Wire up the consumer's main board with MCB & DB'S and switch and distribution fuse box

Objectives: At the end of this exercise you shall be able to

- **place the MCB switch and distribution fuse box on the board as per the given layout observing the standard code of practice**
- **mark on the board to drill holes for the purpose of drawing wires and for fixing the accessories**
- **drill suitable holes to fix accessories and for cable entry**
- **fix the accessories**
- **identify and earth the metal parts**
- **identify the cable to be connected for phase and neutral according to the colour of insulation**
- **select and confirm the size of the cables according to the capacity of the main switch and D.B.**

Requirements

Tools/Instruments

- Steel rule 300mm - 1 No.
- Insulated Side cutter 150mm - 1 No.
- Combination pliers 200mm - 1 No.
- Hand drilling machine 6mm capacity with 3mm,6mm bits - 1 Set
- Poker 200mm - 1 No.
- Insulated Screwdriver 200mm with 4mm blade - 1 No.
- Insulated Screwdriver 150mm with 3mm blade - 1 No.
- Connector screwdriver 100mm - 1 No.
- Neon tester 500V - 1 No.
- Wooden mallet 7.5cm dia.500 g - 1 No.
- Electrician's knife DB 100 mm - 1 No.
- Tenon-saw 300mm - 1 No.
- Gimlet 200mm with 4mm dia. stem - 1 No.
- Firmer chisel 12mm - 1 No.
- Wood rasp file 200mm flat - 1 No.

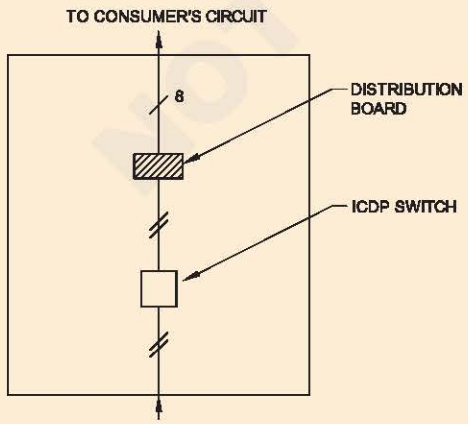
Material

- 2 pole MCB 16A - 1 No.
- Distribution fuse box 4-way 16A 250V - 1 No.
- Wood screws No. 25 x 6 mm - 4 Nos.
- Wood screws No. 20 x 6 mm - 4 Nos.
- Wood screws No. 15 x 6 mm - 2 Nos.
- PVC aluminium cable 2.5 sq mm in red and black colour - 1.5 m each.
- Tinned copper wire 14 SWG - 3 m
- T.W. hinged box 300 x 250 x 80 mm - 1 No.
- 3mm dia. 25 mm long full-threaded G.I bolt, nut and washer - 10 Nos.
- PVC Cable clips 10 mm wide 2 mm thick - 300 mm

PROCEDURE

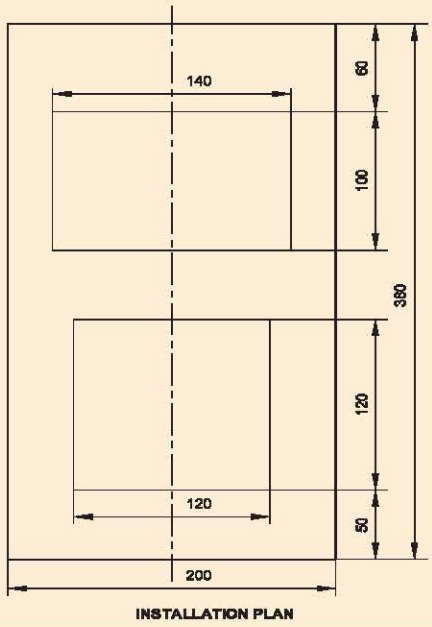
1 Mark the position of the given MCB and DB on the top surface of the T.W. board as shown in Figs 1 and 2.

Fig 1



2 Mark the position of through holes for cable runs and earth conductor.

Fig 2



3 Drill suitable holes (either pilot or through) in the T.W. board to fix MCB and DB.

4 Drill holes for cable entry.

5 Provide holes in the top and bottom of the base T.W. board for the supply and outgoing cables.

6 Fix MCB and DB using wood screws/other fasteners.

7 Select and confirm the size of the cables according to the ratings of the main switch and DB.

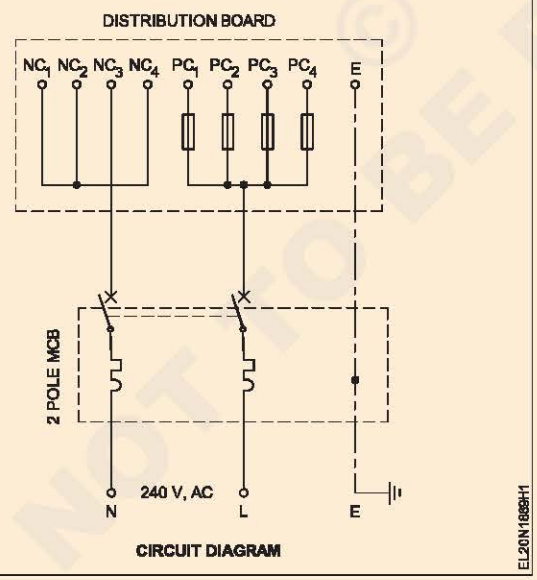
8 Connect the supply leads to the MCB through the T.W. board. Mark the end of the phase cable.

While connecting the incoming and outgoing cables to the MCB and D.B. they should pass through the holes in the top board and then through the holes provided in the top and bottom sides of the base board.

In both cases sufficient allowance of length should be given in the cables such that the hinged top board could be opened at an angle of 120° from the base board. Harnessing of the cables inside the board should be done with the P.V.C. cable clips, and the cables should pass in or out from the MCB and D.B. through the P.V.C. bushed holes.

9 Interconnect the MCB and DB as shown in Fig 4. Provide 4 pairs of outgoing cables from the D.B. for four branch circuits. Compare the wiring diagram (Fig 4) with the Circuit diagram (Fig 3).

Fig 3



While using connecting cables observe the colour code. Phase:red, Neutral:black.

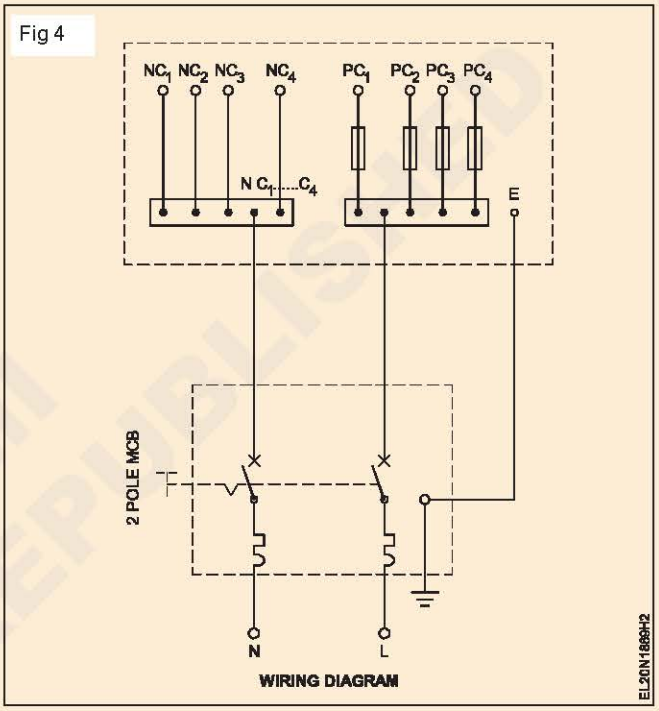
10 Locate the earth connecting points on the DB and drill suitable holes for the earthing leads in the T.W. board.

11 Connect the earth wire to the DB and then connect the E.C.C. to the meter board earth plate.

12 Fix the fuses in the DB and main switch according to the circuit/main loads.

Individual circuit loads have to be indicated in amperes by fixing labels on the D.B

Fig 4



Prepare and mount the energy meter board

Objectives: At the end of this exercise you shall be able to

- **make holes on the wall according to requirement with a rawl jumper and hammer**
- **fill the holes with filling material**
- **make recess holes for fixing wooden gutties**
- **fix wooden gutties (wooden plugs) in the wall**
- **use a pipe jumper for making holes through the masonry wall**
- **mount the given energy meter, iron-clad cut out and the neutral links on the meter board**
- **connect the meter, iron-clad cut out and the neutral link as per regulations**
- **mount the meter board on the wall.**

Requirements

Tools/Instruments

- Insulated Steel rule 300mm - 1 No.
- Insulated Side cutter 150mm - 1 No.
- Combination pliers 200mm - 1 No.
- Hand drilling machine with 3mm and 6mm drills - 1 No.
- Insulated Screwdriver 200mm with 4mm blade - 1 No.
- Insulated Connector screwdriver 100mm - 1 No.
- Poker 200mm long with 4mm dia. stem - 1 No.
- Electrician's knife DB 100 mm - 1 No.
- Firmer chisel 12mm wooden handle - 1 No.
- Rawl jumper No.8 with holder and bit - 1 No.
- Cold chisel 200mm long with 12mm edge - 1 No.
- Ball peen hammer 500 gm. - 1 No.
- Tenon-saw 250mm - 1 No.
- Mallet with 7.5cm dia. head 500 gm - 1 No.
- Neon tester 500 V - 1 No.
- Scriber 200mm with 3mm dia. stem - 1 No.
- Mason's trowel - 1 No.
- Tray for cement mortar - 1 No.

