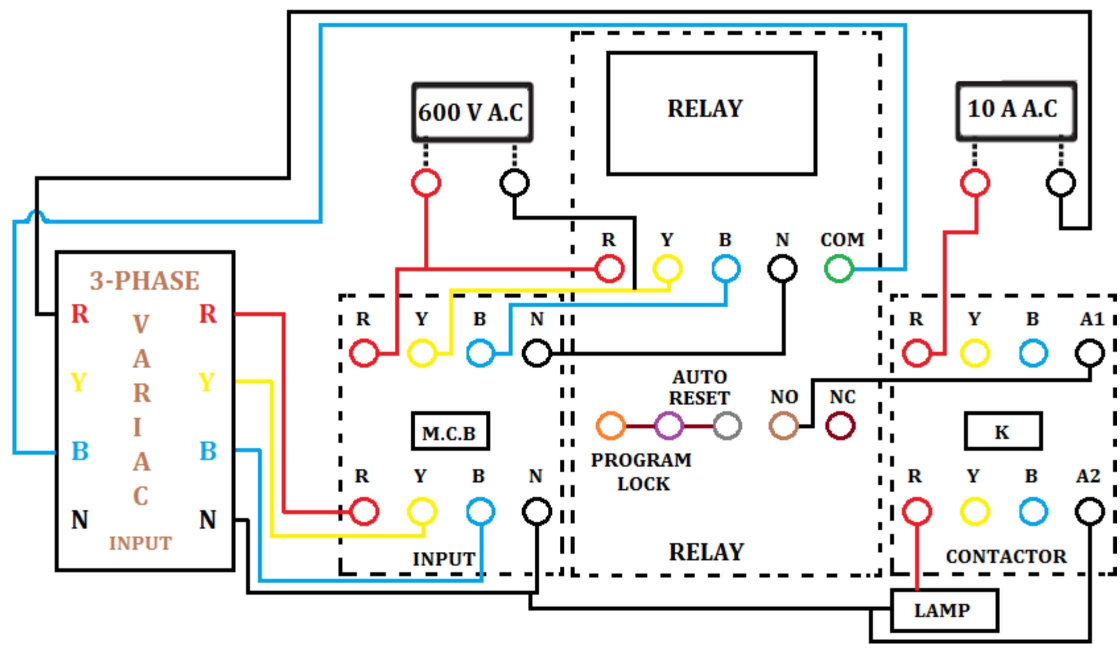
1. Once the fault is recovered, manual key to be pressed to bring back display mode as mentioned above.
2. If faults are rectifiers before set trip delay timing of relay, display will continue to show fault status. Relay status remain unaltered. Press manual key to show the parameter display. Press MENU/ENER key for 35 seconds to HOLD/SCROLL display.
3. **PROGRAM Mode:** (Short 5 & 6 for programming)
4.

	RANGE		**FACTORY SETTINGS**
DISPLAY CODE			
“nUOL”	Nominal voltages:415V		415
“OUOL”	Over Voltage Range: 5 to 100V		030
“UUOL”	Under Voltage Range: 5 to 100V		030
“Ucrt”	Under Current Range:20 – 95%		20
“PUbl”	Phase Unbalance Range: P 1 – 20%		20
“IrdY”	Inrush delay Range: 1- 60sec		01
“tdOU”	Trip delay Over Voltage range: 1 – 250sec		005
“tdUU”	Trip delay Under Voltage range: 1 – 250sec		005
“tdUC”	Trip delay Under Current range: 1 – 250sec		005
“tdUb”	Trip delay Un-balance range: 1 – 250sec		005
bYPS	“OUL Y/n”	Bypass Over Voltage	n
bYPS	“UUL Y/n”	Bypass Under Voltage	n

bYPS	“UCt Y/n”	Bypass Under Current	n
bYPS	“UBL Y/n”	Bypass Phase Unbalance	n
CntL	rLY ’n’	Relay and status LED OFF in health condition	V
	rLY ’Y’	Relay and status LED ON in health condition	

Wiring-Diagram:

WIRING DIAGRAM OF OVER VOLTAGE RELAY



Procedure:

Microprocessor over Voltage Relay:

