

Estimation and Costing - Simple estimation of the requirement of material etc., as applicable to the trade

Introduction

1 Estimating

Estimating means to determine the quantities of various items required to execute a job and to assess the cost of the execution. The estimator keeping in view the requirements arrived at during initial planning, sort out a list of items and quantities. The cost is determined by him by consulting the price catalogue and schedule of labour rates. The various steps to form an estimate are:

- i Sort out a list of items and quantities required.
- ii Consult the rate catalogues for pricing the various items.
- iii Assess the exact number of worker required to complete the job and after consulting the schedule of labour rates add the labour cost to the estimate under preparation. It should be noted that number of workmen required is dependent upon the time limit fixed to complete the services.
- iv Add supervision charges and executor's profit.
- v In case of Govt. organization, where the work is to be executed by the contractor, the tenders are floated only after correctly specifying the description of each item, to avoid any misunderstanding while execution.

For preparing an estimate the following are necessary.

- 2 Drawing:** The necessary drawings of the building with dimension are required for execution of the work and also for estimation. For the electrical installation the layout of the wiring should be shown on a separate drawing along with the position of the points etc.
- 3 Specifications of materials:** Specification gives the details of materials, brand name, grade of quality, rating of current and voltage, quality certification like BIS or ISO etc. Specification helps both the wireman and the consumer to select the material according to commercial practice, cost and the requirement.

Price Catalogue

It is in the form of a booklet in which rates of various terms are indicated. The price catalogue is required to be amended as and when there is variation in the market.

Schedule of labour rates

It is also in the form of booklet indicating the labour rates.

Schedule of rates and estimating data

Almost all the Govt. departments have published schedule of rates or estimating data to facilitate the process of estimating. In these schedules or data, the estimated cost including labour charges for per meter run of wiring,

overhead lines etc. With various sizes of wire, aluminium conductor, pole etc. are given. With the help of such a document, only overhead charges viz. supervision, departmental charges, etc. are required to be added after working on cost of any services.

Determination of Conductor size

Before making an estimate it is necessary to find out the size of wire, cable or aluminium conductor. The following essential points are to be considered while calculating the size:

- a Current carrying capacity
- b Voltage drop
- c Minimum permissible size

They have been discussed separately in the following articles.

Current carrying capacity

In any circuit the value of the current will be more as compared to sub - circuits. In sub circuits as the load decreases, the current is also reduced. Thus it is very necessary to divide the services into groups in accordance with the amount of current which will flow through them. Afterwards, size of wire in each group is determined.

Voltage drop

As is known to the readers that the voltage drop is there as when the current flows through the wiring and the same should be as low as permissible and economical. The voltage drop can be determined by Ohm's law. As the resistance is inversely proportional to area, so the voltage drop will be less if the area of wire is more.

Minimum permissible size

Due to mechanical reason the minimum permissible size of wire, U/G cables and conductors should be as follows:

- a Wire : The area of aluminium wire should not be less than 1.5 sq.mm and its single strand should not be less than 1.40 mm diameter.
- b U/G Cable : The area of conductor for two core cable should not be less than 6 sq.mm. The area of conductor for three and half cores cable should be 50 sq.mm or more.

A.C.S.R. The size of A.C.S.R should not be less than

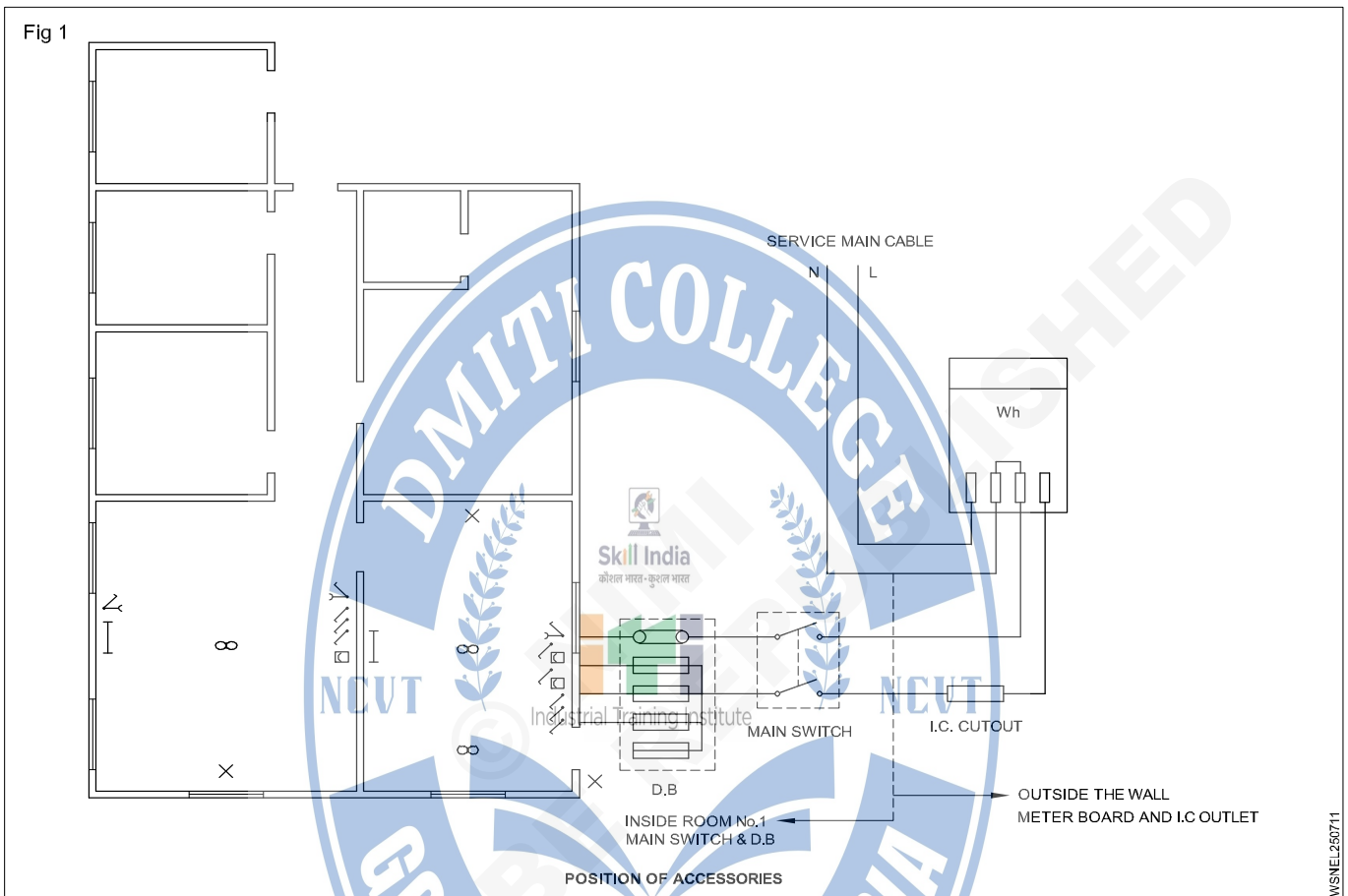
$\frac{6}{0.83}$ inch or $\frac{6}{1 \times 21.08}$ mm having total area of cross section as 20-71 sq.mm.

Conductor size calculation for internal domestic wiring

The important point to be considered is the current carrying capacity, the voltage drop is usually of very small magnitude and will not have much effect for small domestic wiring. For multi - storied building, factories and industries, the voltage drop is required to be ascertained. If the voltage drop is much the house - hold appliance and motors will not work.

After deciding the type of wiring system the electrician has to prepare the following details as per the consumer's interest, durability of wiring accessories, cost and available work force.

- 1 Position of electrical points in each area of the house based on consumer's requirement.
- 2 Prepare a layout of wiring on the building plan. (Fig 1)



- 3 Calculate total connected load and type of load to decide whether three phase or single phase supply is required.
- 4 Prepare a circuit diagram showing the connections and number of lighting and power circuits. Fig 2 shows the cubical wiring diagram model.
- 5 Prepare a list of electrical accessories to be procured.
- 6 Calculate the length of different sizes of cables required based on the load, voltage drop and number of cables in each circuit run.
- 7 Calculate the length of different sizes of batten/PVC casing and capping/PVC/metal conduit required based on the load, voltage drop and number of cables in each circuit run.
- 8 Prepare a list of hardwares like screw, nails, etc. required to execute the job.
- 9 Calculate the labour charges for entire wiring.
- 10 Calculate the cost of accessories, base materials like batten/conduit/PVC casing and capping, cables, hardware and labour charges.
- 11 Calculate the total cost of wiring including 5% contingencies for the unforeseen items and variation in prices.