Equipment Machines

- Single phase energy meter 10/15A 250V

Materials

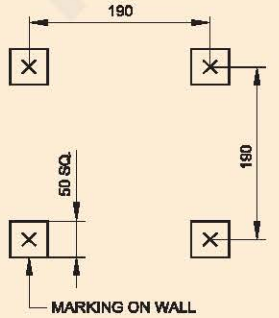
- PVC insulated copper cable 2.5 square mm - 3 m
- Tinned copper wire 14 SWG - 1 m
- Iron-clad cut out 16A - 1 No.
- Neutral link 16A - 1 No.
- T.W. board 250x250x40mm - 1 No.
- Porcelain spacers - 4 Nos.
- Teak wood gutties (wooden plugs) 40mm square x 60mm long x 30mm square - 4 Nos.
- Wood screws No.4 x 25 mm - 3 Nos.
- Cement - 1/2 kg.
- River sand - 2 kgs
- Rawl plug No.8 - 4 Nos
- Rawl plug Compound - 25 gms.
- Chalk piece (colour) - 1 No.
- G.I. pipe 20mm - 400 mm.
- Wood screws No. 50 x 8 mm - 4 Nos.

TASK 1 : **Prepare wall for mounting meter board**

If the wall is not too rigid, follow this method.

1 Mark 50mm square around the marking as shown in Fig 1.

Fig 1



2 Remove the plaster and the brick at the marked surfaces to a depth of 70 mm from the wall surface with the help of a cold chisel and hammer.

3 Prepare cement and sand mortar in the ratio of 1:4.

Let the mortar be in a semi-solid condition.

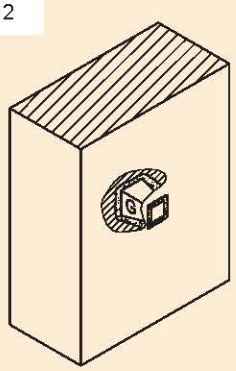
4 Sprinkle water in all the pits.

5 Insert a small quantity of cement mortar inside the pit with the help of a mason's trowel.

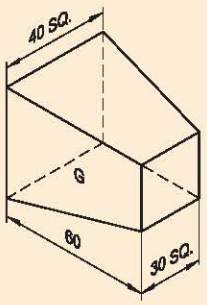
6 Insert the wooden gutties inside the hole pit such that the broad portion is inside and the narrow portion is outside and is just flush with the surface of the wall. (Fig 2)

7 Apply the cement on all sides of the gutty such that the gutty remains in the centre of the square hole.

Fig 2



MOUNTING GUTTY IN THE RECESS



GUTTY

ELN2378-H3

8 Smoothen the surface of the wall with a mason's trowel.

Allow the cement to dry for 4 hours and sprinkle water on the cement every one hour so that the cement settles. The gutties become rigid after approximately 24 hours. Then only the boards could be fixed on to the gutties.

Now the wall is ready for fixing the T.W. board.

9 Fix the T.W. board with the help of 45mm long wood screws.

Trainees are required to identify the relationship between the stem thickness of 45mm long wood screws and the respective designation numbers.

— — — — — — — —

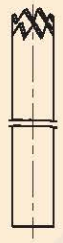
TASK 2: **Preparation of wall for drawing the service connection**

Sometimes the service connection wires need to be taken through the wall using a G.I. pipe. There is then the necessity of making a hole through the wall with the help of a pipe jumper. The method to do it is as explained below. The diameter of the pipe jumper depends on the diameter of the service connection pipe and the length of the pipe jumper depends upon the wall thickness.

1 Take a 20mm dia. G.I. pipe of 400mm length.

2 Make serrations by cutting at one end of the pipe as shown in Fig 3 using a hacksaw.

Fig 3



PIPE JUMPER

ELN2378-H4

This type of pipe jumper is also called crown jumper, due to its very look.

3 Inspect the wall and mark a place on the wall considering the nearest point to the electric service pole.

The marking should be close to the meter terminals. It should not be on the R.C. . beam or granite stone embedded in the wall.

In the case of an old building check whether any concealed wiring is running through the wall at the place of marking. In such cases the marking should be done at a different place. However, in buildings, where wiring exists, switch `off' the mains, remove the fuse-carrier and keep it under your custody.

4 Keep the pipe jumper on the mark and hammer it lightly.

5 Rotate the pipe jumper for every stroke of hammer.

This process removes the broken masonory and allows free movement of the pipe jumper. Take care to keep the pipe jumper perpendicular to the wall surface.

6 Slow down the hammer strokes when the pipe jumper reaches near to the other end of the wall.

Hitting hard on the hammer at the end of a hole will make a larger sized plaster to fall out at the other end of wall.

7 Clear the hole.

8 Insert the G.I. pipe for the service cable in the hole and plaster around the pipe with cement.

Wiring up a meter board

1 Confirm the capacity of the energy meter.

2 Select and confirm the size of the cable as per the meter rating.

Follow the standard colour code for phase and neutral.

3 Position the meter, I.C. cut-out and earth-plate as per layout (Fig 4) and mark their position as per layout on the T.W. board.

4 Mark the cable entry positions and mounting screw positions.

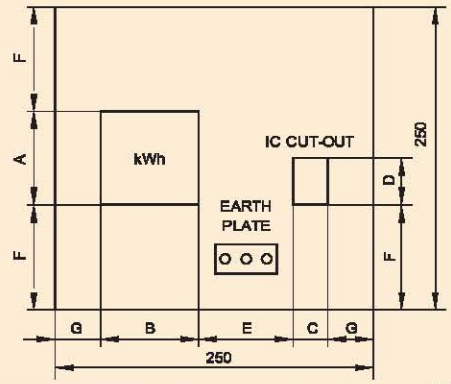
5 Select the drill bit according to the cable size.

6 Drill through holes in the T.W. board for cable entry and pilot holes for fixing the meter, I.C. cut out and the earth plate.

7 Fix the meter, I.C. cut out and the earth plate.

8 Determine the length of the cables according to the layout and cut them with reference to Figs 4 and 5.

Fig 4



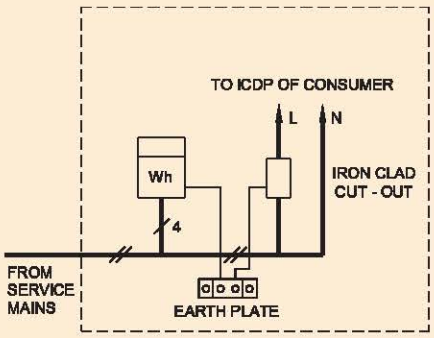
A-B OUTSIDE MEASUREMENTS OF ENERGY METER $F = \frac{250 - A}{2}$

C-D OUTSIDE MEASUREMENTS OF METAL CLAD (IRON CLAD) CUT - OUT
E = 50mm $G = \frac{250 - B - C - E}{2}$

INSTALLATION PLAN

ELN2378H5

Fig 5

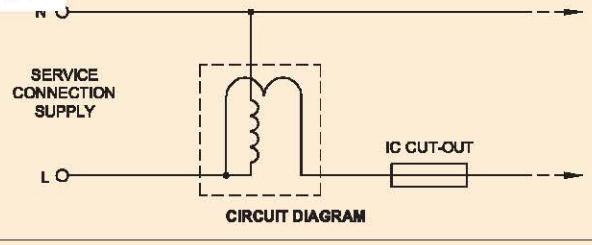


ENERGY METER SINGLE PHASE (6-16A-240V)

LAYOUT DIAGRAM

ELN2378H6

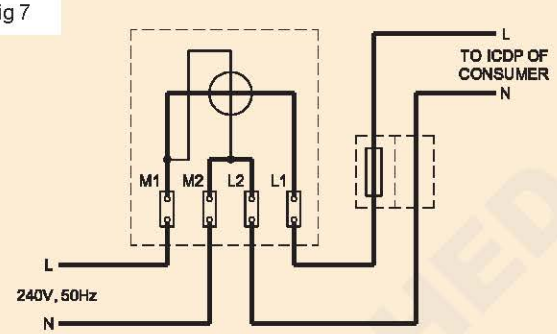
Fig 6



CIRCUIT DIAGRAM

ELN2378H7

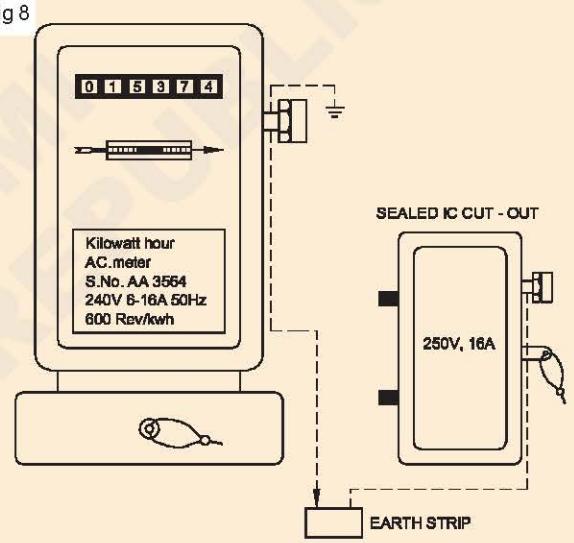
Fig 7



WIRING DIAGRAM

ELN2378H8

Fig 8



METER BOARD WITH MOUNTED ACCESSORIES

ELN2378H9

9 Connect the supply leads and the outgoing phase wire to the I.C. cut–out. Pass the neutral directly as per the wiring diagram. (Figs 6 and 7)

10 Earth the casing of the meter and the I.C. cut out body to the earth plate.

11 Keeping the meter board in a vertical position, test the circuit after getting the approval of the instructor.

12 Mount the meter board on the previously prepared wall with the help of 45mm wood screws.

The completed work should look as shown in Fig 8.

Estimate the cost/bill of material for wiring of hostel/residential building and workshop

Objectives: At the end of this exercise you shall be able to
- **calculate the total load in sub-circuit**
- **select the size of cable in the sub circuits**
- **estimate the quantity of materials**
- **estimate the cost of wiring.**

Requirements

Tools/Instruments

• Measuring tape 0-25 m	- 1 No.
• SWG	- 1 No.
• Steel rule 300 mm	- 1 No.
• Micrometer 0-25 mm	- 1 No.

Materials

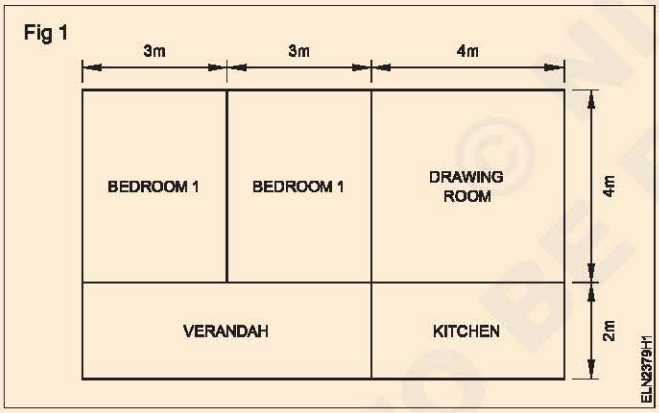
• A-4 Paper	- as reqd.
• Pencil/HP	- 1 No.
• Eraser	- 1 No.

PROCEDURE

TASK 1 : **Estimate the cost/bill of material for wiring of hostel / residential building**

1 Obtain the building plan as shown in Fig.1

Fig 1



2 Collect the requirements of lights, fans, lighting and power sockets etc.

3 Mark the location of switch board, Power loads and DB in the plan.

The type and quantity of loads depend upon the customer's requirement. Hence, complete data are to be collected before starting estimation. A sample requirements is given for the trainee's reference.

The wall thickness	- 40 cm
The height of roof from ground	- 3.5 m
Height of conduit run	- 3 m
Height of main board	- 2.5 m
Height of switch	- 1.5 m
Height of light brackets	- 3 m
Height of main board	- 3 m

The details of standard requirement of Power loads are given in Table - 1

Table -1

Location	Light (60 W)	Fan (80 W)	6A Plug Point (80 W)	16A Power Plug (1000 W)
Verandah	1	1	1	1
Kitchen	1	1	Nil	1
Bedroom	2 +2	1 + 1	1 + 1	Nil
Drawing Room	2	1	1	Nil

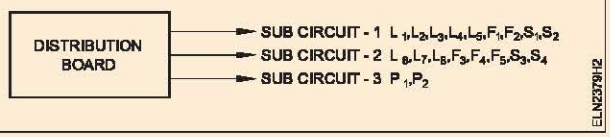
4 Calculate the number of sub circuits required for the above load as per IE rules.

Indian electricity rule states that there should be separate sub circuits for light/fan loads and power loads. Therefore 6A plug points (Sockets) are considered as light / fan load points as they are meant for connecting table fan /table lamp etc. 16A power plug are considered as power points as they are used for connecting heavy loads like heaters, kettles etc.

Total wattage of light points	= 8 x 60 = 480 W
Total wattage of fan points	= 5 x 80 = 400 W
Total wattage of (6A) sockets	= 4 x 80 = 320 W
Total 17 Nos	= 1200 W

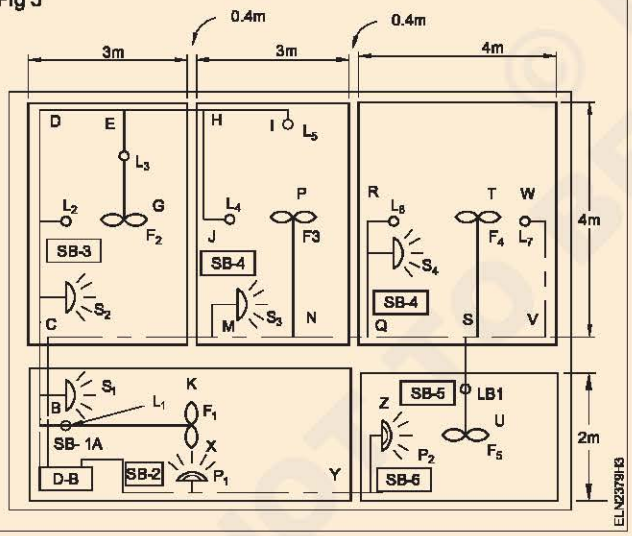
As there are 17 points, we need two sub - circuits. The division of outlets on each sub circuit is made more or less uniform, ie., 8 & 9. Refer Fig 2

Fig 2



5 Draw the layout of conduit, switch board, loads and DB as shown in Fig 3.

Fig 3



6 Calculate the size of each cable as shown below.

i current through subcircuit-1

$$= \frac{(5 \times 60) + (2 \times 80) + (2 \times 80)}{230} = 2.696 \text{ A}$$

ii Current through subcircuit -2

$$= \frac{(3 \times 60) + (3 \times 80) + (2 \times 80)}{230} = 2.522 \text{ A}$$

iii Current through sub circuit 3 $= \frac{2000}{230} = 8.696 \text{A}$

Total current = 2.696+2.522+8.696 = 13.9 A

16A, 250V flush type DP main switch is sufficient

7 Calculate the length of PVC conduit and cable as shown below.

19mm conduit can be used up to ABC length and for remaining length, 12mm conduit is sufficient.

Horizontal runs

19mm conduit for length ABC	= 2.4 m
19mm conduit for length at C (wall thickness)	= 0.4 m
Total	**= 2.8 m**

12 mm Conduit

Length CDEHI (4 + 3 + 1.5)	= 8.5 m
Length EG	= 2.0 m
Length HJ	= 2.0 m
Length CMNQSVW (3+3+4+2)	= 12.0 m
Length MS3	= 1.5 m
Length NP	= 2.0 m
Length QR	= 2.0 m
Length ST	= 2.0 m
Length SV	= 1.0m
Length BK	= 3.0 m
Length AXYZ (6+1)	= 7.0 m
Length (wall thickness) at C, H, M, Q, S & Y (6x0.4)	= 2.4 m
Total	**= 45.4 m**

Vertical down drops (horizontal run to SB's) :

19 mm conduit

Length B to roof	= 0.5 m
Length E to roof	= 0.5 m
Length N to roof	= 0.5 m
Length S to roof	= 0.5 m
Total	**= 2.0 M**

Total 19 mm conduit required = 2.8+1.5+0.5 = 4.8 m

Wastage 10%	= 0.48 m
Total	= 5.28 m (Take 6m)

Total 12mm conduit required 45.4+10.50 = 55.9 M

Wastage 10%	= 5.59 m
Total	= 61.49 m (Take 62m)

Cable for (power) sub circuit -3 (1/1.8m Al)
= 3 x (6+1+1.5+1.5) = 30 m

Cable for subcircuit 1 & 2 (1.0 mm^2 copper)

= 3 x (6+62-10) = 174 m

Trainee shall select the cable size by refering the table given in related theory

8 Calculate the labour cost.

Meter board	= 2 Points
Distribution board	= 2 Points
Light / fan	= 17 Points
Power	= 2 Points
Total points	**= 23 Points**

Labour cost / point should be taken by referring the local rate list.