1. Make the connections as per the circuit diagram given.
2. Set voltage of the relay at a fixed value.
3. The fault voltage in relay coil is adjusted to desired value by varying the 3 - ϕautotransformer
4. Whenever the fault voltage is set, the relay coil trips the circuit and note down thecorresponding operating time of the relay using digital timer.
5. Note down the fault voltage, operating time of the relay
   Repeat the experiment for different values of set voltage and time setting multiplier

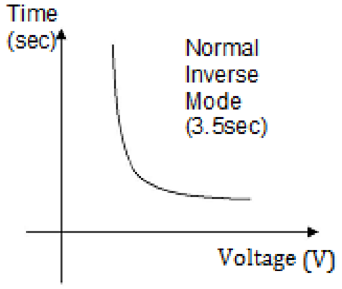
OBSERVATION

S.No.	Operating Time (sec)	Set Voltage (V)	Fault Voltage (V)

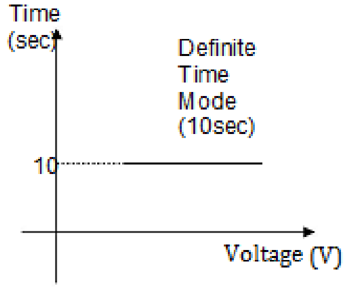
Definite Time (10sec)

S.No.	Operating Time (sec)	Set Voltage (V)	Fault Voltage (V)

Model Graphs:



Microprocessor Over voltage relay



Microprocessor Over voltage relay

RESULT:

Exp. No. **Date:**

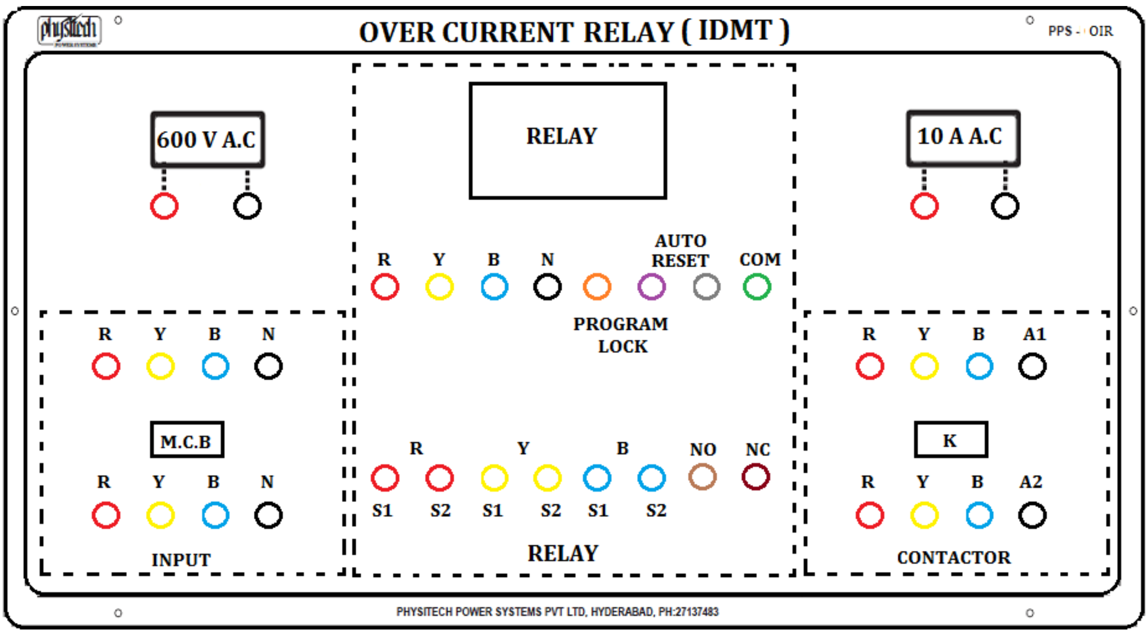
CHARACTERISTICS OF IDMT OVER CURRENT RELAY

Aim: To study the performance of an IDMT overcurrent relay and plot the graph betweentime and plug setting multiplier

Apparatus:

1. Over current relay
2. 3 - ϕ Auto Transformer 415/470V,10A 1 No's
3. Current Transformer 10/1A 1 No's
4. 3 - ϕ contactor 3 pole, 10 A 1 No's
5. Rheostat 100 Ω/5A 1 No's
6. Digital timer
7. Connecting wires

Front panel:



Keys and Operation:

	MENU/ENTER/HOLD/SCROLL KEY **RUN MODE:** used to select scroll/hold the parameters. **PROGRAM MODE:** Used to enter into program mode. **:** Used to select next parameters.
	INC KEY **PROGRAM MODE:** Used to increase the values.
	DEC KEY **PROGRAM MODE:** Used to decrease the values.