Before selection of sizes of cable and their length we have to calculate the total load of the house and also to decide whether three phase or single phase supply to be requisitioned from local electricity board.

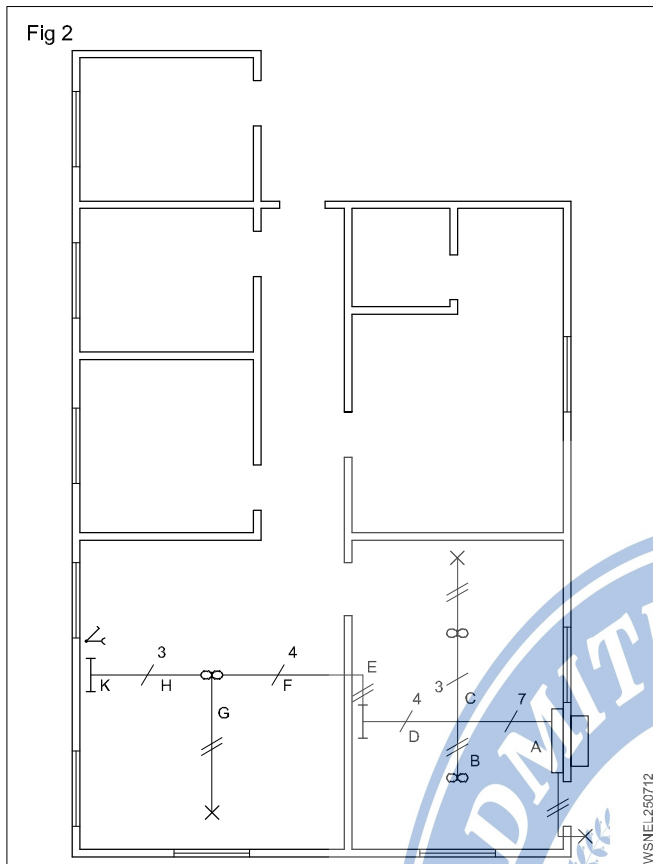
Total connected load : As this exercise is a part of cognitive skill development. Let us assume the total connected load to be 2400 watts.

Assuming the total connected load is 2400w.

then current will be $2400w/240V = 10amp$

(Assumption PF is unity and single phase supply)

Hence copper cable 3/0.036 could be selected for main board connection which can safely carry 10 amp.



Length of cables : Main cable say from meter board to the DB

2 x 1.5 = 3 m of size 3/0.36 copper cable
(1.5m is taken as a rough value)

At this stage we have to analyse the house plan as well as the consumer's requirement of electrical points. Only Room No.1 & 2 are taken in the following example.

According to the consumer the requirements are:

Room No.1 should be provided with

- a one tube light point
 - b one light point
 - c two fan points
 - d one 6 amps three-pin socket
- } circuit - 1

Room No.2 should be provided with

- a one tube light point
 - b one light point
 - c one fan point
 - d two 6 amp three-pin socket
- } circuit - 2

Total connected load of Room No.1 & 2 will be

Circuit 1

Sl. No.	Description	Quantity	Wattage rating	Total wattage
1	Tube light (1200mm)	1	40	40
2	Light point	2	25	50
3	Fan points	2	40	80
4	6A 3 pin socket	1	100	100
				270 watts

Circuit 2

Sl. No.	Description	Quantity	Wattage rating	Total wattage
1	Tube light (1200mm)	1	40	40
2	Light point	1	25	25
3	Fan point	1	40	40
4	6A 3 pin socket	2	100	200
				305 watts

Total wattage = 270 + 305 = 575 watt of circuit 1 & 2

As this is well within 600 watt rating of a branch circuit we can wire up the hall and sitout in one branch circuit. Remember that each branch circuit termination should have one phase cable and one neutral cable brought to the DB.

Draw the position of switches, sockets, lamps and fans in the house plan (position of accessories)

Then draw the layout diagram for the hall and sitout keeping in view of the position of accessories. (Refer layout diagram Fig 1)

After drawing the layout diagram, draw the circuit diagram for the hall and sitout.

At this stage you may have to modify the layout diagram in most of the cases considering economical use of cables and the conduit and also considering aesthetic sense of wiring layout.

After finalising the layout and the circuit diagram, analyse the cable runs, indicate in the layout diagram the number of cables to be drawn in each section of the conduit.

In this case understudy, the total load is lighting, fan and 3A pin sockets amounting to 575 watt which is less than 5 amp as such cable selected is 1 sq.mm (1/1.12) or (1/18) copper cable or say aluminium cable of 1.5 sq.mm (1/1.4).

Horizontal run

J -150cm 1.5m

Total of 2 to 5 25m say 25m

1/1.2 copper cable required for

Conduit Run	J	= (2.5 + 0.9 + 0.8)2	= 8.4m
-do-	A	= (1.5 + 0.9 + 0.8)7	= 22.4m
-do-	B	= 1.1 x 2	= 2.2m
-do-	C	= 1.05 x 4 + 1.85 x 2	= 7.9m
-do-	D	= (1.5 + 0.8 + 0.9)3	= 9.6m
-do-	F	= (1.8 + 0.9 + 0.8)5	= 17.5m
-do-	G	= 2.2 x 2	= 4.4m
-do-	H	= (2.2 + 0.8)2	= 6.0m
-do-	K	= (0.9 + 0.2)2	= 2.2m
			80.6m

Say 90m of cable required

As thumb rule length of cable = length of conduit x 3 = 25m x 3 = 75m. This length is more or less the same as the one calculated.

Required length of copper wire 14 SWG (For earthing)

Router K, H, F, E, D and A

0.8 + 0.9 + 1.8 + 0.9 + 0.8 + 1 + 0.8 + 0.9 + 1.5 + 1.5 + 1.5 + 0.8 + 0.9 + 1 = 15.1 m

Now prepare a complete list of accessories required, length of conduit required, length of the cable required and the required copper wire 14 SWG. Calculate the cost of the above materials. Say in this case Rs.25000/-.

Method of calculating labour charges

Work can be completed in five days by one electrician and one helper.

Electrician @ Rs.1500/- 5 days = Rs.7500

Helper @ Rs.900/- 5 days = Rs.4500

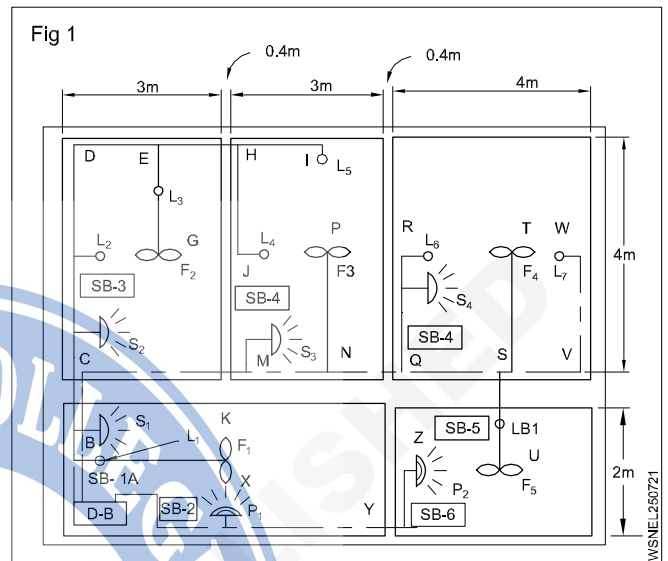
Rs.12000

On the other hand if the consumer wishes to give wiring on contract, based on number of points, the calculation of contract cost according to points.

Exercise

Calculate the length of PVC conduit and cable for the Layout of Conduit, switch boards for Hostel / Residential buildings and material cost.