For example, take the labour cost is Rs.100/point

Then, total labour cost is 23 x 100 = Rs. 2300/-

9 Prepare a list of "material of schedule and cost" as shown in Table-2.

Table 2

Material of schedule and cost

Sl.No.	Material Specification	Rate Cost				
		Qty.	Rs. Ps.	Per	Rs. Ps.	Remarks
1	D.P Main switch 10A, 240V flush type	1 No	.....	each	.....	For M.B For power load
2	I.C cut out 16A, 240V	1 No	.....	each	.....	
3	Flush type fuse unit 16A	1 No	.....	each	.....	
4	Flush type fuse unit 6A	2 Nos	.....	each	.....	
5	PVC conduit 19 mm (heavy guage)	6 m	.....	length	.....	1 length = 3 m
6	PVC conduit 12 mm (heavy guage)	62 m	.....	length	.....	1 length = 3 m
7	1.0mm^2 multistrand copper, VIR cable	174 m	.....	100m	.....	
8	1/1.8 mm aluminium VIR cable	30 m	.....	100m	.....	
9	1/1.8m copper VIR cable	2 m	.....	100 m	.....	From M.B to D.B
10	Switches 6A, 240V one way flush type	17 Nos	.....	each	.....	
11	2-pin sockets 6A, 240V	4 Nos	.....	each	.....	
12	3 -pin sockets 16A, 240V with switch and neon	2 Nos	.....	each	.....	
13	Ceiling rose 2 - plate 6A 240V	5 Nos	.....	each	.....	
14	Lamp holders brass batten type	8 Nos	.....	each	.....	
15	PVC junction boxes 25 mm 4 - way	1 No	.....	each	.....	
	12 mm 3-way	7 Nos	.....	each	.....	
	12 mm 2-way	5 Nos	.....	each	.....	
16	PVC bends 12 mm	4 Nos	.....	each	.....	
17	PVC reducers (25 mm to 12 mm	1 No	.....	each	.....	
18	Saddles 25 mm	24Nos		Doz	.....	
	12 mm	144No		144 Nos	.....	
19	Wooden boards (a) 30 x 30 Cm	2 Nos	.....	each	.....	For M.B & D.B For S.D's
	(b) 18x10 Cm	7 Nos	.....	each	.....	
20	Round blocks	5 Nos	.....	each	.....	
21	Wooden gutties/plugs 9cm2 x 4 cm^2 x50 mm	3 doz		doz	.....	For boards
22	Nails 25 mm	1 kg		kg		Per conduit
23	Wooden screw 60 mm	25 Nos		100		For boards
	Wooden screw 12 mm	25 Nos		100	....	Forholders
24	Copper wire (16SWG) for earth	1 Kg		kg	.....	
	(GI WIRE 14 SWG)	1 Kg		kg		
25	Earth set (Pipe, salt, coal)	1 set		...	.....	
26	Cement	2 kg		kg		
27	Labour cost	2 kg			.....	For 4 gutties
	Total				.....	
	Contingency 10%				.....	
	Grand Total					

The rate of each material shall be obtained from the price list of the branded items

— — — — — — — —

TASK 2 : **Estimate the cost / bill of materials for wiring of workshop**

1 Obtain the floor plan of the workshop.

2 Mark the positions of motors on the floor plan with the consultation of the customer.

A sample requirement is given below for trainee's reference

1 One 5HP, 415V 3 phase motor

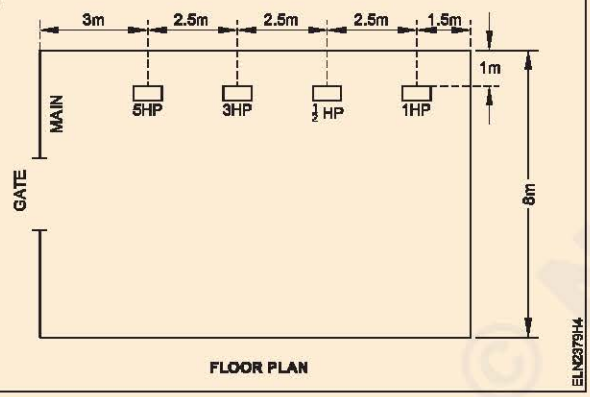
2 One 3HP, 415V 3 phase motor

3 One ½ HP, 240V 1 phase motor

4 One 1HP, 415V 3 phase motor

The motors are to be arranged as shown in Fig.4

Fig 4



The main switch, motor switch and starters are assumed to be mounted at a height of 1.5m from the ground level.

Height of horizontal run from ground level will be 2.5 m

The cost of motors and starters are not to be included in the estimate.

3 Calculate the size of cable

Assuming the motor efficiency to be 85% power factor to be 0.8 and supply voltage is 400 V for all the motors.

$$\text{FL current of 5HP motor} = \frac{5 \times 735.5}{\sqrt{3} \times 400 \times 0.85 \times 0.8} = 7.806\text{A}$$

$$\text{FL current of 3HP motor} = \frac{3 \times 735.5}{\sqrt{3} \times 400 \times 0.85 \times 0.8} = 4.68\ \text{A}$$

$$\text{FL current of ½ HP motor} = \frac{0.5 \times 735.5}{240 \times 0.85 \times 0.8} = 2.25\ \text{A}$$

$$\text{FL current of 1HP motor} = \frac{1 \times 735.5}{\sqrt{3} \times 400 \times 0.85 \times 0.8} = 1.56\ \text{A}$$

The main switch and the cable from meter to main switch should be capable of handling starting current of one motor of high rating plus full load current of the all other motors.

i.e, 15.6+4.68+2.25+1.56 = 24.9A

4 Prepare a table showing cable size of each motors to be installed as shown in Table 3.

Table 3

Sl. No.	Motor	FL current I_L (A)	Starting current $I_s = 2I_L$ (A)	Recommended cable size
1	5HP motor	7.5	15.0	2.0mm² copper conductor cable (17A) or 2.5mm² aluminium conductor cable (16A)
2	3HP motor	4.68	9.36	2.0mm² copper conductor cable (17A)
3	1/2 HP motor	2.25	4.5	1.0mm² copper conductor cable (11A) minimum recommended cable
4	1HP motor	1.56	3.12	1.0mm² copper conductor cable (11A) minimum recommended cable

The type and gauge of cable shall be selected by referring the table given in related theory

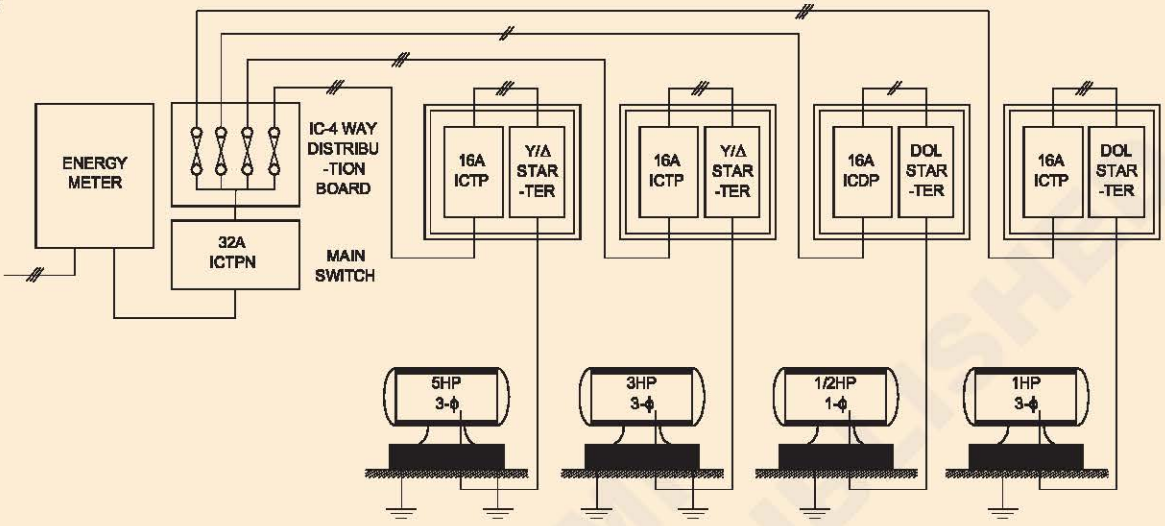
5 Select the suitable switches and distribution board

- 32A, 415V ICTP switch with fuses can be used as main switch.
- 16A, 415V, ICTP switches with fuses can be used for 5HP, 3HP, & 1HP motors.
- 16A, 240V, ICDP switch with fuses can be used for ½ HP motor.
- 415V, 4 way, 16A per way IC distribution board with neutral link can be used for power distribution.

6 Draw the single line diagram of power wirings as shown in Fig 5.

7 Calculate the size and length of conduit.

Fig 5



SINGLE LINE DIAGRAM OF POWER WIRING IN WORKSHOP

19mm heavy gauge conduit should be used for 3 cable runs and 25 mm heavy gauge conduits should be used for 6 cable runs.

- 19 mm heavy gauge conduit

Length from main board of 5HP motor starter

= 1+1+3+1 = 6.0m

Length from main board to 3HP motor starter

= 1+1+5.5+1 = 8.5m

Length from main board to ½ HP motor base

= 1+1+8+1+1.5+1.5 = 14.0m

Length from main board to 1HP motor base

= 1+1+10.5+1+1.5+1.5 = 16.5m

Total = 45.0 m

10% wastages = 4.5m

Total length = 49.5m, say 50.0m

- 25.4 mm heavy gauge conduit.

Length from meter to main switch = 0.75 m

Length from 5HP motor starter to 5HP motor base

(1.5 +1.5) 3.0 m

Length from 3HP motor starter to motor base = 3.0 m

Total = 6.75 m

10% wastage = 0.67 m

Total = 7.42m, Say 8.0m

- 25 mm flexible conduit for 5HP & 3 HP motor (0.75+0.75) = 1.5, Say 2.0m

8 Calcualte the length of cables.

2.0mm^2 copper conductor from main board to 5HP motor terminals = 3(1+1+3+1) + 6(1.5+1.5+0.75) = 40.5m

15% wastages & end connections = 7.2 m

Total = 55.2m , Say = 56.0m

1.0mm^2 copper conductor from main board to 1/2 HP motor terminals = 2(1+1+8+1+1.5+1.5+0.75) = 29.5 m

15% wastages & end connections = 7.76m

Total = 59.51m, Say 60.0m

9 Calculate the labour cost as per the local rate and rules for calcualting number of points.

10 Prepare "Schedule of material and cost as shown in Table 4.

Table 4

Material of schedule and cost

Sl.No.	Specification of material	Qty.	Rate Rs. Ps.	Cost Per	Rs. Ps	Remarks
1	32A, 415V- Iron -clad triple - pole (ICTPN) switch with fuses	1 No.	.....	each	.....	
2	16A, 415V, Iron- clad triple -pole switch with fuses	3 Nos.	.....	each	.....	
3	16A, 240V, Iron -clad double - pole switch with fuses	1 No.	.....	each	.....	
4	4-Way distribution box, 415V, 16A	1 No.	.....	each	.....	
5	Conduit heavy gauge ..... 19 mm	50 m	.....	m	.....	
	25mm	8 m	.....	m	.....	
6	Flexible conduits ..... 19 mm	2 m	.....	m	.....	
	25 m	2 m	.....	m	.....	
7	2.0 mm^2 copper conductor single core (17A)	47 m	.....	100 m	.....	
8	1.0mm^2 copper conductor single core (11A)	56 m	.....	100 m	.....	
9	1.0mm^2 copper conductor single core (11A)	34 m	.....	100 m	.....	
10	1.0mm^2 copper conductor single core (11A)	60 m	.....	100 m	.....	
11	Angle iron frame 50 x 30 m	5 Nos.	.....	each	.....	For M.B & D.B
12	Conduit bends 19mm	10 Nos.	.....	each	.....	
	25 mm	2 No.	.....	each	.....	
13	Saddles ..... 19 mm	150 Nos.	.....	100	.....	
	25 mm	25 No.	.....	100	.....	
14	Conduit couples 19mm	6 No.	.....	each	.....	
	25 mm	1 No.	.....	each	.....	
15	Wooden gutties	120 No.	.....	doz	.....	
16	Earth wire, GI, 8 SWG	40 m	.....	kg.	.....	1kg. $\simeq$ 10 m
17	Lugs for connecting leads to motors	17 No.	.....	each	.....	(6+6+2+3)
18	Earthing pipe perforated 25.4mm dia	2.5 m	.....	m	.....	Two earths
19	Coal	40 kg.	.....	kg.	.....	
20	Salt	40 kg.	.....	kg.	.....	
21	Funnel with wire mesh	1 No.	.....	each	.....	
22	Labour charges for earthing (Civil work)	2 Nos.	.....	pit	.....	
23	Caution plate	1 No.	.....	each	.....	
24	Nails 25.4 mm	2	.....	kg.	.....	
25	Shock treatment chart	1	.....	each	.....	
26	Labour cost	-	.....	point	.....	
	Total	.....	.....	.....	.....	
	Contingency 10%	.....	.....	.....	.....	
	Grand total	.....	.....	.....	.....	
	Say	.....	.....	.....	.....	

Practice wiring of hostel and residential building as per IE rules

Objectives: At the end of this exercise you shall be able to
- **read and interpret the circuit diagram of a bank/ hostel/ jail**
- **mark the layout of the wiring scheme**
- **prepare and install a conduit frame as per layout**
- **draw the cables through the conduit**
- **connect the accessories as per circuit**
- **test the circuits.**

Requirements

Tools /Instruments

• Combination pliers 200 mm	- 1 No.
• Screw driver 200 mm with 4 mm blade	- 1 No.
• Side cutting pliers 150 mm	- 1 No.
• Electrician's knife 100 mm	- 1 No.
• Bradawl 150 mm	- 1 No.
• Ball peen hammer 250g	- 1 No.
• Hacksaw with 24 TPI blade	- 1 No.
• Firmer Chisel 6 mm	- 1 No.
• Flat rasp file 200 mm	- 1 No.
• Neon tester 500V	- 1 No.
• Electirc drilling machine 6 mm capacity with 5mm drill bit.	- 1 No.

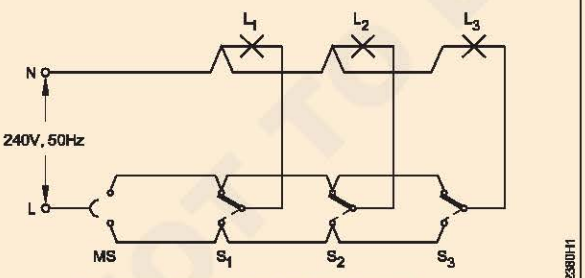
Materials

• 2 way switch 6A 250V	- 4 Nos.
• Batten holder 6A 250V	- 4 Nos.
• PVC switch box 100 X 100 X 40 mm	- 4 Nos.
• PVC Cable 1.5 sq mm, 660 V	- as reqd.
• Saddle 19 mm	- 20 Nos.
• Wooden gutties	- 20 Nos.
• Conduit bend 19mm	- 20 Nos.
• Fish wire	- as reqd.
• PVC Conduit 19 mm	- 50 m
• Flexible conduit 19 mm	- 2 m
• Conduit coupler 19 mm	- 6 Nos.
• Earth wire G1, 8 SWG	- 20 m
• Wood Screw 25 x 6 mm	- 1 box
• Wood Screw 12 x 6 mm	- 1 box

PROCEDURE

1 Read and interpret the schematic diagram (Fig 1) and the layout diagram (Fig 2).

Fig 1



SCHEMATIC DIAGRAM OF A HOSTEL WIRING

2 Draw the wiring diagram based on Figs 1 and 2 and compare with the given wiring diagram. (Fig 3).

3 Draw your own wiring diagram according to the layout.

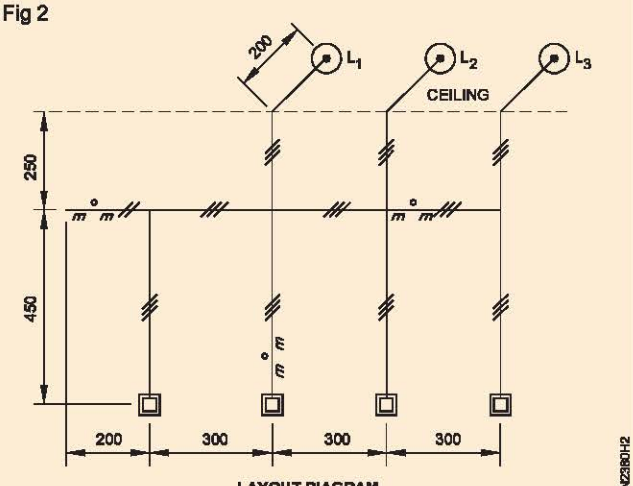
4 Estimate the material required for wiring installation referring to the layout as well as the wiring diagrams.

5 Mark the layout on the Installation Practice Cubicle (IPC).

6 Prepare the PVC conduit frame as per the layout plan.

7 Mark the saddles position and fix them loosely as per the layout plan.

Fig 2



LAYOUT DIAGRAM

8 Fix the conduit pipe on the IPC with the help of saddles.

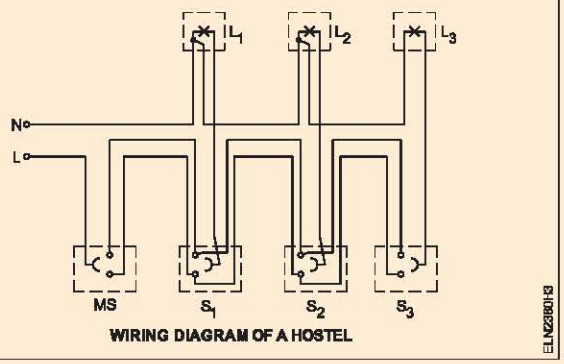
9 Insert the fish wire into the conduit pipe.

10 Draw the cable as per the wiring diagram. (Fig 3)

Leave an excess length of 200 to 300mm in each cable for termination

11 Fix the batten holders as per the Fig 2 and terminate the cable ends.

Fig 3



WIRING DIAGRAM OF A HOSTEL

12 Fix the switches on the PVC switch boxes.

13 Prepare the end termination of cables and connect the accessories as per the circuit.

14 Test the circuit after getting the approval of the instructor.

Practice wiring of Institute and workshop as per IE rules

Objectives: At the end of this exercise you shall be able to
- **read and interpret the floor plan of a workshop**
- **mark the single line diagram of power wiring in workshop**
- **prepare and install a conduit frame as per line diagram**
- **draw the cables through the conduit**
- **connect the accessories as per circuit**
- **test the circuits.**

Requirements

Tools/Instruments

- Power drilling machine 6mm with 5 mm drill bit - 1 No.
- Combination pliers 200 mm - 1 No.
- Side cutting pliers 150 mm - 1 No.
- Electrician's knife - 1 No.
- Bradawl 150mm - 1 No.
- Ball peen Hammer 250 gm - 1 No.
- Hacksaw with 24 TPI blade - 1 No.
- Firmer Chisel 6 mm - 1 No.
- Neon Tester 500V - 1 No.
- 3ϕ Energy meter 30A, 440V - 1 No.

Equipment / Machines

- 5 HP 3ϕ 440V AC motor - 1 No.
- 3 HP 3ϕ 440V AC motor - 1 No.
- 1/2 HP 1ϕ 240V AC motor - 1 No.
- 1 HP 1ϕ 240V AC motor - 1 No.
- Star Delta starter 4, 5V 50 Hz - 2 Nos
- DOL starter 1ϕ, 10A, 250 V - 2 Nos.

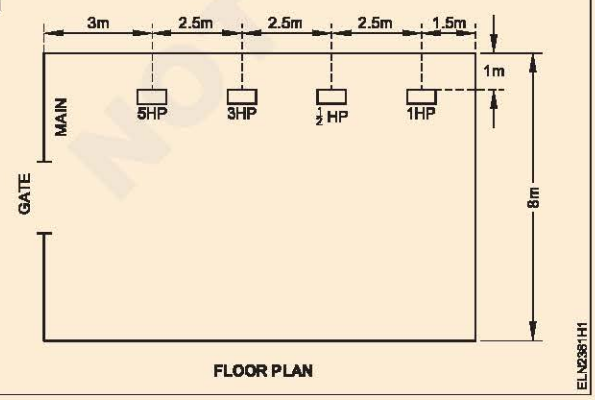
Material

- Metal conduit pipe 20 mm - 10 m
- Conduit junction box - 20 Nos.
- TW box 200 X 150 X 40 mm - 3 Nos
- TW box 300 x 200 x 40 mm - 4 Nos.
- TPIC 16A - 415V - 2 Nos.
- DPIC 16A, 250V - 2 Nos.
- Saddles 19 mm - 50 Nos.
- Wooden gutties - 50 Nos.
- Conduit bend 19 mm - 10 Nos.
- Angle Iron frame 50 x 30mm - 5 Nos.
- Fish wire - as reqd.
- PVC sheathed aluminium cable 4 Sq mm 250 V - 60 m
- Copperwire 14 SWG - 15 meter
- Metal conduit Elbow 20 mm - 25 Nos.
- Distribution box 4 ways 200x150x40mm - 1 No.
- TW wooden spacer - 30 Nos.
- Wood screws 25 x 6 mm - 1 Box
- Wood screws 12 x 6 mm - 1 Box
- Surface mounted kit kat fuse 16A 250V - 4 No.

PROCEDURE

1 Obtain the floor plan of the work shop (Fig 1).

Fig 1



FLOOR PLAN

2 Mark the position of motors on the floor plan with the consultation of the customer.

A Sample requirement is given below for trainees reference.

1 One 5 HP, 415V 3 phase motor.

2 One 3 HP, 415V 3 phase motor.

3 One 1/2 HP; 240V, 1 Phase moor

4 One 1 HP, 240V, 1 Phase motor

The motors are to be arranged as shown in Fig 1.

The mainswitch, motor switch and starter are assumed to be mounted at a height of 1.5 m from the ground level.

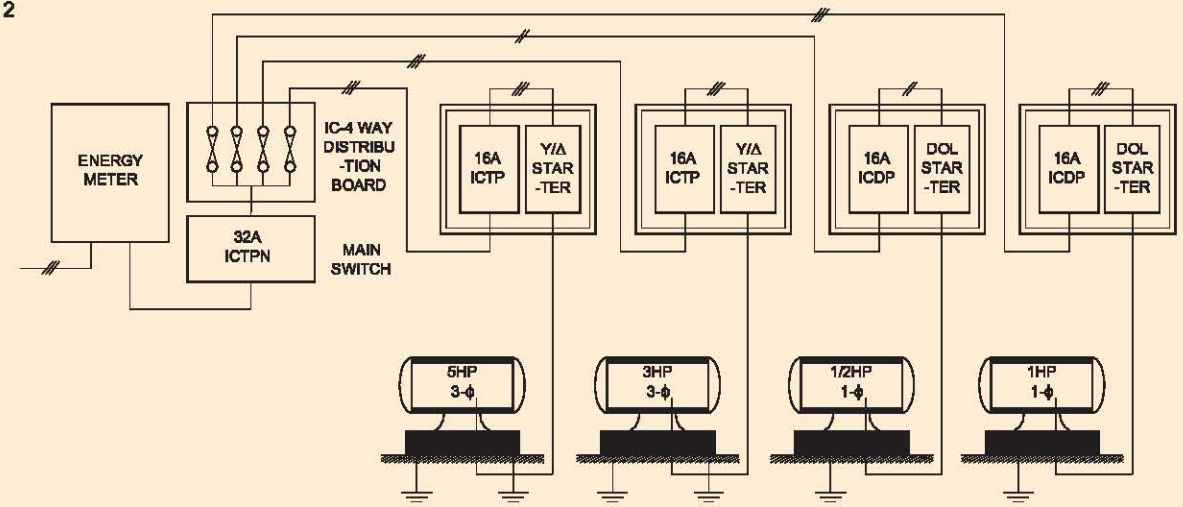
Height of horizotal run from ground level will be 2.5 m

3 Draw the wiring diagram based on Fig 1.

4 Mark the layout based on Fig 2.

5 Prepare the PVC coduit frame as per layout.

Fig 2



SINGLE LINE DIAGRAM OF POWER WIRING IN WORKSHOP

Practice testing /fault detection of domestic and industrial wiring installation and repair

Objectives: At the end of this exercise you shall be able to
- **detect and repair open circuit fault in domestic and industrial wiring**
- **detect and repair shortcircuit fault in wiring**
- **detect and repair earth fault in wiring**
- **prepare the flow chart for location rectification of fault in domestic wiring installation.**

Requirements

Tools/Instruments

• Connecting screw driver 100 mm	- 1 No.
• Cutting plier 150 mm	- 1 No.
• Screw driver 200 mm	- 1 No.
• Neon tester 500 V	- 1 No.
• D.E. Electrician knife100 mm	- 1 No.
• Multimeter	- 1 No.
• Megger 500V	- 1 No.

Materials

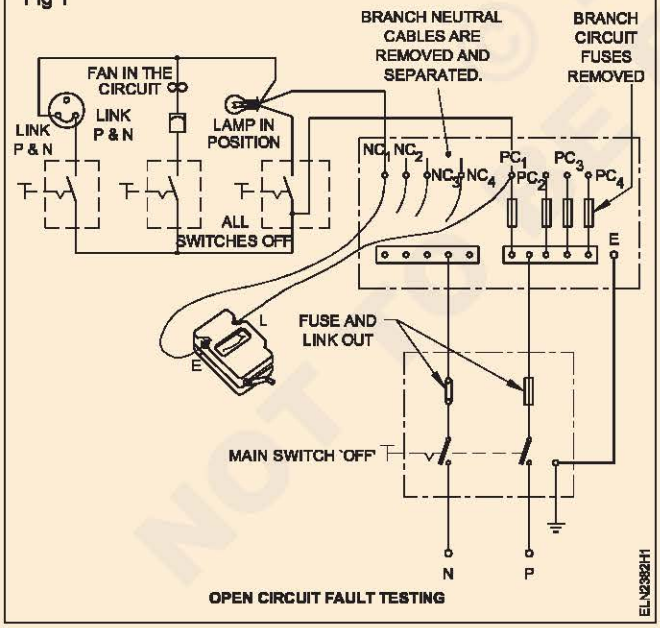
• Test lamp 100W, 240 V	- 1 No.
• Crocodile clip 15A	- 2 sets
• PVC flexible cable 1.5sq.mm, 660 V	- 10m

PROCEDURE

Open Circuit Fault

1 Consider the circuit as shown in Fig 1 in a domestic installation.

Fig 1



For open circuit fault removal of fuses, etc are to be done before doing the test by using megger.

2 Check whether the cables used in an installation have proper continuity or not using megger.

3 Check circuit fuses whether in order or not, if not, rewire the fuses.

4 Check one circuit at a time and then proceed step by step.

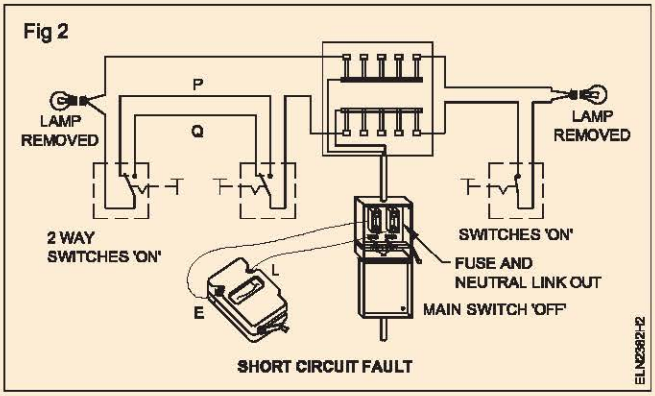
5 Check the circuits having 2 way switches, the concerned switches may be operated alternately to ensure the correct test result.

6 Check the defective fan, regulators or lamps by shorting the suspected appliance if necessary and then retest it.

Short circuit fault

1 Make the circuit as shown in Fig 2 and connect the megger, if it shows continuity in both ON and OFF positions of the switch, this indicates short in circuit.

Fig 2



2 Check insulation resistance between the cables of the installation and earth.

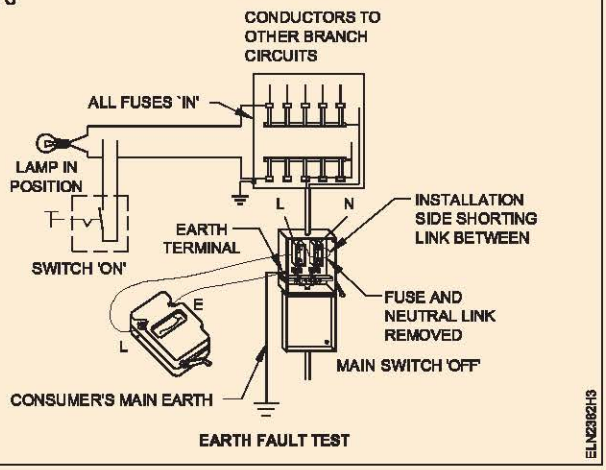
3 Connect the megger terminal 'E' to the live wire and L to the corresponding neutral wire, the megger will read zero or very low value of insulation resistance and confirms the short circuit.

4 Repeat the test procedures in each and every circuit and locate the shorting point of the live and neutral wire by inspection and remove it by insulating the bare conductors.

Earth fault

1 As per the circuit as shown in Fig 3 keep all the fuses, switches bulbs etc in closed position as indicated in the figure.

Fig 3



Isolate the live conductor from neutral, remove all other lamps and other equipments connected with wiring.

2 Switch 'ON' all the switches.

3 Using Insulation resistance Tester, terminal 'E' of the megger connect to the earth point of the system provided at the Meter Board and Terminal 'L' of the megger with each conductor in turn at the main board cut-out terminal and rotate the handle of the megger to send current through closed circuit formed between conductor and earth.

4 Note down the reading of the meter which gives directly the insulation resistance between the conductor and earth.

5 Repeat the step 3 and 4 for other circuits, subcircuits, live conductors and main switch board etc.

Exercise 1.8.75

Prepare pipe earthing and measure earth resistance by earth tester/megger

Scan the QR Code to view the video for this exercise

Objectives: At the end of this exercise you shall be able to
- **prepare the pipe for earthing**
- **dig the pit in the ground**
- **install the earth pipe and test it.**

Requirements

Tools/Instruments

- G.I. die stock with 12.7 mm , 19mm and 38mm dies - 1 Set
- D.E. spanners 5mm to 20mm of six. - 1 Set
- Blowlamp, 1 litre with kerosene - 1 No.
- Crowbar, hexagonal 1800mm long - 1 No.
- Powrah(spade) - 1 No.
- Pick axe - 1 No.
- Cement mortar tray - 2 Nos.
- Tongs 300mm - 1 No.
- Measuring tape 5m - 1 No.
- Ladle - 2 Nos.
- Combination pliers 200mm - 1 No.
- Pipe wrench 50mm - 1 No.
- Hacksaw with 32 T.P.I. blade - 1 No.
- Wooden box 150(l) x 150(b) x 300(h)mm - 1 No.
- Soldering pot (melting) - 1 No.
- Sledge Hammer 2 Kg. - 1 No.

Equipment/Machines

- Earth tester with connecting leads and spikes - 4 Nos. - 1 No.

Materials

- G.I. pipe 12.7mm dia. - 5 m
- G.I. bend 12.7mm dia. - 2 Nos.
- C.I. cover hinged to C.I. frame 300 mm square - 1 No.
- G.I. pipe 19mm dia. - 1 m
- G.I. pipe 38mm dia. having 12mm dia. holes - 2.5 m
- Reducer 38 x 19 mm - 1 No.
- Funnel with 19mm dia. sleeve & wire mesh - 1 No.
- G.I. nut for 19mm dia. sleeve & wire mesh - 1 No.
- G.I. check-nuts for 19mm dia. G.I. pipe - 4 Nos.
- G.I. washer 40mm with 19mm hole - 1 No.
- G.I. wire No.8 SWG - 10 m
- Copper lug 200 amps with 19 mm dia. hole - 1 No.
- Solder 60/40 - 100 gms.
- Matchbox - 1 No.
- Soldering paste - 10 gms.
- Cement - 10 kgs.
- Blue metal chips 6mm size - 40 kgs.
- River sand - 80 kgs
- Salt (common) - 3 bags
- Coke or charcoal - 3 bags

PROCEDURE

1 Collect G.I. pipes and the accessories.

2 Make a slant cut of 30° in the 38mm dia. G.I. pipe to have sharp edge as shown in Fig 1.

3 Make threads in the other end of 38mm dia. G.I. pipe to a length of 25mm.

4 Make threads in both ends of 19mm dia. G.I. pipe to a length of 25mm on one side and 75mm on the other side.

5 Fabricate the 38mm and 19mm dia. G.I. pipes as shown in Fig 1.

6 Select an earth pit site atleast 1.5 metres away from the building foundation.

An earth electrode should not be installed in proximity to a metal fence to avoid the possibility of the fence becoming live. If the metal fence is unavoidable, it should be earthed.

7 Dig an earth pit of dimensions 1 m width x 1 m breadth x 3.75 m depth.

8 Place the fabricated pipe in an upright position as shown in Fig 1 and position the pipe with the help of bamboo sticks.

9 Place the wooden box around the pipe and fill it to a height of about 15cm with charcoal, and fill the sorrounding outer space of the box with soil.

It is difficult to dig a pit 150mm square. A pit of dimension 1 metre square is therefore suggested to be dug. The area sufficient to be filled with salt and charcoal is about 150mm square. Hence fill the surrounding extra area with the soil which was taken out earlier.

10 Lift and place the wooden box above the coke layer. Fill up with salt to a height of about 15cm and to an area of 150 x 150mm area around the pipe.

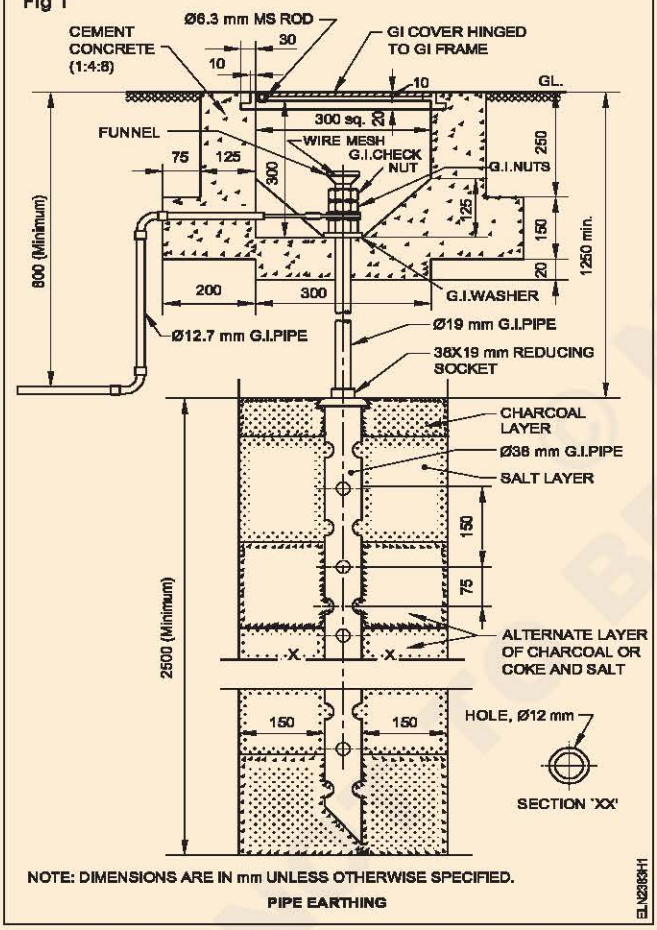
Fill up the surrounding area with soil.

11 Repeat the above steps 10 and 11 up to 2.5 metres as shown in Fig 1.

12 Place the G.I. pipe 12.7 mm dia. meter with G.I. bends in proper position for E.C.C. connection.

13 Prepare the concrete mixture and build the structure as shown in Fig 1.

Fig 1



14 Fix the G.I. cover also.

Atleast allow one day for curing the concrete structure. Pour water every 2 hours. (A wetted gunny sack will hold the moisture for several hours.)

15 Insert the G.I. wire No. 8 SWG through the 12.7 mm dia. G.I. pipe.

The size of the earth wire depends upon the incoming supply cable size.

16 Use the ladle and the blowlamp and melt the solder.

17 Solder the lug in the G.I. wire.

18 Insert the lug in the 19mm dia. G.I. pipe and tighten it with the G.I. nut and check-nut.

19 Pour three or four buckets of water through the funnel.

Allow an hour for the water to be absorbed in the earth.

20 Test the earth electrode resistance with an earth Megger.

The earth continuity conductor (E.C.C.) should not be connected to the earth electrode while measuring the earth electrode resistance.)

21 Enter the value of the earth electrode resistance in Column 5 of Table 1. Fill up the other particulars also. The acceptable value of the earth electrode resistance has been given earlier. Check the value if it.

22 Check the value of the earth resistance is found higher than the acceptable value, make one more pipe earth electrode at a distance of 8 metres from the earlier one and connect both of them in parallel.

23 Measure the earth electrode value and enter it in Column 6 of Table 1.

The second reading with two electrodes will be approximately half the first reading which was taken with one electrode. The measured value should be within the recommended value.

24 Get it checked with your instructor.

Table 1

Sl.No.	Date	Climate	Earth electrode Location	Earth resistance in ohms		Remarks
				Single	Double	
1	2	3	4	5	6	7

Prepare plate earthing and measure earth resistance by earth tester / megger

Objectives: At the end of this exercise you shall be able to
- **prepare the plate for earthing according to ISI standard**
- **prepare the earthing pit in ground according to required standard**
- **install the plate in earthing pit**
- **test the earthing and measure the earth resistance using earth tester / Megger.**

Requirements

Tools/Instruments

- G.I. die stock with 12.7 mm, 19mm and 38mm die - 1 Set
- D.E. spanner set 6mm to 25mm - 1 Set
- Blowlamp, 1 Pint - 1 No.
- Crowbar38mmx 1800mm long - 1 No.
- Spade 300mm x150mm - 1 No.
- Cement mortar tray - 1 No.
- Tongs 300mm - 1 No.
- Hacksaw frame with 24 TPI blade - 1 No.
- Pipe wrench 50mm - 1 No.
- Soldering pot with ladle - 1 No.
- Combination pliers 200mm - 1 No.
- Measuring tape 5m - 1 No.
- Sledge Hammer 2 Kg. - 1 No.

Equipment/Machines

- Earth tester with spikes and connecting lead - 1 Set

Materials

- G.I. plate 600mmx600mmx63mm - 1 No.
- G.I. pipe 12.7mm dia. - 5 m.
- G.I. pipe 19mm dia. - 1 m.
- C.I.cover hinged to C.I. frame 300mm square - 1 No.
- Funnel with 19mm dia. sleeve & wire mesh - 1 No.
- G.I.nut for 19mm dia. sleeve & wire mesh - 2 Nos.
- G.I. check-nuts for 19mm dia. G.I.pipe - 2 Nos.
- G.I.washer 40mm with 19mm hole - 2 No.
- G.I. wire No.8 SWG - 10 m
- Copper lug 200 amps with 19mm dia. hole - 1 m
- Solder 60x40 - 100gms.
- Soldering paste - 10 gms.
- Matchbox - 1 No.
- Cement - 10 kgs.
- Blue metal chips 6mm size - 40 kgs.
- River sand - 80 kgs.
- Charcoal or coke - 5 kgs.
- CommonSalt - 5 kgs.

PROCEDURE

TASK 1: **Prepare the plate for earthing according to ISI standard**

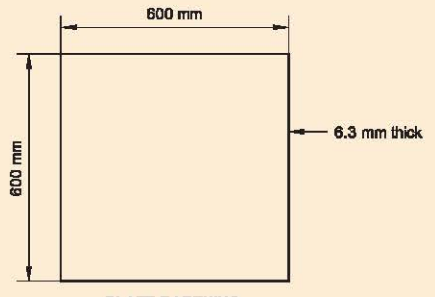
1 Collect G.I plate and accessories for earthing

2 Mark thread on one side of 19mm dia GI pipes to a length of 25mm

3 Fabricate GI plate as shown in Fig 1 600mmx600mm square plate with a thickness of 63mm

4 Fabricate 19mm dia G.I pipe as shown in Fig 2

Fig 1



TASK 2 : **Prepare the earthing pit in ground as per standard**

1 Select an earth pit site atleast 1.5meters away from the building foundation

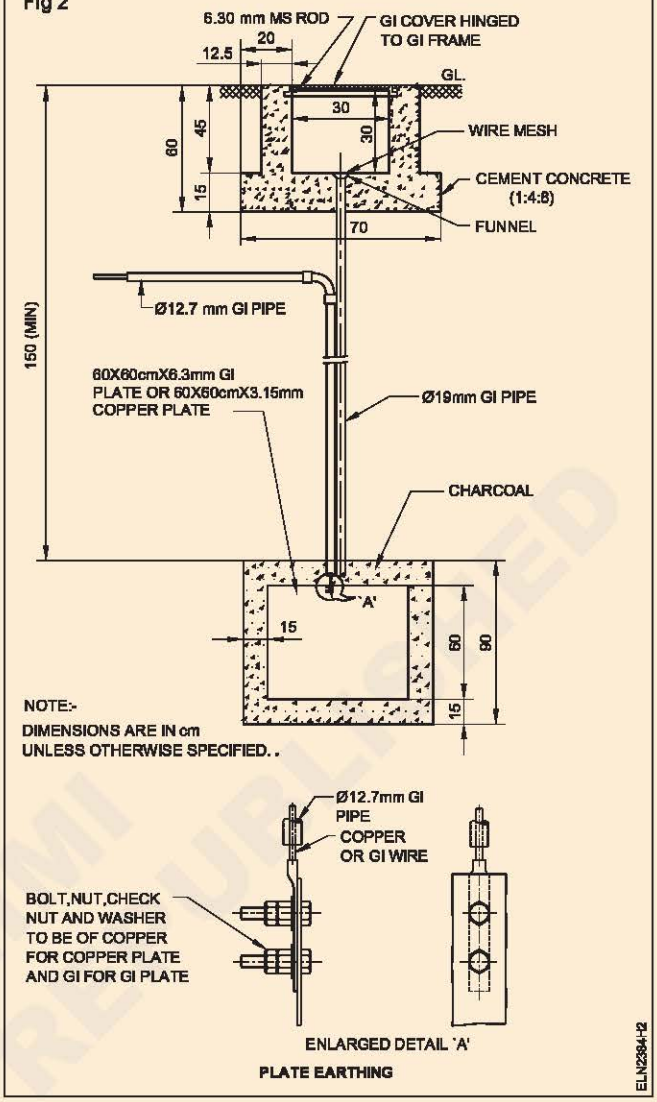
An earth electrode should not be installed is proximity to a metal fence to avoid the possibility of the fence becoming live.

2 Dig an earth pit of dimensions 1m width x 1m breadth x2.5m depth

The depth given here is the minimum recommended. However the depth may be increased till moist soil is reached

3 Fabricate G.I pipe 12.7mm diameter with GI bonds in proper position and insert the G.I wire missing through GI pipe by soldering lug at external and fix GI plate with bolt and nut as shown in (Fig 2)

Fig 2



TASK 3 : **Install the plate in earthing pit already prepared**

1 Place the fabricated 19mm GI plate in an upright position as shown in fig 2 and position the pipe with the helps bamboo sticks

2 Place the wooden box around the plate and fill it to a height of about 15cm with charcoal and fill the surrounding outer space of the box with soil.

It is difficult to dig a pit 150mm square .A pit of dimension 1 meter square is therefore suggested to be dig. The area sufficient to be filled with salt and charcoal is about 150mm square. Hence fill the surrounding area with the soil which was taken out earlier

3 Lift and place the wooden box above the coke layer and fill up with salt to a height of about 15cm and to an area of 150x 150mm area around the pipe.

Fill up the surrounding area with soil.

4 Prepare the concrete mixture and build the strcuture as shown in figure 2.

5 Fix the GI core with the plates

At least allow one day for curing the concrete structure. Pour water every 2 hours (A wetted gunny is a act will hold the moisture for several times.

6 Pour three or four buckets of water through the funnel to the earth pit

Allow an hour for the water to be obsorbed in the earth.

TASK 4 : **Test the earthing and measure the earth resistance using earth tester**

1 Test the earth electrode resistance with an earth tester.

2 Record the earth electrode resistance.

If the earth resistance is found higher than the acceptable value, make one more plate earth electrode at a distance of 8 meters from the earth in one and connect both of them in parallel

3 Measure the resistance of earth electrode value and record

The second reading with two electrodes will be approximately half the first reading which was taken with one electrode. The measured value should be with in the recommended value. If not have an another earth electrode may be distance of 8 meters from the other electrodes.

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Test earth leakage by ELCB and relay

Objectives: At the end of this exercise you shall be able to
- **identify the terminals of ELCB**
- **connect the ELCB in an Power circuit and test its functioning**
- **measure the leakage current at which ELCB trips off.**

Requirements

Tools/Instruments

- Cutting plier 150mm - 1 No.
- Screw driver 150mm - 1 No.
- Electrician's knife 100 mm - 1 No.
- Wire stripper 150 mm - 1 No.
- Ammeter MI (0 - 10A) - 1 No.
- Ammeter MI (0 - 100mA) - 1 No.
- Philips star screw driver 100 mm - 1 No.

Equipments

- ELCB 240V, 25A, 2 pole with Tripping leakage current 30mA - 1 No.
- MCB 240V, 10A, 2 pole - 1 No.

Materials

- 10KW 1W wire wound variable resistor - 1 No.
- 5KW 1W fixed resistor - 1 No.
- Pushbutton switch 250V, 6A - 1 No.
- Water rheostat - 1 No.

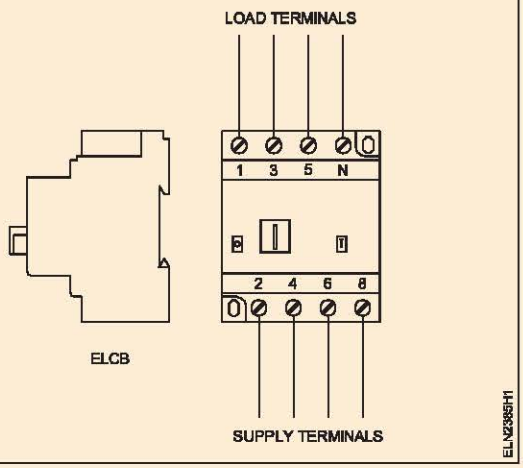
PROCEDURE

TASK 1 : **Identify the terminals of ELCB**

1 Collect the ELCB from your instructor and read the specification given on it.

Identify the supply terminals and load terminals referring the marking on the unit as given in Figure 1.

Fig 1



TASK 2 **: Connect and test the operation of ELCB**

1 Wire up the circuit as shown in the circuit diagram. (Fig 2)

2 Switch on the main supply keeping the MCB and ELCB in ON position.

3 Close switch S_1 and operate the water rheostat till the ammeter 'A' reads about 5 A current.

Keep variable resistance in full cut in position.

4 Press the test switch and vary the variable resistance and note the leakage current and record

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5 Record the leakage current at which the ELCB trips off

_____

6 Open the external test switch and reset the ELCB.

7 Test ELCB for 'Trip function' by operating the 'Test button'. In this case the ELCB must trip off when the button is pressed.

Fig 2