●	**MANUAL/ESC KEY** **RUN MODE:** When fault recovery happens this key shall used to load ON/OFF manually. **PROGRAM MODE:** It is used to view the previous parameters.

<u>RUN Mode:</u>

1. On power application, relay will be in NC condition for approximately 10 sec.
2. During health condition, all the voltage parameters shall be displayed with instantaneous values. Relay and relay LED will be in ON or OFF condition dependingupon the relay ‘y’ or relay ‘n’ settings.
3. During fault condition, type of fault shall be displayed with relay OFF or ON statusdepending on relay ’y’ or ‘n’ setting.

<u>AUTO Mode:</u> (6 & 7 terminals – short)

1. Once the fault is recovered, unit automatically comes back to parameter display mode asmentioned above.

<u>MANUAL Mode:</u> (6 & 7 terminals – open)

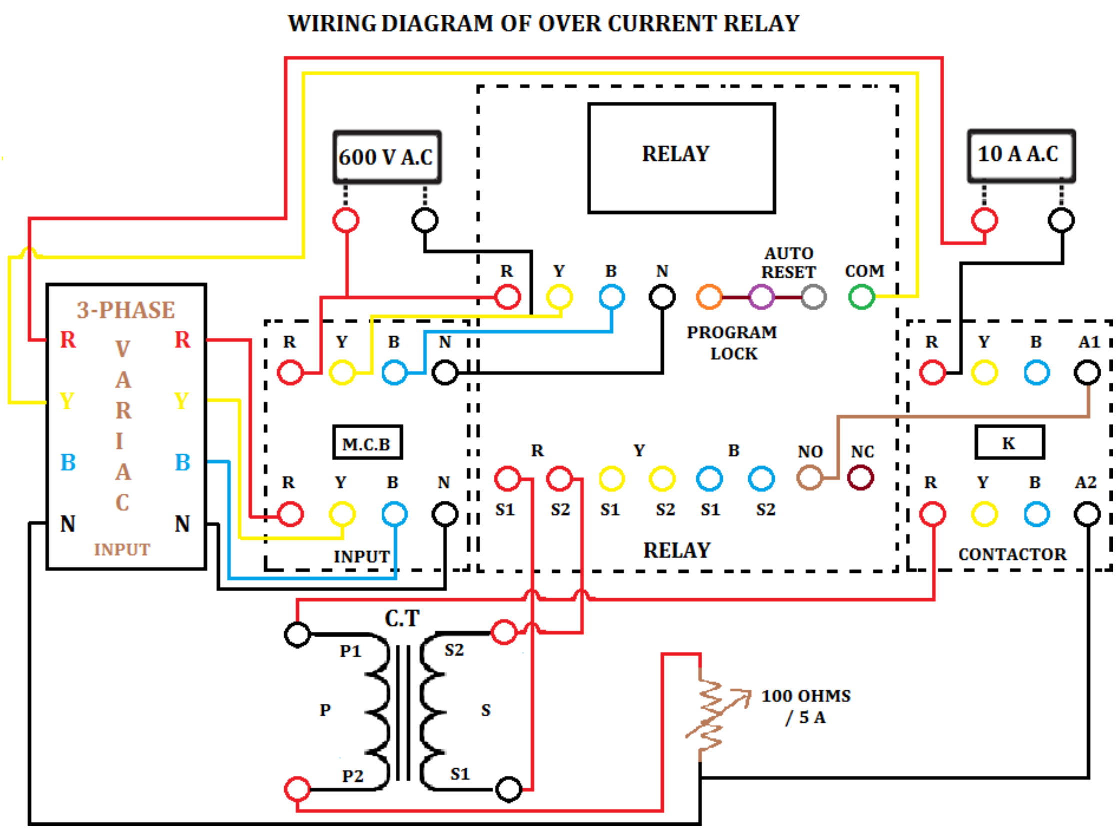
1. Once the fault is recovered, manual key to be pressed to bring back display mode asmentioned above.
2. If faults are rectifiers before set trip delay timing of relay, display will continue to showfault status. Relay status remain unaltered. Press manual key to show the
3. parameter display. Press MENU/ENER key for 35 seconds to HOLD/SCROLL display.
4. **<u>PROGRAM Mode:</u>** (Short 5 & 6 for programming)