Layout of Conduit, switch boards for Hostel / Residential buildings (Fig 1)



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 CMNQS VW (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 XYZ (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) :

Table 1

Material of schedule and cost

SI.No.	Material Specification	Rate		Cost		Remarks
		Qty.	Rs. Ps.	Per	Rs. Ps.	
1	D.P Main switch 16A, 240V flush type	1 No	200	each	200	For M.B For power load
2	I.C cut out 16A, 240V	1 No	75	each	75	
3	Flush type fuse unit 16A	1 No	65	each	65	
4	Flush type fuse unit 6A	2 Nos	55	each	110	
5	PVC conduit 19 mm (heavy guage)	6 m	40	length	240	
6	PVC conduit 12 mm (heavy guage)	62 m	30	length	1860	1 length = 3 m From M.B to D.B
7	1/1.8m copper VIR cable	2 m	300	100 m	6	
8	Switches 6A, 240V one way flush type	17 Nos	25	each	425	For M.B & D.B For S.D's
9	2-pin sockets 6A, 240V	4 Nos	30	each	120	
10	3-pin sockets 16A, 240V with switch and neon lamp	2 Nos	100	each	200	
11	Ceiling rose 2 - plate 6A 240V	5 Nos	30	each	150	
12	Lamp holders brass batten type	8 Nos	50	each	400	
13	PVC junction boxes 25 mm 4 - way	1 No	30	each	30	
	12 mm 3-way	7 Nos	30	each	210	
	12 mm 2-way	5 Nos	25	each	125	
14	Saddles 25 mm	24Nos			10	
	12 mm	144Nos			10	
15	Wooden boards (a) 30 x 30 Cm	2 Nos	150	each	300	
	(b) 18x10 Cm	7 Nos	200	each	1400	
16	Round blocks	5 Nos	5	each	25	
17	Wooden gutties/plugs 9cm ² x 4 cm ² x50 mm	3 doz	3	doz	9	For boards
18	Nails 25 mm	1 kg	75	kg	75	
19	Wooden screw 60 mm	25 Nos	0.5	100	12.5	Forboards
	Wooden screw 12 mm	25 Nos	0.5	100	12.5	
20	Copper wire (16SWG) for earth	1 Kg	450	kg	450	For holders
	(GI WIRE 14 SWG)	1 Kg	300	kg	300	
21	Salt, coal	2 kg	35	kg	70	For 4 gutties
22	Cement	2 kg	20		40	
Grand Total					6930	

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 + 2.0 = 4.8 m

Wastage 10% = 0.48 m

Total = 5.28 m
(Take 6m)

Total 12mm conduit required = 45.4 m

Wastage 10% = 4.54 m

Total = 49.94 m
(Take 50m)

2 Current through subcircuit - 2 = 2.522 A

3 Current through subcircuit - 3 = 8.696 A

Total Current = 13.9 A

Cable for subcircuit (power) = 30 m

Cable for subcircuit - 1&2 = 174 m

Total Material cost

1 19 mm conduit pipe = 6m x Rs.40 = Rs.240

2 12 mm conduit pipe = 50m x Rs.30 = Rs.1500

3 Cable = 174m x Rs.8 = Rs.1392

4 Power cable = 30 m

Rate = Rs.30

= Rs. 30 x 30 m = Rs.900

5 List of tool cost = Rs.6930

Total Material cost = Rs.4032 + Rs.6930

=Rs.10,962

1 Current through subcircuit - 1 = 2.696 A

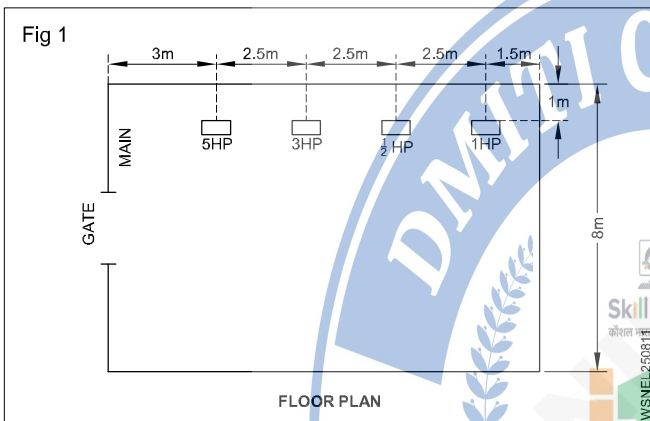
Estimation and Costing - Simple estimation of the requirement of material etc., as applicable to the trade - Wiring of workshop

Estimate the cost of material PVC conduit and cable for the wiring of workshop having 4 different HP motor.

Obtain the floor plan of the workshop.

- 1 One 5HP, 415V 3 phase motor
- 2 One 3HP, 415V 3 phase motor
- 3 One 1/2 HP, 240V 1 phase motor
- 4 One 1HP, 415V 3 phase motor

The motors are to be arranged as shown in Fig 1



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.

- 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.

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

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

$$\text{FL current of } \frac{1}{2} \text{ HP motor} = \frac{0.5 \times 735.5}{240 \times 0.85 \times 0.8} = 2.25 \text{ A}$$

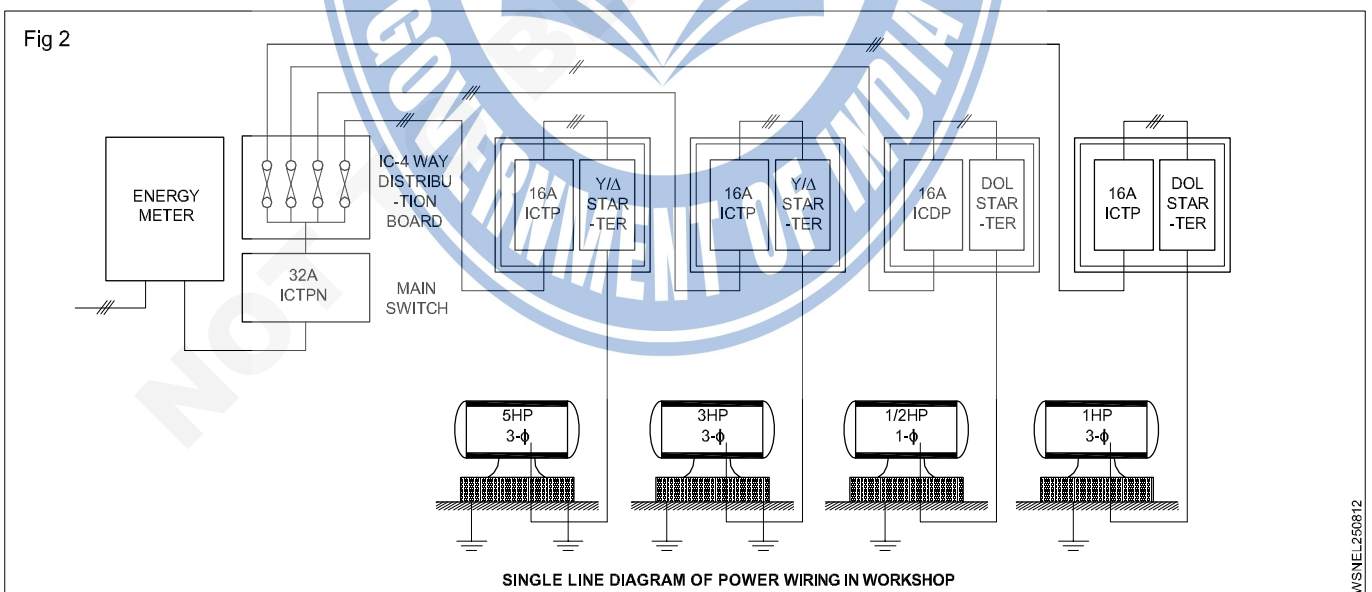
$$\text{FL current of 1HP motor} = \frac{1 \times 735.5}{\sqrt{3} \times 400 \times 0.85 \times 0.8} = 1.56 \text{ A}$$

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.

$$\text{i.e., } 7.806 + 4.68 + 2.25 + 1.56 = 16.296 \text{ A}$$

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

- Prepare a table showing cable size of each motors to be installed as shown in Table 1.



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 = 7.42 m = 8.0m

- 25 mm flexible conduit for 5HP & 3HP motor (0.75+0.75) = 1.5, Say 2.0m
 - Calculate the length of cables.
- 2.0mm² 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 = 47.57m, Say = 48.0m
- 1.0mm² 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 = 37.26m, Say = 38m
- Calculate the labour cost as per the local rate and rules for calculating number of points.
 - Prepare "Schedule of material and cost as shown in Table.

Table 1

Material of schedule and cost

Sl.No.	Specification of material	Qty.	Rate	Cost	Rs. Ps	Remarks	
			Rs. Ps.	Per			
1	32A, 415V- Iron -clad triple - pole (ICTPN) switch with fuses	1 No.	2000	each	2000	For M.B & D.B	
2	16A, 415V, Iron- clad triple -pole switch with fuses	3 Nos.	1400	each	4200		
3	16A, 240V, Iron -clad double - pole switch with fuses	1 No.	450	each	450		
4	4-Way distribution box, 415V, 16A	1 No.	1200	each	1200		
5	Angle iron frame 50 x 30 m	5 Nos.	7000	each	35000		
6	Conduit bends	19mm	10 Nos.	25	each		250
		25 mm	2 No.	30	each		60
7	Saddles	19 mm	150 Nos.				15
		25 mm	25 No.				10
8	Conduit couples	19mm	6 No.	10	each		60
		25 mm	1 No.	15	each		15
9	Wooden gutties	120 No.	3	doz	30		1kg. ≈ 10 m
10	Earth wire, GI, 8 SWG	40 m	70	kg.	280		
11	Lugs for connecting leads to motors	17 No.	6	each	102		
12	Earthing pipe perforated 25.4mm dia	2.5 m	75	m	187		
13	Coal	40 kg.	100	kg.	4000		
14	Salt	40 kg.	10	kg.	400		
15	Funnel with wire mesh	1 No.	100	each	100		
16	Caution plate	1 No.	200	each	200		
17	Nails 25 mm	2	5	kg.	10		
18	Shock treatment chart	1	50	each	50		
Grand Total		48,619		

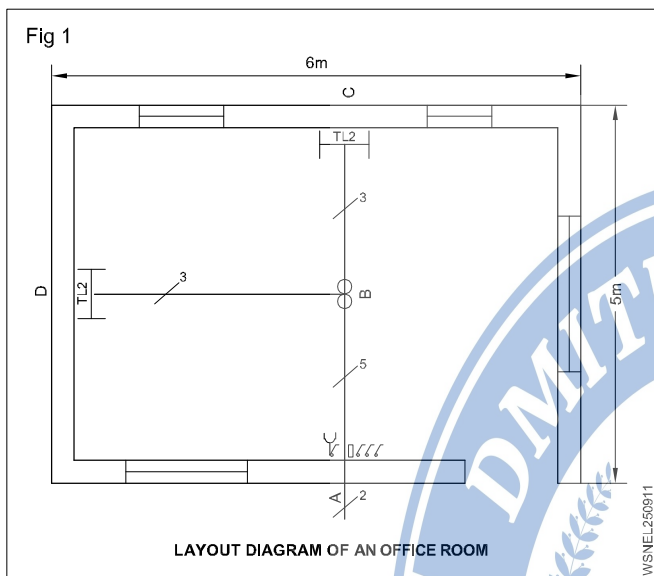
- 1 19mm heavy gauge conduit = 50 m
= Rs.25 x 50 m
= Rs.1250
- 2 25mm flexible conduit = 2 m
= Rs.30 x 2 m
= Rs.60
- 3 2.0mm² copper conductor = 48.0 m
= Rs.80 x 48 m
= Rs.3840
- 4 1.0mm² copper conductor = 38.0 m
= Rs.60 x 38 m
= Rs.2280
- 5 Material of schedule and cost = Rs.48,619
- Total Material Cost = Rs. 7430 + Rs.48,619
= **Rs.56,049**



Estimation and Costing - Simple estimation of the requirement of material etc., as applicable to the trade - Office room

Estimate the cost of material for wiring PVC conduit for an office room 6m x 5m size having 2 lamps 1 fan and 6A socket outlet.

Layout of the office has to be prepared (Fig 1).



Total load to be calculated, In the given example

- i) Tube light 2nos x 40 W = 100 W
- ii) Fan 1no x 60 W = 60 W

- iii) 6A socket 1 no = 100 W
- Total = 260 W

- 1 Length of PVC channel in Roof = 5 + 3 = 8m
- 2 Vertical drops = 0.5 + 0.5 + 2.0 = 3.0m
- Total = 8 + 3.0 = 11.0 m
- 3 Add 10% tolerance = 1.1 m
- 12.1 m

1 The total load is 260W the current taken by the total load are,

$$I = \frac{p}{v \times \cos \theta} = \frac{260}{240 \times 0.8} = 1.35A$$

From A to B and vertical drop = (2.5 + 2)m x 5 = 22.5 m

From B to C and vertical drop = (2.5 + 0.5) m x 3 = 9m

From B to D vertical drop = (3 + 0.5)m x 3 = 10.5m

total length = 22.5 + 9 + 10.5 = 42m

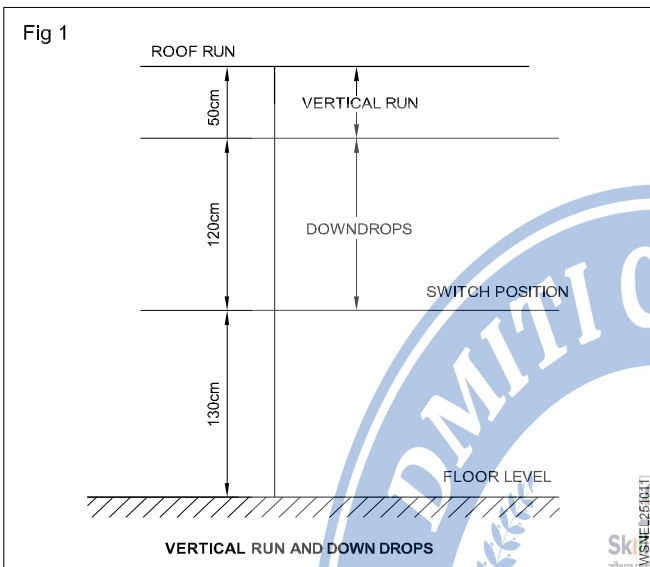
add 10% tolerance = 42 + 4.2 = 46.2 = 46 m

SI No	Accessories	Length	price
1	PVC conduit 19 mm x 10mm	12m x Rs.25	Rs. 300
2	1.5 sq mm PVC insulated copper flexible 650V	46m x Rs.80	Rs. 3680
3	Flush type SPT switch 6 A 250 V	4 Nos x Rs.50	Rs. 200
4	Flush type socket 6 A 250V	1 No x Rs.50	Rs. 50
5	Wooden switch board 250mm x 150mm	1 No x Rs.500	Rs. 500
6	Wood screws 15 x 4mm, 25 x 5mm, 30 x 6mm	25 Nos	Rs. 50
7	PVC insulation tape 19mm width 9m length	1 No x Rs.10	Rs. 10
8	Ceiling rose 3 plate 250 V , 6 A	3 Nos x Rs.10	Rs. 30
Total Material cost			Rs. 4820

Estimation and Costing - Simple estimation of the requirement of material etc., as applicable to the trade - Estimation of house wiring

Estimate the cost of material for house wiring, PVC conduit and cable.

Fig 1 shows the vertical and down drops and switch position measurement from the ground level.



Divide the load equally in 3-phases while doing so, as a requirement, the light and fan circuits of one room should be from the same phase.

1 Vertical run :

Length of selected conduit =

Roof height - (down drop + switch height) x No. of vertical runs

$$= 3\text{m} - (1.20\text{m} + 1.30\text{m}) \times \text{No. of vertical heights}$$

$$= (3\text{m} - 2.5\text{m}) \times \text{No. of vertical heights}$$

$$= 0.5\text{m} \times \text{No. of vertical heights (Eqn. 1)}$$

The value 0.5m will change if there is difference in roof height and height of horizontal run of conduit changes.

2 Length of conduit required for down drops

Length of selected = Height of conduit in horizontal run - Switch position height x No. of down drops for switches

$$= (2.5\text{m} - 1.3\text{m}) \times \text{No. of down drops for switches}$$

$$= 1.2\text{m} \times \text{No. of down drops to switches}$$

3 Length of conduit required for roof runs

Length of selected = Sum of the actual length of roof conduit run taken in each case.

For each size the total requirement is to be calculated.

4 Length of conduit required for horizontal run

Length of selected = Sum of the actual length of conduit horizontal run taken in each case.

Length of conduit required for the distance between main switch and DB is to be calculated. In most of the cases wall thickness has to be taken into account.

1 Length of conduit required for vertical run

Length for vertical run = 0.5m x No. of vertical height

$$= 0.5\text{m} \times 8 = 4\text{m of } 19\text{mm PVC conduit}$$

2 Length of conduit required for down drops

Length of down drops = 1.2m x No. of down drops

A careful study of layout indicates there are 9 down drops = 1.2m x 9 = 10.8m

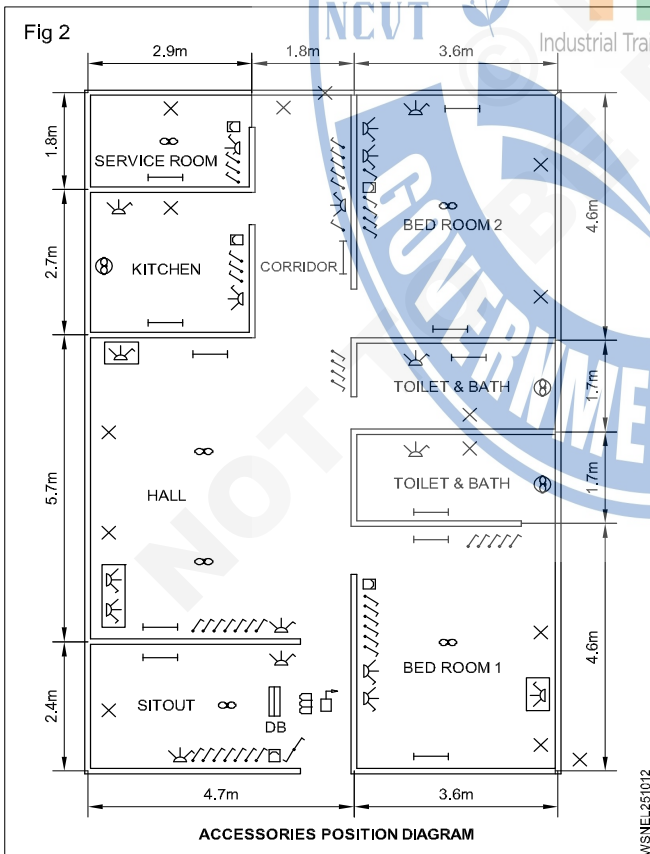
3 Length of conduit required for roof runs

$$\text{Length of conduit} = 2.35\text{m} + 2.35\text{m} + 2.35\text{m} + 2.35\text{m} + 1.45\text{m} + 0.9\text{m} = 11.75\text{m}$$

4 Length of conduit required for horizontal runs

$$\text{Length of conduit} = 4.7\text{m} + 3.6\text{m} + 1\text{m} + 1\text{m} + 1.2\text{m} + 4.7\text{m} + 2.4\text{m} + 1.35\text{m} + 1.2\text{m} + 2\text{m} + 2.35\text{m} + 5.7\text{m} + 2.9\text{m} + 2.9\text{m} + 1.35\text{m} + 2.7\text{m} + 2.5\text{m} + 1.45\text{m} + 1.8\text{m} + 1.45\text{m} = 48.25\text{m}$$

Study the consumer's requirement of light, fan and power points in each room (Fig 2).



Length of conduit required for the distance between main switch and DB :

$$\begin{aligned} \text{Length of conduit} &= \text{Wall thickness} + \text{allowance for connection} \\ &= 0.36\text{m} + 0.5\text{m} + 0.5\text{m} \\ &= 1.36\text{m} \end{aligned}$$

Total length of PVC conduit 19mm for wiring

$$= \text{Vertical run} + \text{down drops} + \text{roof runs} + \text{horizontal runs} + \text{switch DB}$$

$$= 4\text{m} + 10.8\text{m} + 9.75\text{m} + 48.25\text{m} + 1.36\text{m} = 74.16\text{m}$$

Assuming 10% wastage, the total required length of 19mm PVC conduit will be,

$$74.16\text{m} + 7.4\text{m} = 81.56\text{m} \quad (\text{or}) \\ \text{say } 82\text{m}$$

Cable required

$$\begin{aligned} = &+ (3.6\text{m} + 1\text{m})^2 + (4.7\text{m} + 1\text{m})^3 && 26.3\text{m} \\ &+ (0.36\text{m} + 0.5\text{m}) \times 5 + \\ &+ (1.2\text{m} + 3\text{m} + 1.2\text{m})^2 && 15.1\text{m} \\ &+ (1.2\text{m} + 3\text{m} + 1.2\text{m})^2 && 10.8\text{m} \\ &+ (1.2\text{m} + 4\text{m} + 1.2\text{m})^5 && 32.0\text{m} \\ &+ (0.5\text{m} + 2.35\text{m})^2 && 5.7\text{m} \\ &+ (1.2\text{m} + 2.35\text{m})^3 + 2.35\text{m} \times 2 && 15.35\text{m} \\ &+ (1.2\text{m} + 2\text{m} + 1.2\text{m})^2 && 8.8\text{m} \\ &+ (1.2\text{m} + 4\text{m} + 2\text{m})^6 && 43.2\text{m} \\ &+ (0.5\text{m} + 2.35\text{m})^2 && 5.7\text{m} \\ &+ (1.2\text{m} + 1.5\text{m})^2 && 5.4\text{m} \\ &+ (1.2\text{m} + 4\text{m} + 2\text{m} + 1.2\text{m})^2 && 14.8\text{m} \\ &+ 2\text{m} \times 4 && 8.0\text{m} \\ &+ (0.5\text{m} + 2.35\text{m})^2 && 5.7\text{m} \\ &+ (2\text{m} + 2.5\text{m})^2 && 9.0\text{m} \\ &+ (1.2\text{m} + 5\text{m} + 1.2\text{m})^2 && 14.8\text{m} \\ &+ (1.2\text{m} + 4\text{m} + 5.7\text{m} + 2.9\text{m} \\ &+ 2\text{m} + 1.2\text{m})^2 && 34.0\text{m} \\ &+ (1.2\text{m} + 1.4\text{m} + 1.5\text{m})^3 && 12.3\text{m} \\ &+ (1.5\text{m} + 1.35\text{m})^2 && 5.7\text{m} \\ &+ (1.35\text{m} \times 3\text{m}) + (1.35\text{m} \times 2\text{m}) && 6.75\text{m} \\ &+ (1.35\text{m} + 1.45\text{m} + 1.2\text{m})^2 && 8.00\text{m} \\ &+ (1.2\text{m} + 1.4\text{m} + 0.9\text{m} + 1.2\text{m})^2 && 9.4\text{m} \\ &+ (1.2\text{m} + 1.45\text{m} + 1.2\text{m})^2 && 7.7\text{m} \\ &+ (1.2\text{m} + 1.45\text{m})^3 && 7.95\text{m} \\ &+ 0.9\text{m} \times 2\text{m} && 1.8\text{m} \\ &+ 0.9\text{m} \times 2\text{m} && 1.8\text{m} \end{aligned}$$

$$316.05\text{m}$$

$$\text{Add } 10\% \quad 31.60\text{m}$$

$$\text{Say } 360\text{m of } 1 \text{ sq.mm copper} \quad \underline{\underline{347.65\text{m}}}$$

The length of the cable required for power circuit in phase L_1 . The cable chosen is 4 sq.mm copper cable which can carry 24 amps

$$\begin{aligned} \text{Total length of cable} &= (1.2\text{m} + 0.36\text{m} + 2.4\text{m} + 3.6\text{m} \\ &+ 2.4\text{m} + 1.2\text{m})^2 \\ &= 11.16\text{m} \times 2 \\ &= 22.32\text{m} \end{aligned}$$

$$\begin{aligned} \text{Add } 10\% \text{ for wastage} &= 2.23\text{m} \\ &24.55\text{m} \end{aligned}$$

Say 25m of 4 sq.mm copper cable is required.

$$\begin{aligned} \text{Total cost of wiring} &= \text{cost of the accessories} \\ &+ \text{cost of cable} \\ &+ \text{cost of conduit} \\ &+ \text{cost of hardware items} \\ &+ \text{labour cost} \end{aligned}$$

$$1 \text{ Total conduit required} = 228.32\text{m}$$

$$= 230 \text{ m}$$

$$2 \text{ Total cable required} = 347.65\text{m}$$

$$= 350 \text{ m}$$

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$$\text{Rate of conduit PVC pipes} = \text{Rs.}42/\text{metre}$$

$$\text{Rate of copper cable} = \text{Rs.}1400/100\text{metre}$$

$$\text{Amount of conduit PVC} = \text{Rs.}42 \times 230 \text{ m}$$

$$= \text{Rs.}9660$$

$$\text{Amount of copper cable} = \frac{1400}{100} \times 350$$

$$= \text{Rs.}4900$$

$$3 \text{ } 4 \text{ sq.mm copper cable power circuit} = 25 \text{ metre}$$

$$\text{Rate of } 4 \text{ sq.mm cable} = \text{Rs.}48/\text{metre}$$

$$= 25 \times 48$$

$$= \text{Rs.}1200$$

$$\text{Total Material cost} = \text{Rs.}9660 + \text{Rs.}4900 + \text{Rs.}1200$$

$$= \text{Rs.}15,760$$

Estimation and Costing - Problems on estimation and costing

Introduction

Points to be considered before taking up domestic wiring

The following points shall be noted particularly in respect of domestic dwellings.

Before starting the wiring installation, information should be exchanged between the owner of the building or architect and the local supply authority in respect of tariffs applicable, types of apparatus that may be connected under each tariff, requirement of space for installing meters, switches, service lines etc. and for the total load requirement of lights, fans and power.

While planning an installation, consideration should be given to the anticipated increase in the use of electricity for lighting, general purpose socket-outlet, kitchen, heating etc. Otherwise, the householder may be tempted to carry out extension of the installation himself or to rely upon the use of multiplug adaptors and long flexible cords, both of which are against the electric supply rules. Fundamentally safe installation may be rendered dangerous, if extended in this way.

Hence the National Electricity Code suggests the following schedule.

Number of points in branch circuits: The recommended yardstick for dwelling units for determining the number of points is given in Table 1.

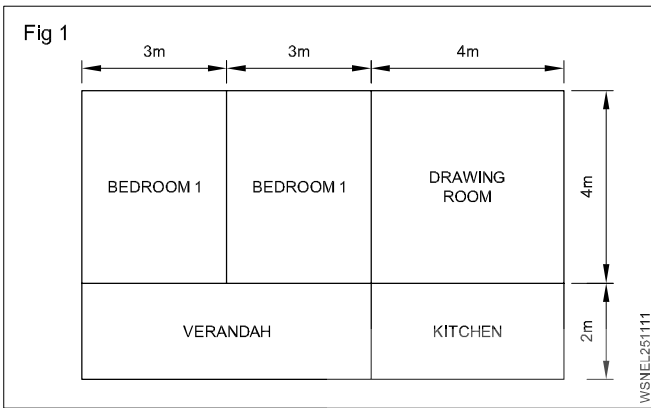
Table 1
Number of points for dwelling units

SI.No.	Description	Area of the main dwelling unit (m ²)				
		35	45	55	85	140
1	Light points	7	8	10	12	17
2	Ceiling fans (See NOTE below.)	2-2	3-2	4-3	5-4	7-5
3	5 A socket outlets	2	3	4	5	7
4	15 A socket outlets	—	1	2	3	4
5	Call bell (buzzer)	—	—	1	1	1

NOTE: The figures in the table against SI.No.2 indicate the recommended number of points and the number of fans. Example: For the main dwelling unit of 55m², 4 points with 3 fans are recommended.

Calculate the labour charge and total estimation cost for wiring of hostel / residential building.

Building plan as shown in Fig. 1



- 1 Study the plan
- 2 Collect the requirements of lights, fan and power socket, etc., from the customer.
- 3 Complete data are to be collected before starting estimation
- 4 mark the location of switch board, power loads and DM in the plan

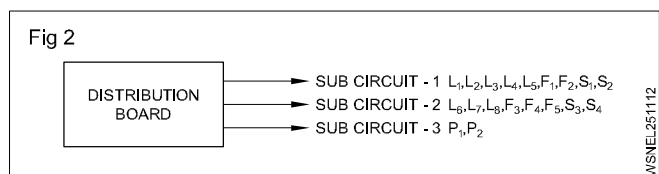
- | | | |
|----------------------------------|---|-------|
| 1 The wall thickness | - | 40 cm |
| 2 The height of roof from ground | - | 3.5 m |
| 3 Height of conduit run | - | 3 m |
| 4 Height of main board | - | 2.5 m |
| 5 Height of switch | - | 1.5 m |
| 6 Height of light brackets | - | 3 m |
| 7 Height of main board | - | 3 m |

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

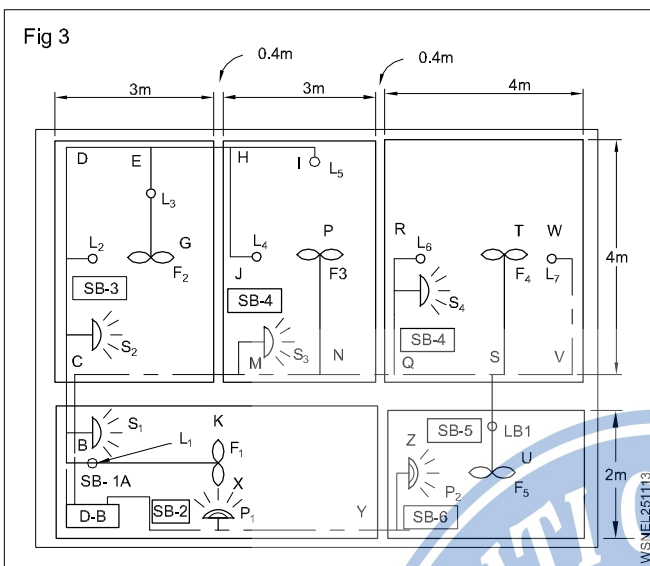
- 5 Calculate the number of sub circuits required for the above load as per IE rules.

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	<u> </u> = 1200 W

- 6 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 points & 9points. Refer Fig 2



7 Draw the layout of conduit, switch board, loads and DB (Distribution Board or Distribution Box) as shown in Fig 3.



8 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

7 Horizontal run -- 2.8 m

8 Conduit PVC pipes for all lights and fan -- 45.4m

9 Vertical down drops (horizontal run to SB's) -- 2 m

10 Cable for (power) sub circuit -3 (1/1.8m Al) -- 30 m

11 Cable for subcircuit 1 & 2 (1.0 mm² copper) -- 1&2

Calculate the labour charges

- 1 Review electrical job specification
- 2 Analyse drawing
- 3 Perform a material take off
- 4 Calculate a labour charge
- 5 Add in your overhead costs
- 6 Decide your profit margin
- 7 Type of wiring system is recommended for office
- 8 Avoid wire looping from one point to another for durability and ofcourse safety work.

Cost of electrical work charges according to the quality and thickness of the wiring or circuit used. A rough estimation of electrical as follows:

Meter board	= 2 Points	= Rs.2,000
Distribution board	= 2 Points	= Rs.2,000
Light / fan	= 17 Points	= Rs.12,000
Power	= 2 Points	= Rs.2,000

Labour charge = Rs.18,000

Total cost

Material cost	=	Rs.10,962
Labour charge	=	Rs.18,000

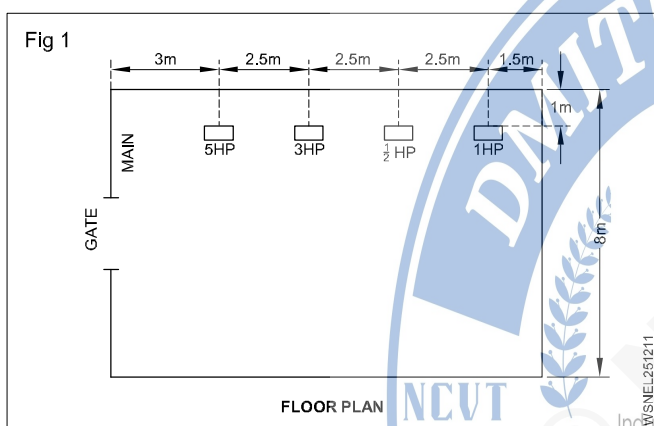
Total Estimation cost = Rs.28,962

Estimation and Costing - Problems on estimation and costing - Estimate the cost/bill of material for wiring of workshop

Calculate the labour charge and total estimation cost for wiring of workshop

- 1 Floor plan of the workshop.
- 2 Mark the positions of motors on the floor plan with the consultation of the customer.
 - i One 5HP, 415V 3 phase motor
 - ii One 3HP, 415V 3 phase motor
 - iii One 1/2 HP, 240V 1 phase motor
 - iv One 1HP, 415V 3 phase motor

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



- 1 The main switch, motor switch and starters are assumed to be mounted at a height of 1.5m from the ground level.
- 2 Height of horizontal run from ground level will be 2.5 m
- 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.

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

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

$$\text{FL current of } \frac{1}{2} \text{ HP motor} = \frac{0.5 \times 735.5}{240 \times 0.85 \times 0.8} = 2.25 \text{ A}$$

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

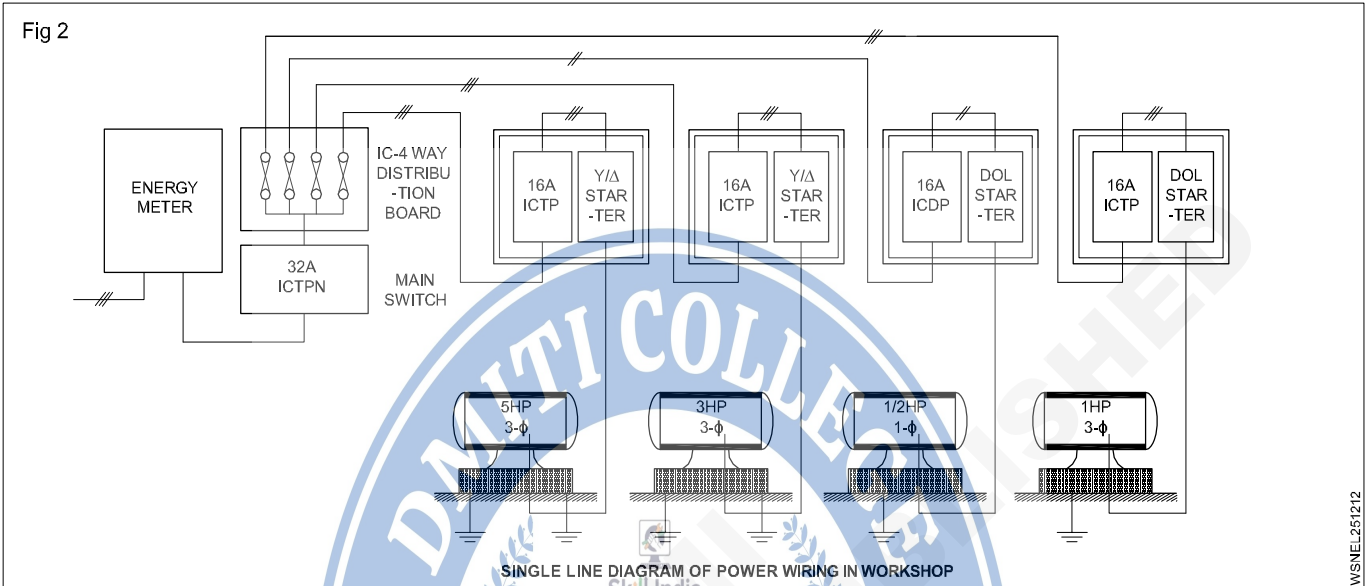
The main switch and the cable from meter to main switch should be capable of handling starting current of one motor of high rating plus full load current of the all other motors. i.e, $15.6 + 4.68 + 2.25 + 1.56 = 24.9 \text{ A}$

- 4 Prepare a table showing cable size of each motors to be installed as shown in Table 1.

Table 1

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	2.0mm ² copper conductor cable (17A) or 2.5mm ² aluminium conductor cable (16A)
2	3HP motor	4.68	9.36	2.0mm ² copper conductor cable (17A)
3	1/2 HP motor	2.25	4.5	1.0mm ² copper conductor cable (11A) minimum recommended cable
4	1HP motor	1.56	3.12	1.0mm ² copper conductor cable (11A) minimum recommended cable

- 5 The type and gauge of cable shall be selected by referring the table given in related theory.
- 6 Select the suitable switches and distribution board
 - 32A, 415V ICTPN switch with fuses can be used as main switch.
 - 16A, 415V, ICTPN 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.
- 7 Draw the single line diagram of power wirings as shown in Fig 2.
- 8 Calculate the size and length of conduit.



Total cost:

Material cost

- | | | |
|---|-------------------------------------|----------------------|
| 1 | 19mm heavy gauge conduit | = Rs.1250 |
| 2 | 25mm flexible conduit | = Rs. 60 |
| 3 | 2.0mm ² copper conductor | = Rs.3840 |
| 4 | 1.0mm ² copper conductor | = Rs.2280 |
| 5 | Material of schedule and cost | = Rs.45811 |
| | | = Rs.7430 + Rs.48619 |

Total material cost = Rs.56,049

Labour charge

- | | |
|----------------------------------|--------------------|
| Motor installation labour charge | = Rs.3000/motor |
| 4 motor installation | = 4 x Rs.3000 |
| | = Rs.12,000 |

Total cost of material and labour charge = Rs.56,049 + Rs.12000

= Rs.68,049

Estimation and Costing - Problems on estimation and costing - Office room

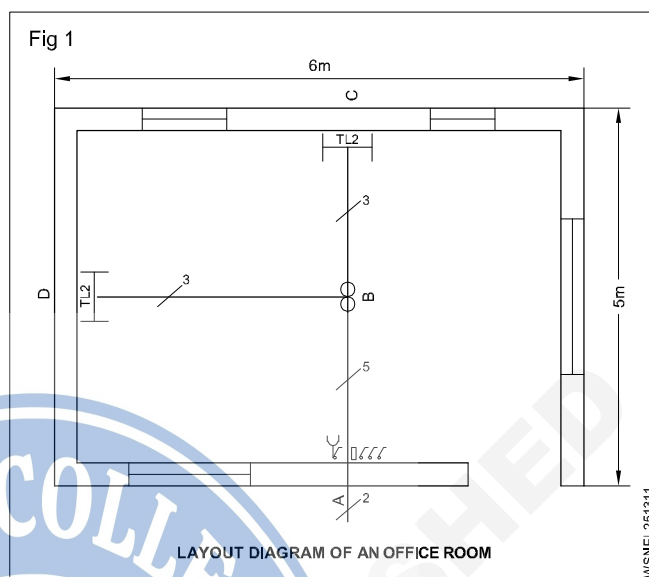
Calculate the labour charge and total estimation cost for office room 6m x 5m size having 2 lamps, 1 fan and 6A socket outlet.

- 1 Analyse drawing.
- 2 Review electrical job specification
- 3 Type of wiring system recommended for office room.
- 4 Avoid wire looping from one point to another for durability and of course safety work.

Layout of the office has to be prepared (Fig 1).

Total load to be calculated, In the given example

- i) Tube 2nos x 50 W = 100 W
 - ii) Fan 1no x 60 W = 60 W
 - iii) 6A socket 1 no = 100 W
- 260 W



SI No	Accessories	Length	price
1	PVC channel 19 mm x10mm	12m x Rs.25	Rs. 300
2	1.5 sq mm PVC insulated copper flexible 650V	46m x Rs.80	Rs. 3680
3	Flush type SPT switch 6 A 250 V	4 Nos x Rs.50	Rs. 200
4	Flush type socket 6 A 250V	1 No x Rs.50	Rs. 50
5	Wooden switch board 250mm x 150mm	1 No x Rs.500	Rs. 500
6	Wood screws 15 x 4mm, 25 x 5mm, 30 x6mm	25 Nos	Rs. 50
7	PVC insulation tape 19mm width 9m length	1 No x Rs.10	Rs. 10
8	Ceiling rose 3 plate 250 V , 6 A	3 Nos x Rs.10	Rs. 30
9	Tube light 2 Nos x 40 W		Rs. 100
10	Fan 1 No x 80 W		Rs. 2500
Total Material Cost			Rs. 7420

Estimation Cost calculation

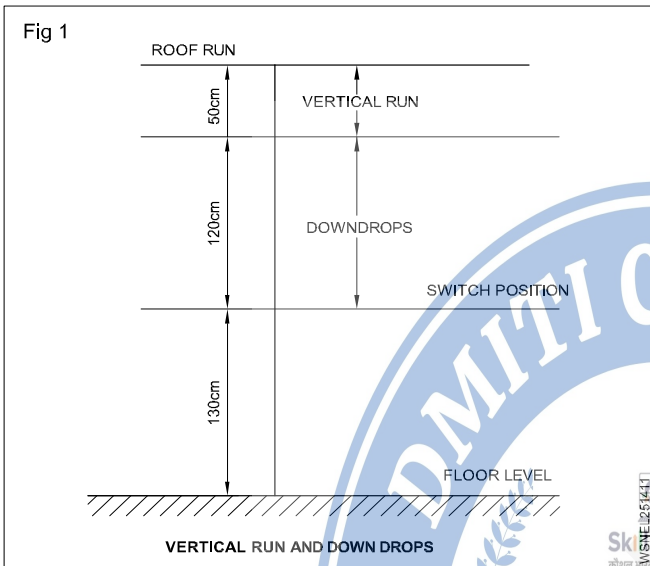
Labour charge for office room = Rs.375/point
 = 2 lamps and 1 fan
 = 3 points
 = 3 x 375
= Rs.1125

Total cost of material and labour charge = Rs.7420 + 1125
= Rs. 8545

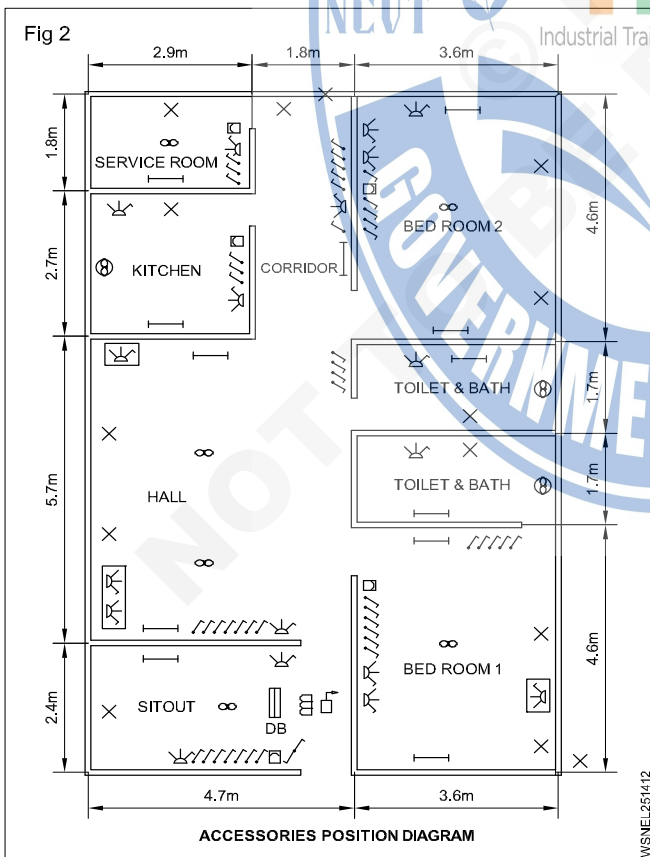
Estimation and Costing - Problems on estimation and costing - Estimation of house wiring

Calculate the labour charge and total estimation cost for house wiring.

Fig 1 shows the vertical and down drops and switch position measurement from the ground level.



Study the consumer's requirement of light, fan and power points in each room (Fig 2).

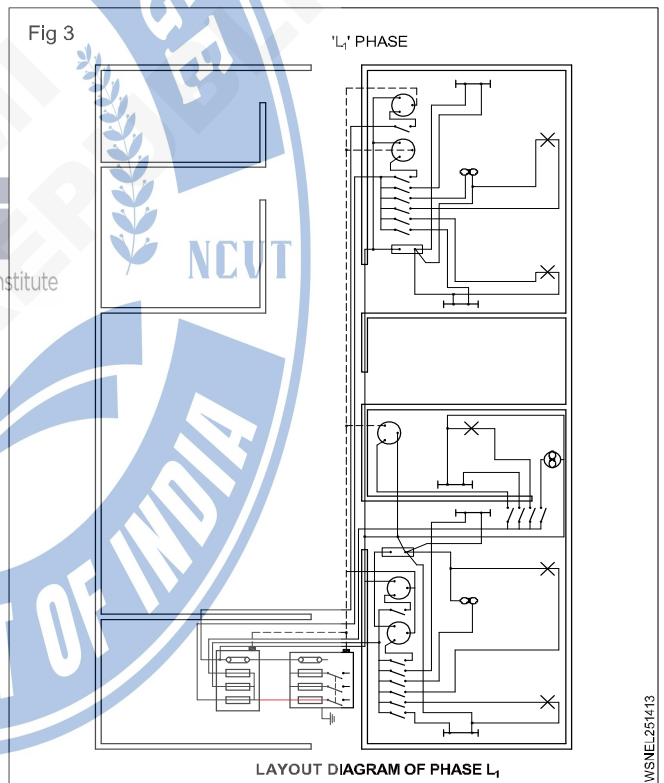


Divide the load equally in 3-phases while doing so, as a requirement, the light and fan circuits of one room should be from the same phase.

In other words a single room should not get supply from two phases as this will pose a great danger to maintenance electrician and also separate line for individual phase is to be taken through the separate conduits. Clubbing of two or three phases through single conduit should be avoided.

Calculate the wattage of light, fan and power circuits in individual branch circuits of each phase. Then calculate the total connected load of the installation as well as current in each branch circuit.

Refer to the position of accessories diagram and also the load division, then draw the layout diagram showing individual phase lines feeding to various rooms and exterior of the building. Fig 3 shows the layout diagram of phase L₁.

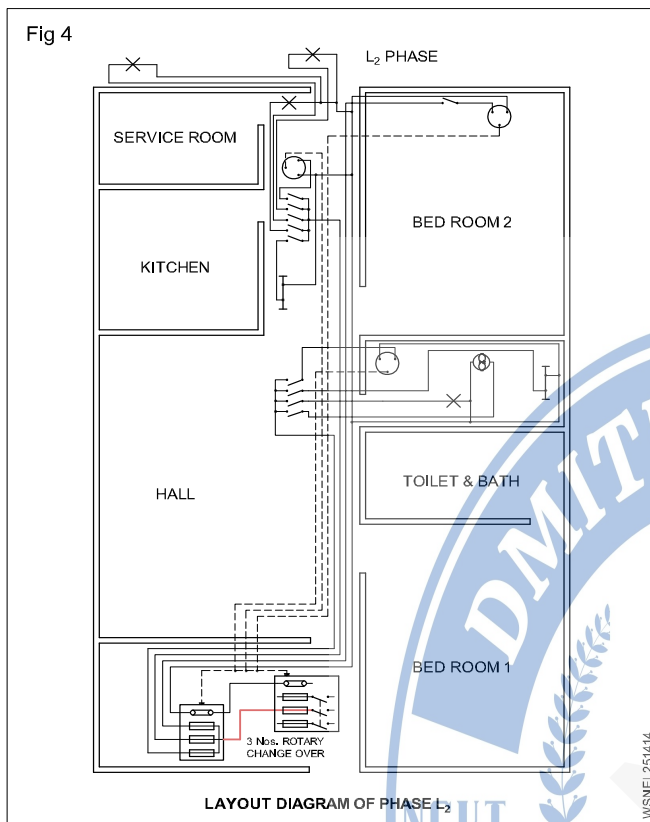


After finalizing the layout, the wiring diagram has to be drawn.

Check the current capacity of each branch and select the size of the cable. After selecting the size of the cable and number of cables in each conduit run refer the PVC conduit table and select the size of the conduit (In the govt. installation CPWD has prescribed 19mm conduit as the minimum size to be used).

Required conduit length has to be calculated as per given method.

NE code recommends the horizontal run of cables should be at a height of 2.5m (250cm) and the height of switches from floor level should be 130cm. The example taken here for the roof height is 3m (300cm) from floor level. In all cases the dimension of the rooms should be available for estimating.



Length of conduit required for main switch and DB

If individual phase line is to be drawn through 19mm PVC conduit will be sufficient on the other hand if all three phase cables to be drawn through single pipe, the requirement to be calculated separately.

Assuming individual phases will be drawn through individual conduits the 19mm PVC conduit will be sufficient to draw two cables of sizes upto 1/2.8 or 7/1.06 aluminium and copper cables respectively.

Labour charge calculation

1 Light point = 16

2 Fan point = 6

3 Plug point = 8

Total point = 30

Cost = Rs.375 / point x 30

= Rs.11250

Total estimation cost = Material cost + labour charge

= Rs.15760 + Rs.11250

= Rs.27,010