Expt. No. 01 Date

Page No. 01

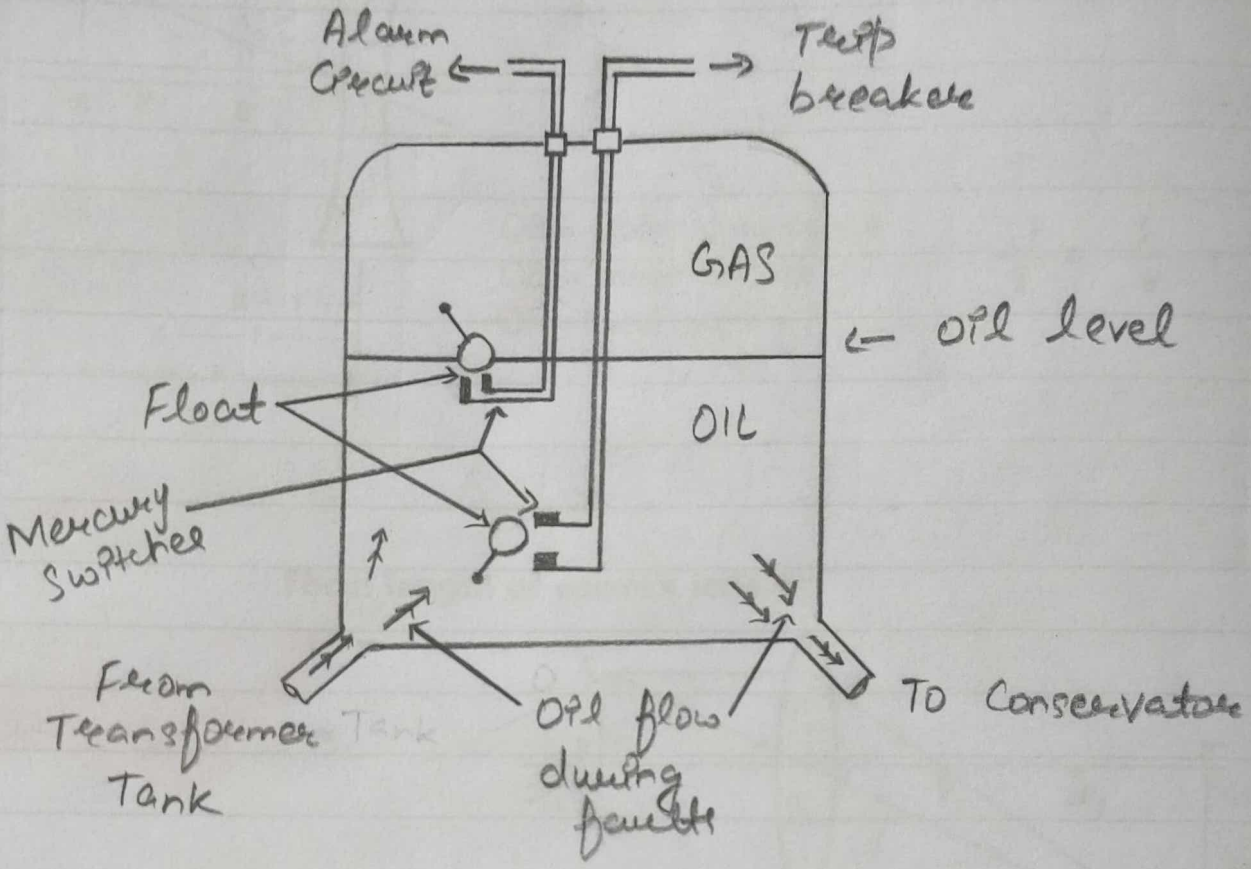
AIM:
Study of gas actuated Buchholz relay for the protection of the transformer.

EQUIPMENTS REQUIRED:
Buchholz Relay Setup

THEORY:
The Buchholz relay is one of the important protective devices for oil immersed power transformers, which will operate based on the oil or gas pressure. It detects two types of faults i.e. minor and major fault. Minor faults comprise of faults in core laminations, over heating in windings, bad connections, low oil levels etc. In minor faults the alarm circuit will be actuated to switch on the buzzer. In case of major faults like internal short circuit between phase and earth, phase to phase fault, insulation breakdown etc., the trip circuit will be closed due to enormous amount of gas bubbles.
Buchholz relay is a gas actuated relay used for protecting oil immersed transformer against all types of internal faults and makes use of the fact that fault produces over current and overheating that decomposes oil, thus generating gases.

Teacher's Signature

CONSTRUCTION:

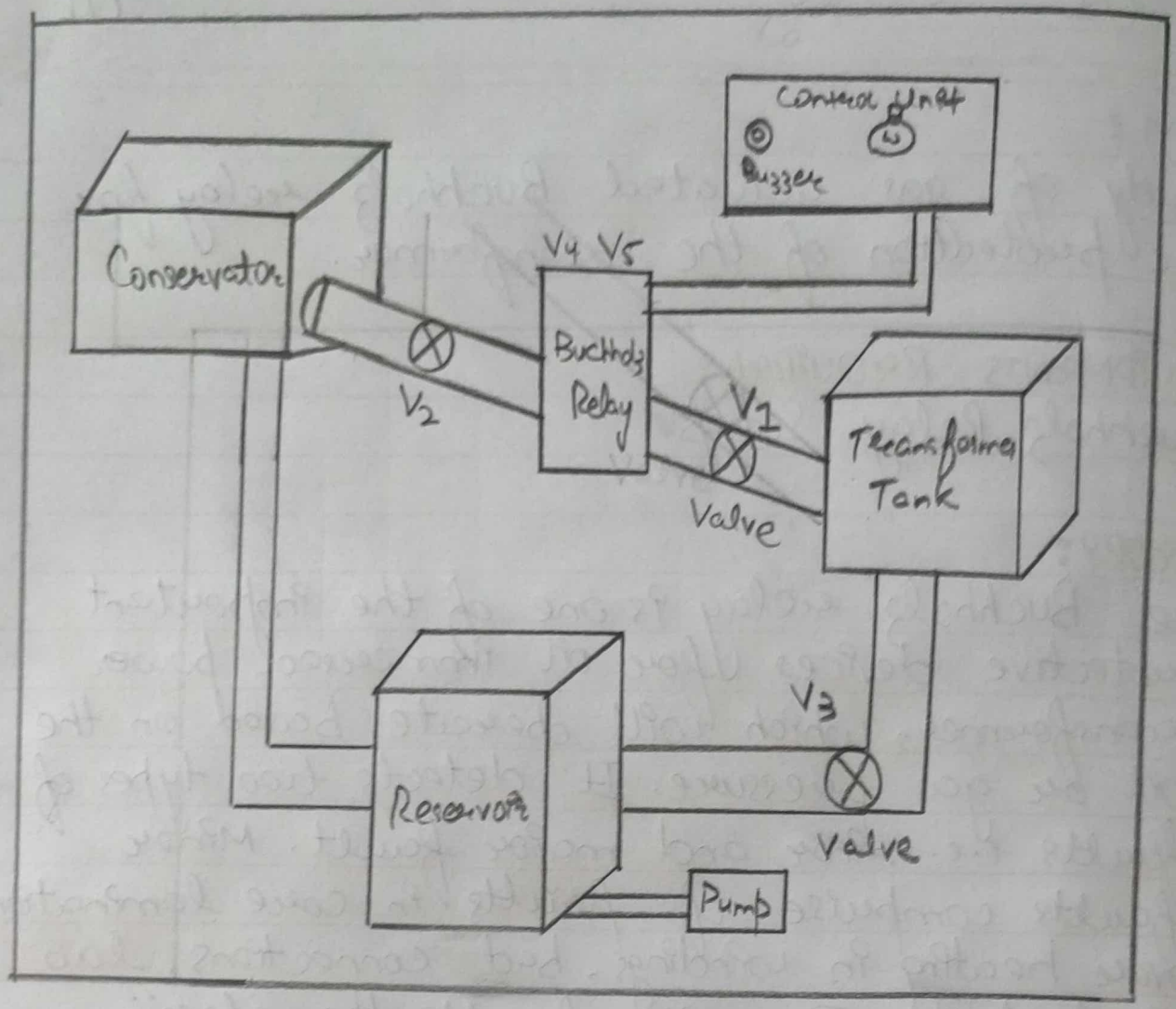


"BUCHHOLZ RELAY"

WORKING PRINCIPLE:

The Buchholz relay comprises hinged float and mercury switch assembly for both the alarm and trip circuits. The entire assembly is in an oil proof case which has two glass windows. When the oil level is reduced from the desired level, the float switch moves down that will touch the contact. In case of major faults, the gases generated in transformer tank due to decomposing of oil rush towards conservator tank through Buchholz relay. These gases pressurize the oil and reduce the oil level in buchholz relay and the float switch go down to close the trip circuit as shown in figure. While reducing the oil level, the alarm will get activated. If the pressure is higher in the transformer tank the trip circuit will be activated to close the mercury switch and trip the power to transformer.

Teacher's Signature



"BLOCK DIAGRAM OF BUCHHOLZ RELAY"

Date

Expt. No. 02

Page No. 03

AIM:
To study Inverse over current relay (electro mechanical type).

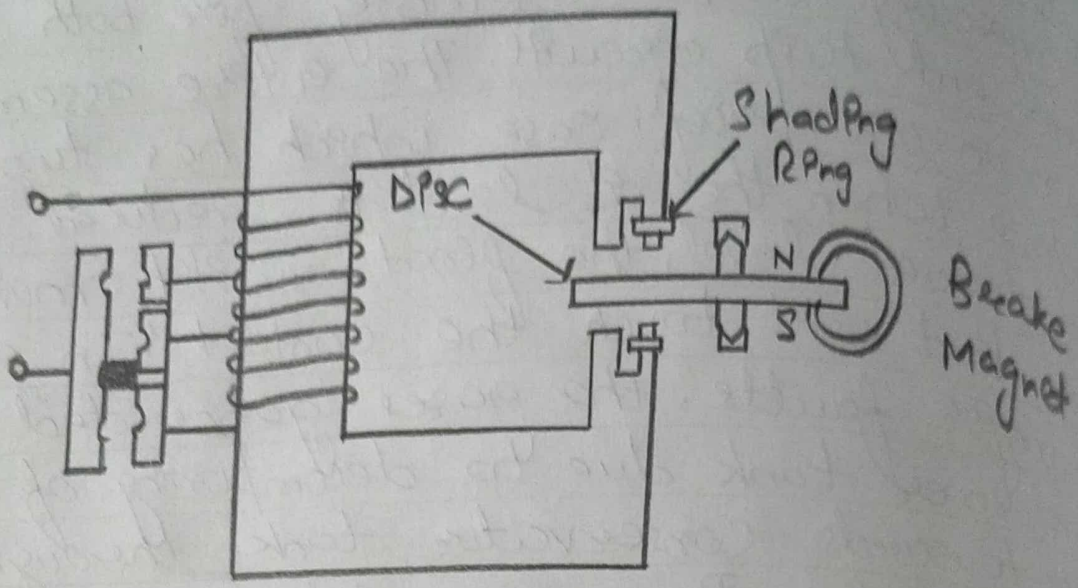
EQUIPMENTS REQUIRED:
1) Over Current Relay setup
2) Power Chord.

THEORY:
It operates when the load current exceeds the preset value. The value of preset current above which the relay operates is known as pick-up current. This scheme is known as over current protection of an element of a power system. The induction disc type construction is commonly used. The operation of induction disc relay is based on electromagnetic induction principle. So this can be used only on a.c. circuits and not on dc circuits.

PROCEDURE:

1) Switch on the power supply.
2) Switch on the MCB ON/OFF switch.
3) Press the start button S1. Now start, LED glows.
4) Change the current value using current adjustment knob provided on the left side of the Relay setup module.
5) After setting the fault current then press

Teacher's Signature



"INDUCTION DISC RELAY"

the reset button of the stop clock to make the displayed time to zero.
6. Now, press the start button 31. The stop clock start counting and when relay trips, it stops counting. During the interval the disc in the relay will rotate.
7. When the relay coil trips, the disc returns to the normal (original position). Note down the relay current from the Relay-current meter and trip time from the stock clock.
8. Repeat the above procedure from step 5 for various fault currents.

PRECAUTIONS:

1. Disc must be stationary before applying fault current.
2. TSM setting must be changed with due time.

Teacher's Signature

OBSERVATION TABLE :

S.No	Fault Current	Time(sec
01	1.2A	13.74
02	2A	5.293
03	2.5A	3.62

Date

Expt. No. 03

Page No. 04

AIM:
To study the Instantaneous Under Voltage Relay.

EQUIPMENTS REQUIRED:
1. Patch Coreds
2. Main Coreds
3. Colored Bulb 230V, 15W.

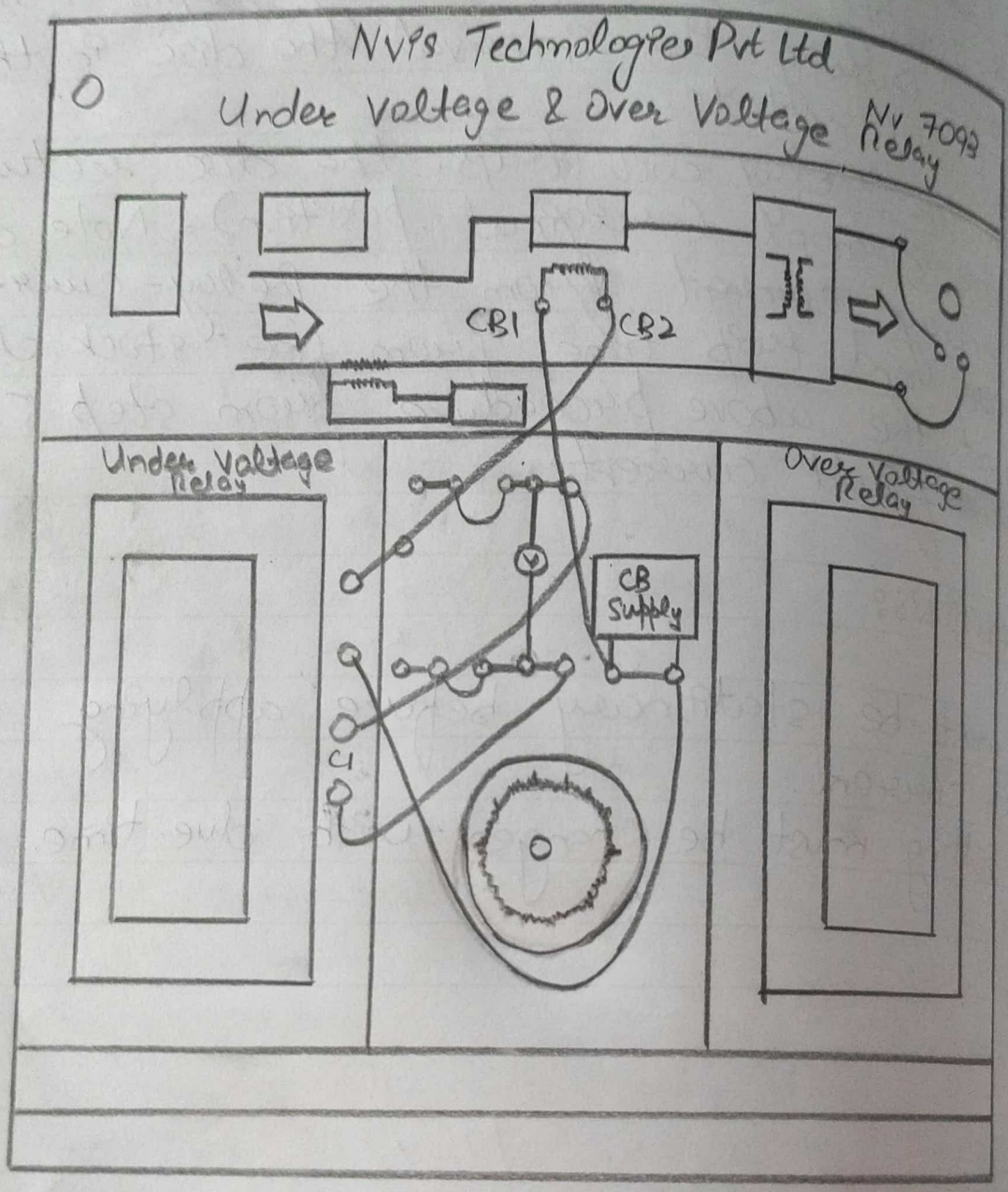
THEORY:
An under-voltage relay operates when the voltage that flows through a relay's coil falls below a predetermined value. Under voltage relays protect loads against voltage drops that can lead to power shortages and brownouts. The relay contacts trip the circuit breaker when the voltage decreases to a certain level.

PROCEDURE:

1. Connect 1 single phase mains coreed to single phase socket provided at the back side of the control panel
2. First make sure that the mains supply is 'OFF' & variac knob should be at zero position.
3. Connect terminal 1 to terminal 3 and terminal 2 to terminal 4.
4. Switch on the mains and set the value of

Teacher's Signature

CONNECTION DIAGRAM:



Vs = 110V through variac with LCD.
Switch off the mains.
Connect terminal 3 to terminal C1 of under voltage relay and terminal 4 to terminal C2 of under voltage relay.
Connect terminal 5 to terminal CB1 and CB2 connect with terminal NO1 of under voltage relay.
NO2 of under voltage relay is connecting with terminal 6.
Connect terminal 7 & 8 to terminal 9 & 10 respectively and insert 15W bulb in bulb holder.
Check all the connection once again as per connection diagram.
Firstly unscrew the cover of relay and set the plug at appropriate position as we want for example set at 44V. After plug setting screw the cover.
Switch "On" single phase supply as well as MCB.
If LCD is not "On" then use Reset switch.

The variac knob is already set at 110V (normal voltage of relay) as per step 3.

Move variac knob in anticlockwise direction and voltage will decrease.
Relay will trip at its plug setting voltage.
See the limit of tripping voltage in the

Teacher's Signature

OBSERVATION TABLE:

S.NO	PWM (V) SETTING VOLTAGE	TRIP (V) VOLTAGE
01	51.3V	49
02	58.6V	56
03	65.9V	63
04	73.2V	70
05	88V	85

(Temp content will get open, Complementary switch close)

observation table.

16. Relay will trip at the plug setting voltage. See the limit of tripping voltage in the observation.

17. Record the tripping voltage of under voltage relay from LCD

18. Similarly repeat the above procedure for different plug settings.

PRECAUTIONS:

1. Before performing any experiment make sure that earthing of your laboratory is proper and is connected to the back side of the panel.

Date

Page No. 09

Exp. No. 04

AIM:
To study the instantaneous over voltage relay

EQUIPMENTS REQUIRED:
1) Patch Cords
2) Main Cords
3) Colored Bulb 230V, 15W

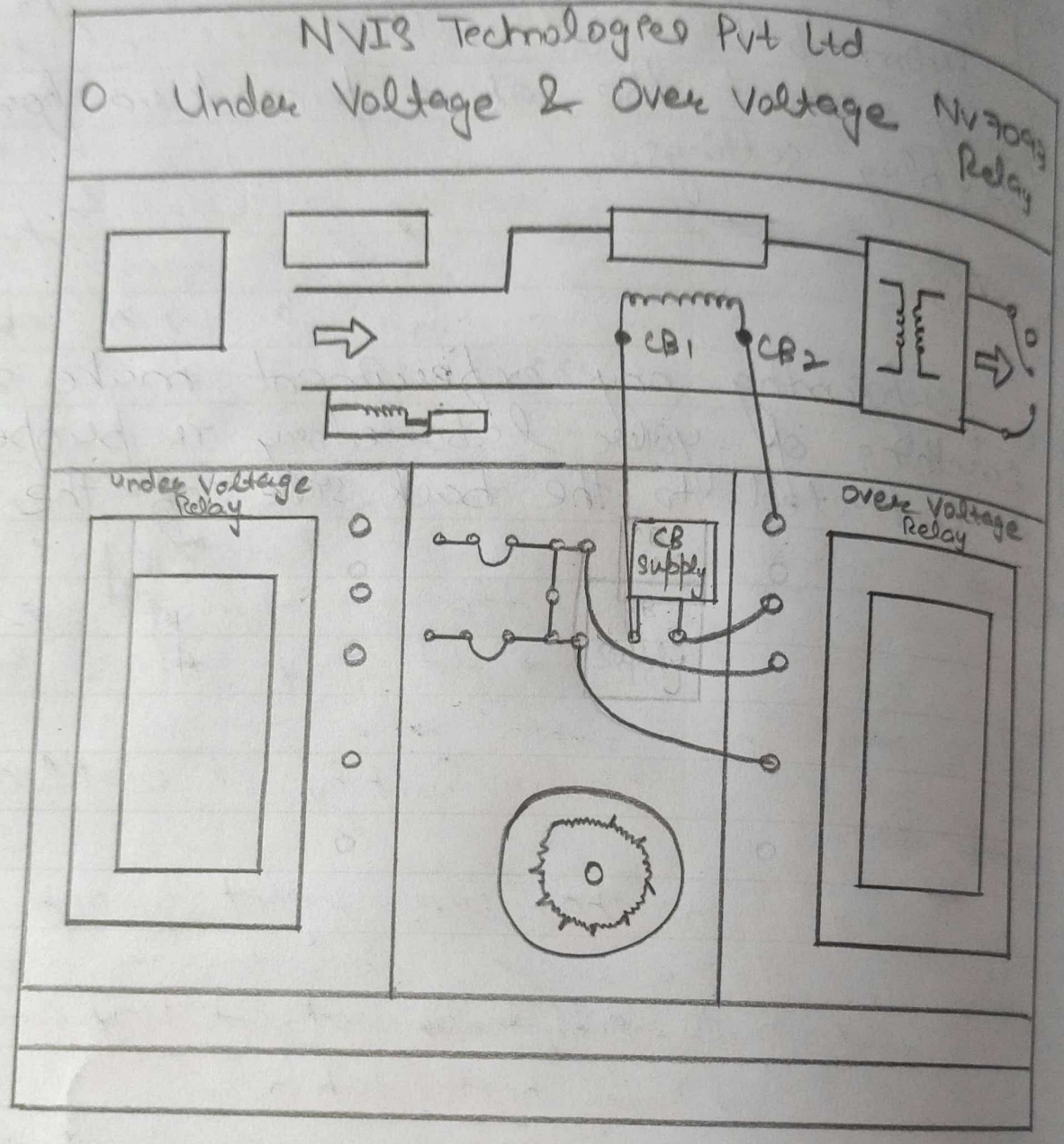
THEORY:
An over voltage relay operates when the current produced by a load, or device connected to the output of a circuit, exceeds a predetermined value. The over-voltage relay connects to a transformer, or device that transfers electrical energy from one circuit to another.

PROCEDURE:

1. Connect single phase mains cord to single phase socket provided at the back side of control panel.
2. First make sure that the mains supply is "Off" and variac knob should be at zero position.
3. Connect terminal 1 to terminal 3 and terminal 2 to terminal 4.
4. Switch on the mains and set the value of VP=110V through variac in LCD.

Teacher's Signature

CONNECTION DIAGRAM:



Date

Expt. No. 04

Page No. 08

5) Switch off the mains.
6) Connect terminal 3 to terminal C1 of over voltage relay and terminal 4 to terminal C2 of over voltage relay.
7) Connect terminal 5 to terminal CB1 and CB2 connect with terminal NO1 of Over voltage relay.
8) NO2 of over voltage relay is connecting with terminal 6.
9) Connect terminal 7, 8 to terminal 9, 10 respectively and insert 15W bulb in bulb holder.
10) Check all the connection once again as per connection diagram.
11) Firstly unscrew the cover of relay and set the plug at appropriate position as you want for example set at 121V. After plug setting screw the cover.
12) Switch 'On' Single phase supply as well as MCB.
13) If LCD is not 'on' then use Reset switch.

The variac knob is already set at 110V (normal voltage of relay) as per step 3.

14) Move Variac knob in clockwise direction and voltage will increase.
15) Relay will trip at the plug setting voltage. See the limit of tripping voltage in the

Teacher's Signature

OBSERVATION TABLE:

S.NO	PICK UP (V) SETTING VOL	TRIP (V) VOLTAGE
01	121	131
02	126.5	136
03	132	141
04	137	147
05	143	153

(Trip contact closed)

observation table.
Record tripping voltage of over voltage relay from DCD.
Similarly repeat the above procedure for different plug setting.

PRECAUTION:

Before performing any experiment make sure that earthing of your laboratory is proper and is connected to the back side of the panel.

Date

Page No. 10

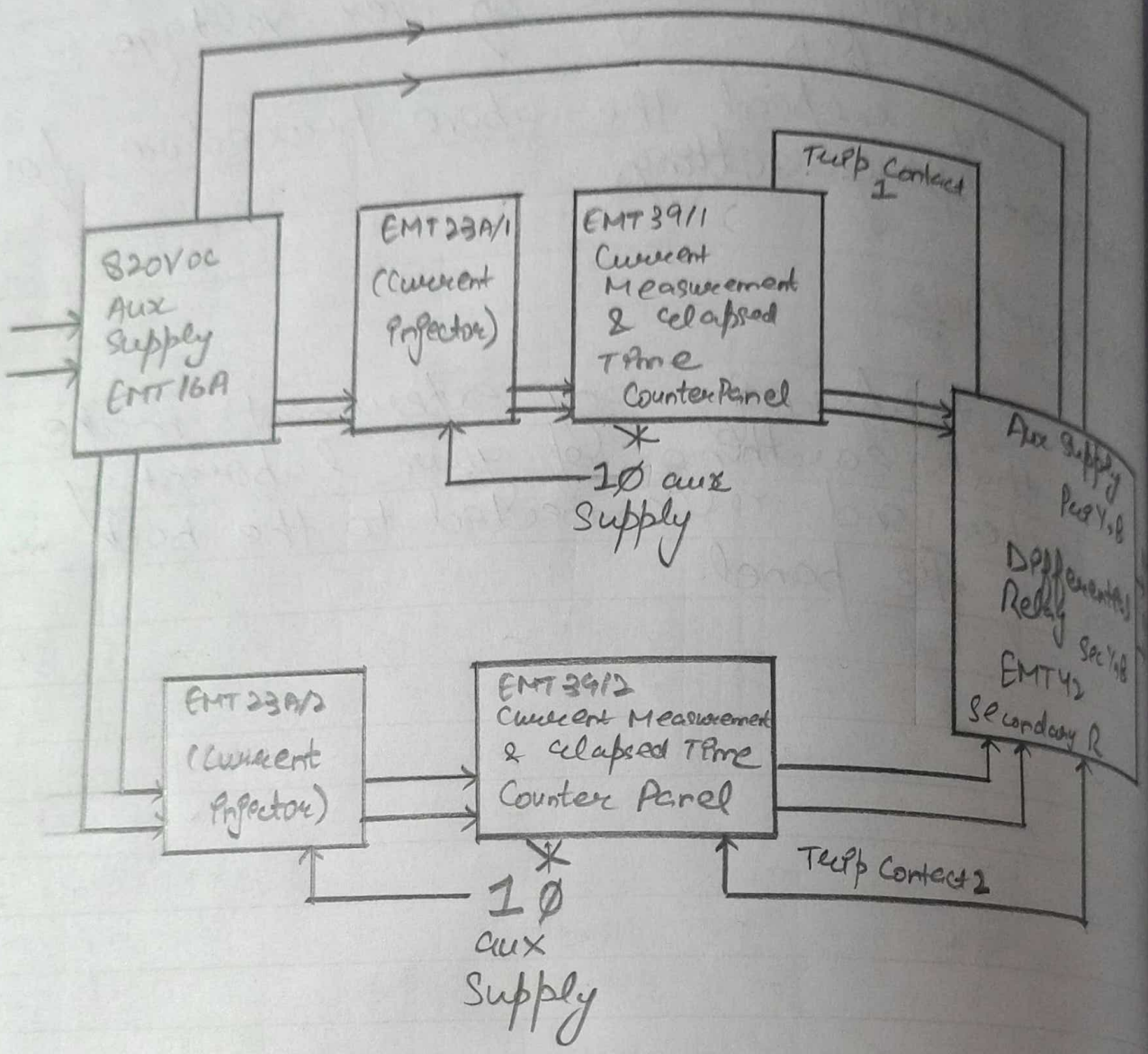
Expt. No. 05

AIM:
To study Percentage Differential Relay using Numerical Relay.

EQUIPMENTS REQUIRED:
1. Numeric & differential relay trainer

THEORY:
Numerical transformer Differential Relay, used for protection of two winding power transformers against hazardous internal faults. Transformer Differential Relay shall not operate for faults external to the power transformer. Protected zone of power transformer is the area up to line CTs. During external faults primary and secondary currents increase equally. Hence the balanced input to Differential Relay is still maintained. Differential Relay is meant for protection of power transformers from internal faults such as inter-turn, phase to phase winding short, HV & LV winding shorts etc.
It measures the phase current from each winding of transformer and calculates differential current (I_d) and restraining current (I_r) per phase. The differential characteristics define the operating and the restraining regions.

Teacher's Signature



"BLOCK DIAGRAM FOR DIFFERENTIAL RELAY CHARACTERISTICS"

Date

Page No. 11

Expt No. 05

PROCEDURE:

1. Make the wiring sequence as per wiring schedule. Keep both the dimmers at minimum position (CCW).
2. Ensure that 'Bypass switch' on EMT-39 Panel is at 'CLOSE' position i.e RHS side. R, Y and B. While performing experiment we are using only one phase say 'R' phase.
3. Relay setting Now switch on auxiliary supply for differential relay by making ON 4A MCB at EMT 16A. Press Menu key you will observe two options i.e View & edit. Press 2 key for edit, it will ask for password. Press '1234' and press enter, it will show accepted. The options in edit mode are Group 1, Group 2, Active group, clock, LCD & reset. Select Group 1 by pressing 1, now setting corresponding to group 1 are displayed. Now enter following setting in for group 1 by using Numeric keys & enter key.

Pickup (Ik) = 0.2pu, slope 1 = 20%, slope 2 = 50%, Breakpoint (K_B) = 1pu, Diff. Hiset = 00pu, CTR(W1) = 1pu, CTR(W2) = 1pu, Inrush (2f) = 00%, over excitation (5f) = 00%, Vector group = Dd0. After entering all above parameters press reset key on relay.

4. Now press start push buttons PB1 on both EMT39/1 & 2 simultaneously to switch ON the

Teacher's Signature

Date

Expt. No. 05

Page No. 12

protection circuit and contactor.

5. Now slowly increase the current on both the panel EMT 3911 & EMT 3912 simultaneously observing on EMT 3911 & EMT 3912 adjust both to 1A.

6. Now keep secondary current I_2 constant on (EMT 3912) i.e 1A, increase primary current I_1 (on EMT 3911) until the relay trips. Note down this I_1 reading in observation table.

7. To take other set of readings press reset button, change slope 1 = 40%, press start push buttons, increase primary current until relay trips.

8. Now take various readings of I_1 for different setting of slope 1 (DF1) as given in observation table.

9. Calculate differential current $Id = |I_1 - I_2|$ & restraining current $Ir = \frac{I_1 + I_2}{2}$ as given.

10. Now calculate slope 1 (DF1) using formula

$$DF1 = \frac{(Id - Ik)}{(Ir - Ik/2)} \times 100$$ where $Ik = 0.2\,pu = 1A$.

11. The same experiment may be repeated for other two phases also.

Teacher's Signature

OBSERVATION TABLE:

S.No	% bias slope DF setting	I_2 on EMT3911 'A'	Error in I_2	I_1 on EMT3911 'A'	Error in I_1	$Id = \lvert I_1 - I_2 \rvert$	$It = \frac{I_1 + I_2}{2}$	Calculated % bias $\left(\frac{Id - Ik}{It - \frac{Ik}{2}}\right) \times 100$ $(Ik = 0.2\ P.u)$
01	20	1.07	0.26	2.03	-0.03	0.67	1.665	30%
		$I_2 = 1.33$		$I_1 = 2.00$				
02	40	0.99	0.26	2.10	-0.03	0.8	1.67	38.2%
		$I_2 = 1.27$		$I_1 = 2.07$				
03	60	1.01	0.26	2.80	-0.03	1.5	2.02	67.7%
		$I_2 = 1.27$		$I_1 = 2.77$				
04	80	1.04	0.28	3.24	-0.03	1.89	2.265	78.0%
		$I_2 = 1.32$		$I_1 = 3.21$				
05	100	0.99	0.25	3.61	-0.03	2.34	2.41	96.6%
		$I_2 = 1.24$		$I_1 = 3.58$				

CONCLUSION: From observation table, it is observed that the experimentally measured BPAR slope 1 percentage using formula is found to be matching with setting value of bias slope I within practical limitations of measurement due to instrument accuracy, variation in supply voltage / frequency etc.

Date

Expt. No. 06 Page No. 13

AIM:
Study of differential protection scheme of three phase transformer.

EQUIPMENTS REQUIRED:
Numeric Differential relay trainer.

THEORY:
A transformer is a static device totally enclosed and generally oil-immersed. Thus, chances of fault occurence on them are rare. The transformer differential protection provides fast tripping in case of a fault- before severe damage spreads out. Such faults are:

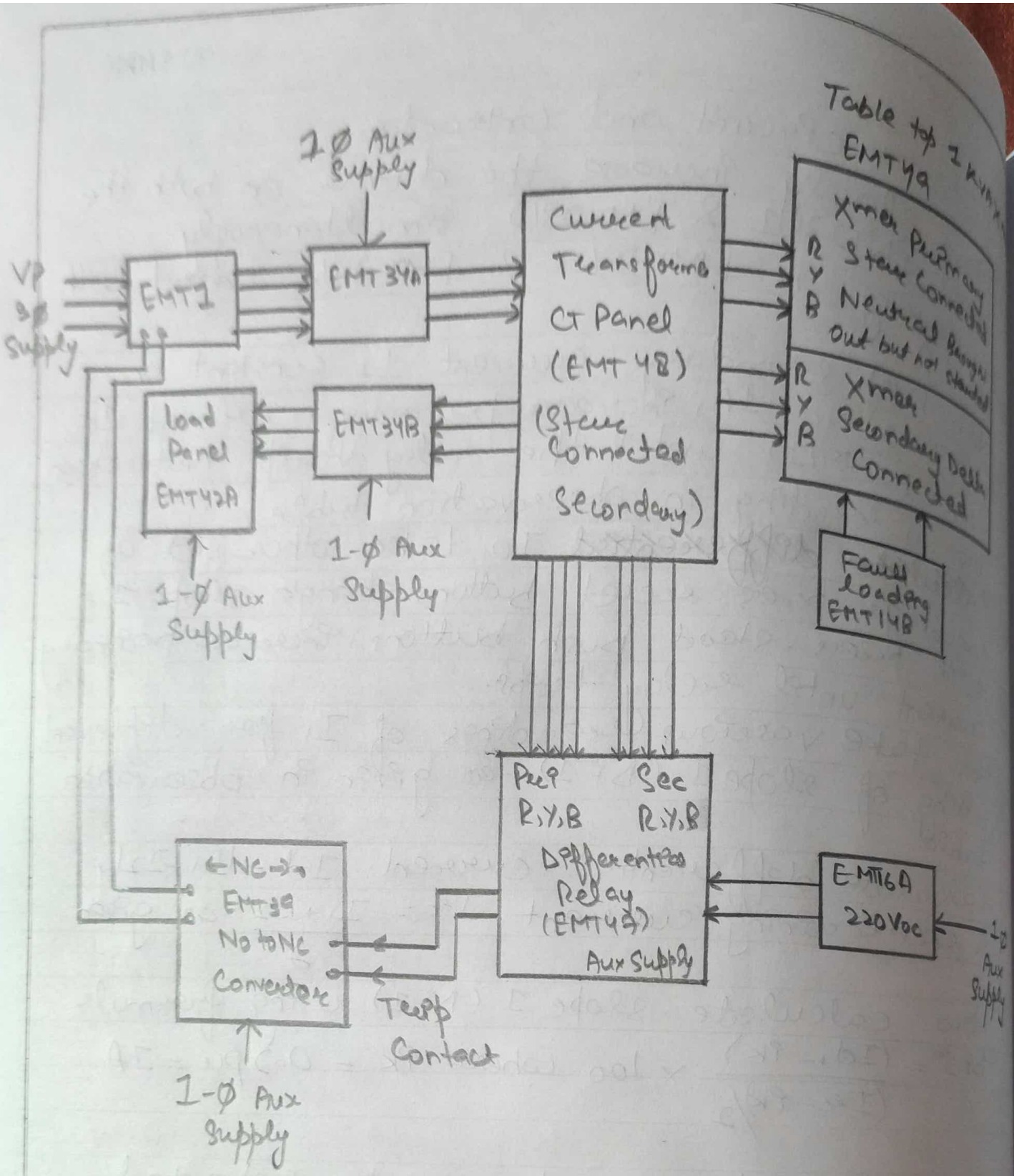
- Short circuits between turns, windings and cables inside the transformer.
- Earth faults inside the housing.
- Short circuits and earth faults outside the housing but within protected zone.

A differential relay is one that operates when the phase difference between the two or more similar electrical quantities exceeds a pre determined value.

PROCEDURE:

1. Make the wiring sequence as per wiring schedule. Observe table of wiring for Xmer & CTs.

Teacher's Signature



"BLOCK DIAGRAM FOR TRANSFORMER PROTECTION USING DIFFERENTIAL RELAY"

Date

Expt. No. 06 Page No. 14

2. Differential relay we are using is a three phase numerical relay indicating three phases as R, Y and B.
3. Relay setting, Now switch on auxiliary supply for Differential relay by making ON 4A MCB at EMT 16A. Press menu key you will observe two options i.e View & edit. Press 2 key for edit, it will ask for password. Press '1234' & press enter, it will show accepted. The options in edit mode are Group 1, Group 2, Active ~~group~~ groups, clock LCD & reset. Select groups 1 by pressing 1. Now setting corresponding to group 1 are displayed. Now enter following setting in for group 1 by using numeric keys & enter key. Pickup (Ipk) = 0.2pu, slope 1 (DF1) = 40%, slope 2 (DF2) = 80%, Brkpt (kp) = 1pu, Diff Hset = 00pu, CTR (W1) = 2pu, CTR (W2) = 1.12pu, Inrush (2f) = 00%, over excitation (5f) = 00% Vector group = Yd1.

After entering above parameter come out of edit mode and press reset key on relay.

4. Keep load selection switch on EMT-42A at 125Ω position & on EMT 148 at OFF position.
5. Keep Bypass switch on EMT-39 panel at 'OPEN' Position for LHS side.
6. Now switch on AC supply by making 4A MCB ON at EMT16A.
7. Now press start push buttons PB1 on EMT39

Teacher's Signature

OBSERVATION TABLE:

Faults Name	Fault side EMT 149	Shorting resistance value (EMT 148)	Pre Primary current (IP) %	Secondary Current (IS) -1.
L-L (R-Y)	Pre Primary	600	50	19
L-L (R-Y)	Pre Primary	300	74	8
L-L (R-Y)	Pre Primary	220	30	6
L-N (R-N)	Pre Primary	162	52	20
L-L (R-Y)	Secondary	162	49	18
L-L (R-Y)	Secondary	125	64	10

Conclusion:
From above experiment, it is observed that for any in zone faults like L-L, L-G whether primary or secondary the relay will trip

first & then on EMT1 to switch ON the protection circuit, contactor & 3ϕ supply.
8. Observe the LEDs on Relay. If 'I> Dir. TRIP' LED is ON then press reset push button on Keypad. If all the LEDs except AUX. supply on LED are OFF no need to press reset push button.
9. Now keep Bypass switch on EMT-39 panel at 'CLOSE' position the RHS side.
10. Now to create a fault of L on primary side connect resistor on EMT148 to transformer primary (EMT49) side between R & Y phase keeping resistance selection switch on EMT148 at OFF position.
11. Now put the resistor selector switch on EMT 148 at 75Ω position & then on 600Ω position and note that the relay will trip. Note down the resistance value from EMT148 and % of primary (Ip) & Secondary (Is) current from relay display in table.
12. Press reset button on relay panel.
13. Now to create LN fault on primary side remove previous connection of EMT148 & connect resistor from EMT148 between R & N of primary of transformer EMT49 keeping selector switch on EMT148 at OFF position.
14. Now press steps push buttons PB1 on EMT39 first and then on EMT1 to switch ON the protection circuit.

Teacher's Signature

Date

Expt. No. 06

Page No. 16

15. Now put the resistor selector switch on EMT14B at 750Ω position, then on 600Ω, then on 300Ω & 212Ω position, and note that the relay will trip
16. Press reset button on relay front keypads
17. Similarly to create fault of R on secondary side, remove previous connect of EMT14B & connect resistor from EMT14B to secondary side of transformer, between R and Y phases.
18. Now press start push buttons PB1 on EMT39 panel & then on EMT1 to switch ON the protection circuit, contactors & 3Ø supply.
19. Now put the resistor selector switch on EMT14B at 750Ω position, then on 600Ω, then on 300Ω, 212Ω & 162Ω position and note that the relay will trip.

Teacher's Signature

Date

Expt. No. 07 Page No. 17

AIM:
To study current greaded protection of feeders using static over current relay.

EQUIPMENT REQUIRED:
Static Over current relay set up.

THEORY:
The word feeder here means the connecting link between two circuits. The feeder could be in the form of transmission line, short, medium or long, or this could be a distribution circuit. The various methods of protecting the feeders are:

1) Over current protection.
2) Distance protection.
3) Pilot, relaying protection.

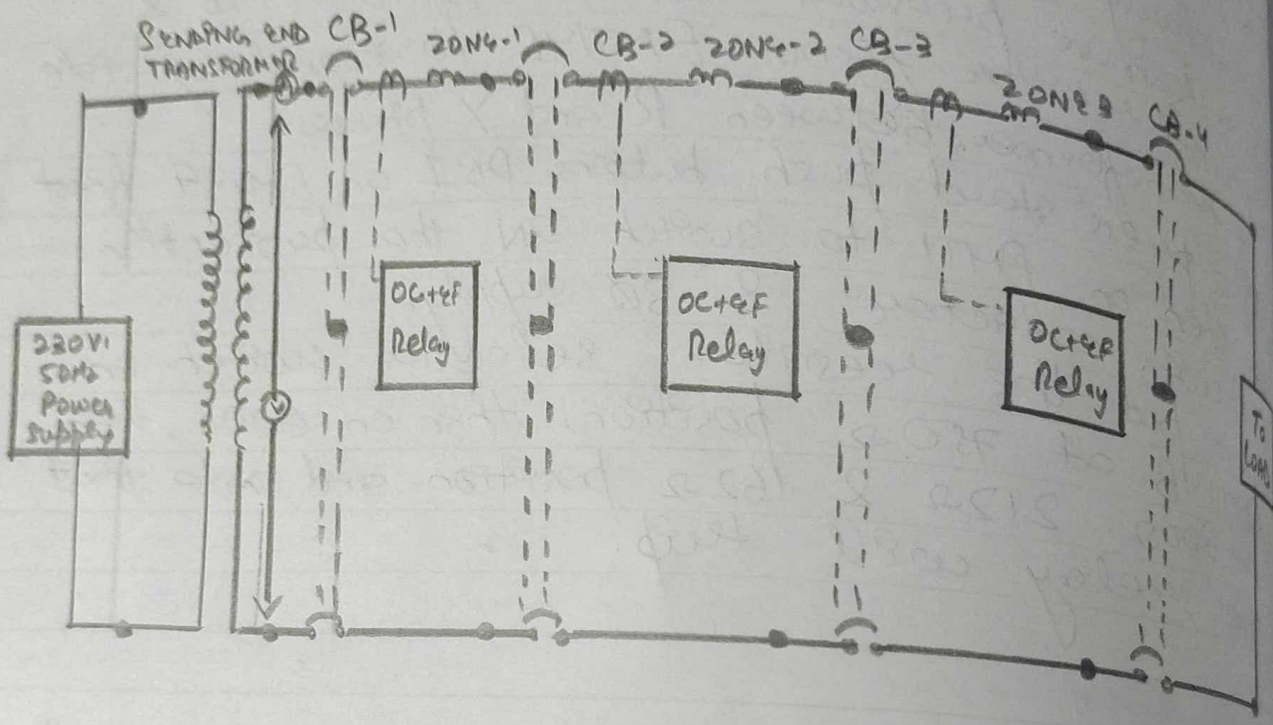
Of these, over current protection is the simplest and cheapest form of protection. Over current relaying for distribution circuit feeder being simple and cheap provide following advantages.

i) Very often the relays need not be directional and hence no AC voltage source is required.
ii) Two phase and one earth fault relay or three element, earth fault relay can be used.

The over current protection is normally used as back up protection where the primary protection

Teacher's Signature

CIRCUIT DIAGRAM:



is provided with distance schemes.
The discrimination using over current protection is achieved in the following ways
(i) Time graded system
(ii) Current graded system
(iii) Time - current graded system.

CURRENT GRADED SYSTEM:
This type of grading is done on a system where the fault current varies appreciably with the location of the fault. This means as we go towards the source the fault current increases. With this if the relays are set to pick at progressively higher current towards the source, then the disadvantages of the long-time delay that occurs in case of time graded system can be partially overcome. This is known as current grading.
Since it is difficult to determine the magnitude of the current accurately and also the accuracy of the relays under transient condition is likely to suffer, current grading alone cannot be used. Usually a combination of the two grading i.e current time grading is used.

PROCEDURE:

1) Connect the input terminal to the Mains.

Teacher's Signature

OBSERVATIONS:

→ Operating time = 2.015

→ Operating time = 1.997 (375mA)

For Definite

→ Back up relay = 3.95

Date

No. 007 Page No. 19

Set the relay current - (setting procedure - refer LT manual)

$Is = (0.1R + R\Sigma a)In$

where

Is = Set Current level (Fault Current level) in Amps

In = CT Rating (1A)

a = weight of switch in ON Position

R = Constant depending on the setting rating.

Setting Range	'R' Value
10% to 40%	1
20% to 80%	2
50% to 200%	5

Set the Relay High Current - (Setting procedure - refer LT MANUAL)

$Ihs = (2 + \Sigma b)Is$

Where,

Ihs = High set Current level in Amps

Is = Set Current level in Amps

b = Weight of switch in ON Position

Set TMS

$T = k(0.1 + \Sigma t)$

Where

T = trip time in second

k = Constant depending on Trip time Characteristics

t = weight of switch in ON Position.

Ensure the Ammeter & Voltmeter connect.

Connect the rheostat between the zone where

Teacher's Signature

fault has to be created.
7. Put on the Mains MCB. Results (Mains on indicator, ammeter display, relay power and Timer display will glow).
8. Turn on the Relays and Circuit breakers of respective Zones.
9. Now gradually reduce the rheostat which leads to increase of current in respective zone creating the fault.
10. Once the fault is created & relay of corresponding zone operates leading the respective zone circuit breaker to open indicating us the fault zone.
11. To get the trip time & safe operation fault simulation switch is to be used.