PROGRAMMING PARAMETERS		RANGE	FACTORY SETTINGS
S. NO	DISPLAY CODE		
1)	“nUOL”	Nominal voltages:415V	415
2)	“CT - P”	CT Primary range:5 to 2500 A	005
3)	“nCrt”	Nominal Current Range: 0.5 to 500V	005.0
4)	“Ocrt”	Over Current Range:105 - 800%	120
5)	“Ucrt”	Under Current Range:20 – 95%	20
6)	“PUbl”	Phase Unbalance Range: P 1 – 20%	20
7)	“IrdY”	Inrush delay Range: 1- 60sec	01
8)	“tdOC”	Trip delay Over Current range: 1 – 250sec	005
9)	“tdUC”	Trip delay Under Current range: 1 – 250sec	005
10)	“tdUb”	Trip delay Un-balance range: 1 – 250sec	005
11)	bYPS	“OCt Y/n” Bypass Over Current	n

12)	bYPS	“UCt Y/n”	Bypass Under Current	n
13)	bYPS	“UBL Y/n”	Bypass Phase Unbalance	n
14)	CntL	rLY ’n’	Relay and status LED OFF in health condition	V
		rLY ’Y’	Relay and status LED ON in health condition	

5. Note: C.T primary must be set at 50/5 A. If a different C.T is used then the settings must bechanged accordingly.

Wiring-Diagram:



Procedure:

Microprocessor over Voltage Relay:

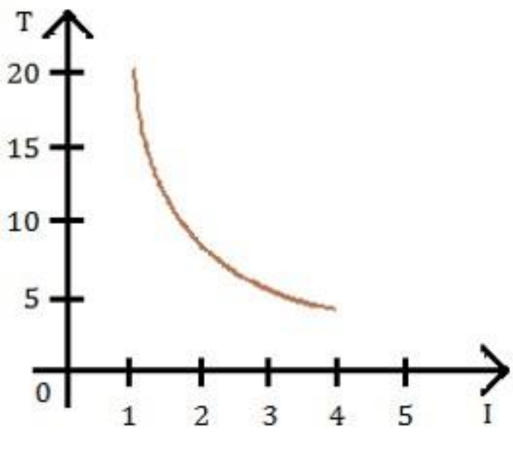
1. Make the connections as per the circuit diagram given.
2. Set voltage of the relay at a fixed value.
3. The fault voltage in relay coil is adjusted to desired value by varying the 3 - ϕautotransformer

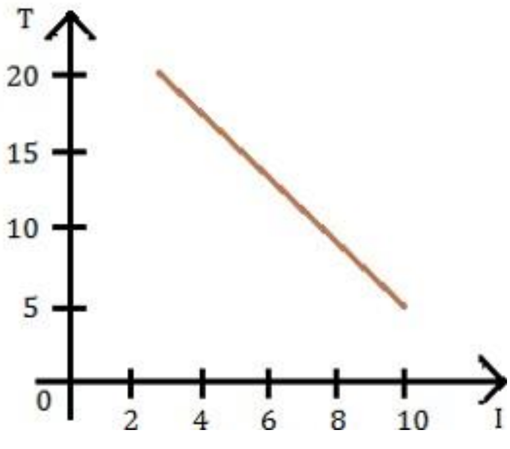
4. Whenever the fault voltage is set, the relay coil trips the circuit and note down the corresponding operating time of the relay using digital timer.
5. Note down the fault voltage, operating time of the relay
6. Repeat the experiment for different values of set voltage and time setting multiplier

Observations:

S. no.	% NCRT (Normal Current)	Current through contactor (amps)	Time of operation (sec)	Fault Current
1.				
2.				
3.				
4.				

Graphs:





$$\textbf{In terms of percentage}\ \% = \frac{\textbf{Required current}}{\textbf{NCRT}(\textbf{Normal current})} * \mathbf{100}$$

Result: