Sub:	Electrical Estimation and Costing					Code:	17EE553
Date:	14/10/2019	Duration:	90 mins	Max Marks:	50	Sem: 5	Branch: EEE

Answer Any FIVE FULL Questions

		Marks	OBE CO	RBT
1	Figure shows the plan of a house which is to be wired in open conduit system for providing lighting outlets only. a) List the Lighting load b) Draw the wiring plan c) Prepare an estimate of cost for the electrification of the lighting outlets. 	[10]	CO2	L4
2	The accompanying sketch shows the plan of a house to be wired in concealed system for providing lighting outlets only. a) Estimate the number and rating of lighting outlets. b) Draw the wiring plan. C) Estimate the required wiring accessories. d) Prepare an Estimate the cost for interior lighting. 	[10]	CO2	L4
3	Describe about Service mains and its methods.	[10]	CO3	L2
4	Calculate the material required for single phase overhead service lines of a home located 10 meter away from the pole, the loads are ; Lighting=300Watts, Heating= 2500 watts. Assume safety factor =2.	[10]	CO3	L3
5	Describe about power wiring & also determine the load current, fuse rating, cable rating, and size of conduit, main switch and starter.	[10]	CO3	L3
6	List the important consideration for wiring motor installation.	[10]	CO3	L1
7	In a workshop plan shown below, one 15HP, 400Volts, 3-phase, 50Hz induction motor is to be installed. Prepare the estimate of the cost required with a layout of the wiring. The distribution board is placed vertically at height of 1.5m from ground level. 	[10]	CO3	L4
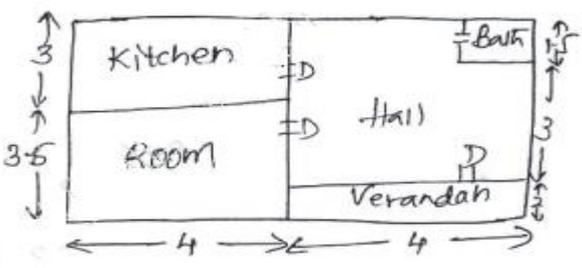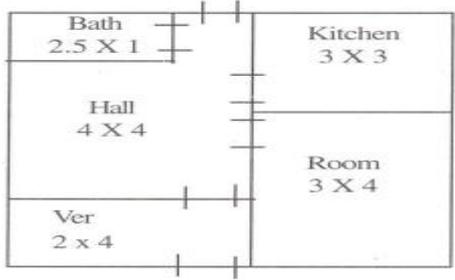
Scheme of Evaluation:

1   a) List the Lighting load ------------------------ 2 marks
         b) Wiring plan ---------------------------------- 2 marks
         c) Prepare an estimate of cost------------------- 6 marks

2.   a) Estimate the number and rating of lighting outlets----- 2 marks
         b) Wiring plan-- 2 marks
         c) Estimate the required wiring accessories----------------- 2 marks
         d) Prepare an Estimate the cost for interior lighting------- 4 marks

3   Service mains – definition----------------- 2 marks
         Methods- explanation--------------------- 8 marks

4   List of Material----------------------------- 5 Marks
         Cost Estimation ---------------------------- 5 marks

5   power wiring calculation ------------------- 2 Marks
         Determine the load current, fuse rating, cable rating ------4 Marks
         Size of conduit, main switch and starter --------------------4 marks

6   Important consideration for wiring motor installation 10 points---- 10 marks

7   List of Material------------------------ 3 marks
         Wiring Plan--------------------------- 3 marks
         Cost Estimation ---------------------- 4 marks

Solution:
1).

a) No. and Rating of lighting outlets:

Sl. No.	Places	Area in Sq.m.	AH 40W	BF 60W	Fan 50W	W/P 60W	FL 40W	Total load
1.	Verandah	4 × 2 = 8	1	1	—	—	—	100 W
2.	Room.	3.5 × 4 = 14	1	—	1	1	1	220 W
3.	Hall	4 × 3.5 = 14	—	—	1	1	2	180 W
4.	kitchen	3.5 × 3 = 10.5	2	—	—	1	—	140 W
5.	Bath	2.5 × 1.5 = 3.75	1	—	—	—	—	.25 W
	Total.		5	1	2	3	3	665 W

Since the total load is only 665 watt, one subcircuit is efficient.

b) Wiring Plan:

C) Material Calculation:

Load current $I = W/V = 665/230 = 2.89 A$

∴ 3BA Flush type D.P is to be used.

3A, 1 ph, MCB, 230 V grade.

3 ½ 5 × 300 × 4.5 mm, Varnished T.W. Board 1 m.

No. of angle holders = 5

No. of Bulk leed / Bracket Fitty = 1.

No. of ceiling me = 5

No. of wall plate socket = 3

No. of Sp. switch = 14

Requirement of Pipe:

Place	Horizontal cs in plan.	Vertical Drop	Vertical rise	Total Pipe	Elbow	Tee
verandah Hall	4 × 2 (1.75×2)+4+3.5	1	—	9 13	3 3	2 2
Room kitchen	4 + (1.75×3) 3.5 +(1.5×2)	1 1	1 1	11.25 8.5	3 2	2 1
Bath pump	1.5+1.5+0.25	1	—	4.75	1	1
Total				46.50	12	8

Adding 5% of wall crossing & wastage

$$= 46.50 + 2.325 = 48 M.$$

No of 15mm tin saddles = 45/0.75 = 64 nos.

Adding 5% of elbow requirement = 8×1.05 = 8.4 (or) say 9.

1/18 wire requirement = 48×3 = 144 M.

No of round blocks = 10+1 (for switch of both lines) = 11.

No. of 250×200×45mm TW Board - 2 nos.

No. of 150×150×45mm TW Board - 2nos.

No. of 1way PVC fuse Box - 1 No.

Length of 40mm GI pipe [For Earthing] = 1.5M.

Requirements of 8 SWG. GI wire (for Earthing) = 1kg.

Miscellaneous materials such as wooden wedges, nut bolts, screws, cement, lock, salt etc.

Estimate of Cost For Lighting :

Sl. no	Particulars	Unit	Qty	Rate	Cost
1	15mm PVC pipe 2mm thick	length(am)	48M	20.00	320.00
2.	15mm pvc Elbows " "	—	13	1.00	13.00
3.	15mm PVC Tees Suiting for above pipe	—	9	1.50	13.50
4.	1/18 cu multistrand PVC cable 1.1kvg	Coil(90M)	144	465.00	744.00
5	Tin Saddles for above pipe	Gross	64	75.00	33.33
6	5 A SP Flush type Switch 250vg	—	14	17.00	238.00
7.	5 A, 3/2 pin wall plug socket Flush type 250vg	—	3	20.00	60.00
8.	5A, 3node bakelite ceiling rose 250 vg	Dz	5	14400	60.00
9.	Bulkhead fitting with porcelain holder, glass doom mesh complete	no.	1	140	140.00
10.	5A, Bakelite angle holder 250vg	No.	5	17	85.00

2)

a) The No. and rating of lighting outlets

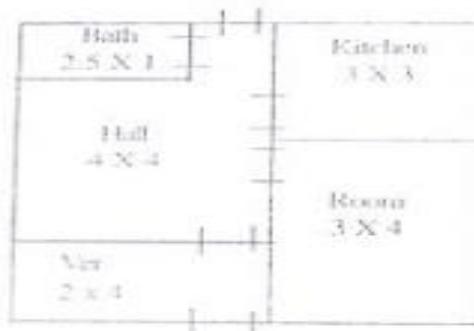| Sl. No	Places	Area In SqM	A.H. 40W	B.F. 60 W	Fan. 80W	W.P. 60 W	F.L. 40 W	Total load
1	Verandah	4 X 2 = 8	--	1	--	--	1	100 W
2.	Room	3 X 4 = 12	1	--	1	1	1	220 W
3.	Hall	4 X 4 = 16	1	--	1	1	1	220 W
4.	Kitchen	3 X 3 = 9	1	--	--	--	--	40 W
5.	Passage		1/25W	1	--	--	--	85 W
6.	Bath	2.5 X 1	1/25W	--	--	--	--	25 W
	Total		5	2	2	2	3	690 W

b) Wiring Plan is as shown in fig.5

Fig.4 : Plan of the house
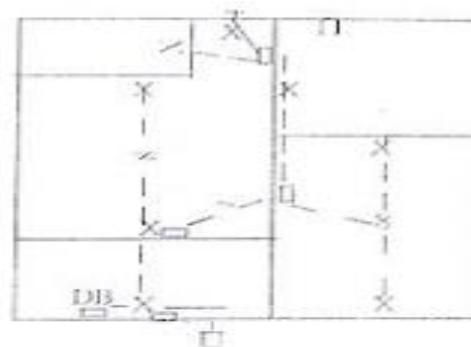

Fig. 5 : Wiring Plan

c) Required wiring accessories:

Refering above table

No. of S.P. switch = 5 + 2 + 2 + 2 + 3 = 14

No. of 100 x 100 x 45 mm T.W. boards = 5 + 2 + 3 = 10

No. of 100 x 100 x 3 mm Hylem Plate = 10

No. of Angle Holder = 5

No. of Bulk head fittings = 2

No. of wall plug sockets = 2

No. of 150 x 100 x 45mm T.W. Block = 2 (for 3 switches at verandah and 4 switches at the entrance of kitchen)

No. of 150 x 100 x 3 mm Hylem Plate = 2

No. of 200 x 250 x 45mm T.W. Block = 2

No. of 200 x 250 x 3 mm Hylem Plate = 2

No. of 200 x 300 x 45mm T.W. Block = 1

No. of 200 x 300 x 3 mm Hylem Plate = 1

No. of ceiling rose = 2(for fan) + 3(for F.L.) = 5

Pipe Requirement :

Place	Horizontal	Vertital Raise	Vertital Drop	Total	Bends
Verandah	2 + 1	2 + 1 + 1	–	8	4
Room	4 + 2 + 3	2 + 1	2 + 1 + 1	15	5
Hall	4 + 2	2 + 1	2 + 1	12	6
Kitchen	–	1	–	1	1
Passage	1 + 1 + 0.5	2 + 2	1 + 1	8.5	4
			Total	44.5	19

Allowing 5% wastage, total pipe requirement = 44.5 + 2.22 = 46.7 or say 48 M

Total no. of bends = 19 + 1 = 20

Wire requirement = 48 x 3 = 144 M

No. of J-hooks = 48/1.5 = 32

Load current = 700/230 = 3.0 A

Rating of flush type main switch = 30 A

Rating of current limiter (with box) = 3 A

No. of 30 A flush type fuse unit = 1

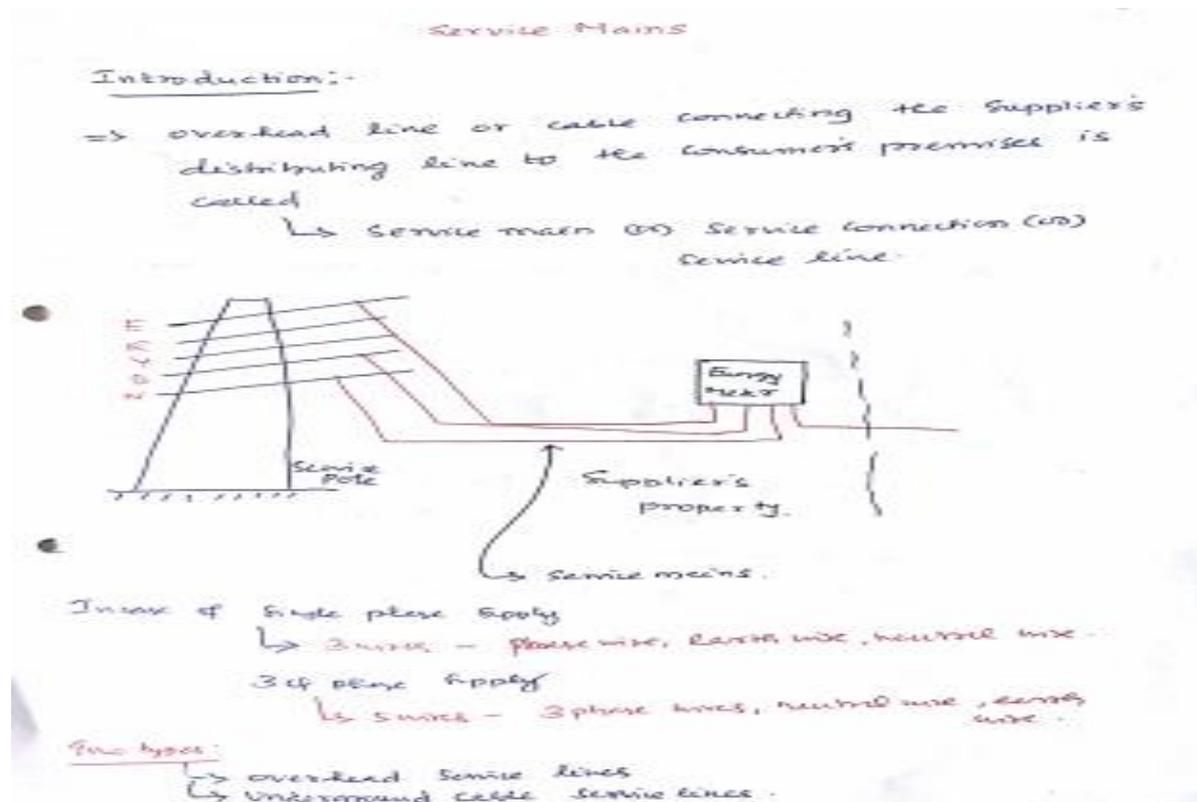1.5 M length, 40 mm G.I. Pipe for earthing.

8 SWG G.I. Wire 1 Kg.

Miscellaneous Materials such as nut, bolts, screws, coal, salt etc.

a) ESTIMATE FOR INTERIOR LIGHTING

Sl. No.	Particulars	Unit	Quantity	Rate Rs.	Cost Rs.
1	30 A Concealed flush type main switch 250 V	No.	1No.	80.00	80.00
2	3 A Current limiter with shackle box	No.	1No.	105.00	105.00
3	20 mm PVC pipe 2 mm thick	length(3M)	48M	20.00	320.00
4	20 mm PVC Bends 2mm thick	No.	20Nos.	1.50	30.00
5	J-hooks for 20 mm PVC pipe	Dozens	32 No.	15.00	40.00
6	1/18 multi strand (3/22) Copper PVC Cable 1 1/2 Kg	Coil(90M)	144M	465.00	744.00
7	Bakelite angle holder 6A, 250v/g.	No.	5Nos.	17.00	85.00

8.	Bulk-head fitting complete with porcelain holder, glass doom & mesh	No	2Nos.	140.00	280.00
9.	5A 2 plate bakelite ceiling rose 250Vg.	No	5Nos.	12.00	60.00
10.	5A S.P.flush type decorative switch 250Vg.	No.	14 Nos	25.00	350.00
11.	8 SWG GI wire	Kg.	1Kg.	60.00	60.00
12.	40mm G.i. pipe 3mm thick for earth	Moter	1.5M	140.00	210.50
13.	5A 3/2 pin flush type Wall plug socket 250Vg	No.	2 Nos	20.00	40.00
14.	100X100 X 45 mm T.W concealed block	No.	10Nos.	8.00	80.00
15.	150 X 100 X 45mm T.W concealed Block	No.	2 No	13.00	26.00
15.	200 X 250 X 45 mm T.W. Concealed Block	No.	2 Nos.	40.00	80.00
16.	250 X 300 X 45 mm T.W. Concealed Block	No.	1 No	30.00	30.00
17.	16A porcelain Fuse unit 250Vg.	No	2 No	25.00	50.00
18.	100 X 100 X 3 mm hylem sheet	No.	10Nos.	10.50	105.00
19.	150 X 100 X 3 mm hylem sheet	No.	2 No	19.50	39.00
20.	200 X 250 X 3 mm hylem sheet	No.	2 Nos.	52.50	105.00
21.	250 X 300 X 3 mm hylem sheet	No.	1 No	75.00	75.00
22.	10A flush type Fuse unit 250Vg.	No.	1 No	25.00	25.00
23.	Misc. Materials such as screws, wedges etc.	Lumpsum			45.50
24.	Labour Charges for a) 14 light points each @ Rs. 55.00 = 770.00 b) Earth work Rs. 60.00 X 1 = 60.00 c) Main Switch & Circuits Rs. 75.00 X 1 = 75.00				895.00
25.	Contingencies @ 5% for the unforseen items and variations in prices				204.75
				Total Rs.	4299.75
				or Say Rs.	4300.00

3).

Service Mains

Introduction:-

=> overhead line or cable connecting the supplier's distributing line to the consumer's premises is called
↳ service main (or) Service connection (or) service line.

In case of single phase supply
↳ 3 wire - phase wire, earth wire, neutral wire.
3ф phase supply
↳ 5 wire - 3phase wires, neutral wire, earth wire.

Two types:
↳ overhead service lines
↳ Underground cable service lines.

For domestic – load of the consumer $\ngtr 1kW \rightarrow$ 10SWG Cu conductor used

domestic/commercial loads – load not exceeding 2.5kW

$\downarrow$

8 SWG Cu (or) 13.9mm² AAC (All Aluminum conductor)

(or)

ACSR

Aluminium Conductor Steel reinforced.

Power loads up to 12 kW – 6 SWG Cu (or) 14.4mm² AAC (or) ACSR

→ water proof cables
← lead
← GI pipe

⇒ underground service connection
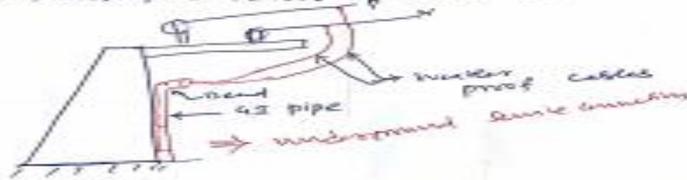
⇒ weather proof Al (or) Cu PVC cables are used.

⇒ low tension 3½ core cable is used for underground service connection.

Methods of Installation of Service lines:

1. Over head service lines
2. Underground cable service lines.

1 (i) High Roof Building:

↳ Service bracket [mild steel angle iron piece] is embedded into a wall at suitable height.

⇒ Pin (or) shackle type insulators are fixed on the bracket.

⇒ No of insulators – depends no. of wires.

⇒ Dis. b/w insulators 30cm.

⇒ Earth is connected to angle iron.

⇒ GI pipe used – opening face should be down

$\downarrow$
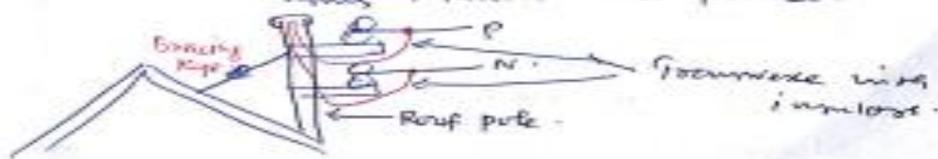
to avoid the entry of rain water.

(ii) Low Roof Building:

Very low light – no need of service bracket

⇒ GI pipe connection is used.

⇒ Roof pole consists of a strong steel tube (60mm, 80mm, 90mm in dia) & three span insulator are provide.

Bracket Kyt
P
N
Roof pole.

Insulators with insulator.

⇒ height of roof pole not exceed 3 mtrs otherwise tensile stress involved will become too high.

⇒ To keep tensile stress less - roof pole is braced by steel rope.

(iii) Weather proof cable method:

⇒ 8 SWG GI wire is stretched from service pole to eye bolt.

(iv) Use of Junction @) Joint Box.

Taking connection from one house to another house joint box is made.

2) Underground cable service connection:
Load current = 25 Kw
MS clamp = 16mm × 20mm, bolts & nuts
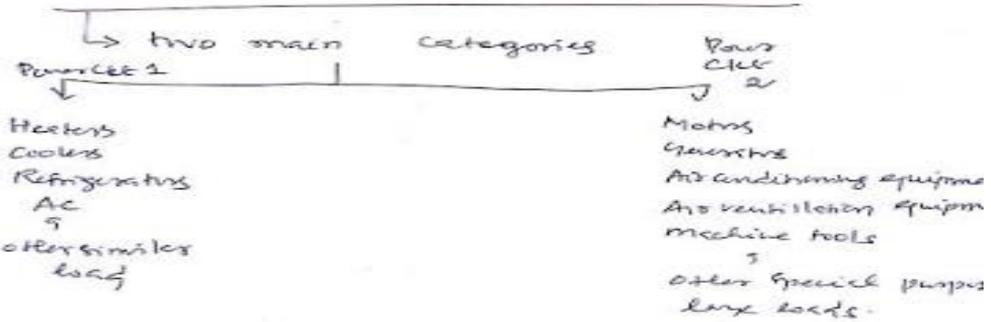Stretch -

4).

Connected load, $P = 8$ kW or 8,000 W
Supply voltage, $V = 240$ V

Load current, $I = \dfrac{P}{V} = \dfrac{8,000}{240} = 33.3$ A

Hence 16 mm² aluminium conductor 650 V grade, twin core weatherproof cable having current carrying capacity of 43 A will be used for street distribution mains. The quantity and cost of material required is estimated as below :

No.	Description of Material With Complete Specifications	Quantity Required		Rate			Amount		Remarks
		Quantity	Unit	₹	P	Per	₹	P	
1.	16 mm², 2-core, aluminium conductor, 650 V grade weatherproof cable	204	m	50	00	m	10,200	00	
2.	GI wire 8 SWG	204 (20.4)	do (kg)	270	00	kg	5,508	00	
	Clips 31 mm	7	pkts	30	00	pkt	210	00	
	Rag eye bolts 16 mm × 225 mm	70	no	15	00	each	1,050	00	
	25 mm diameter GI pipe	20	m	75	00	m	1,500	00	
	Tee-joints	5	nos	100	00	each	500	00	
	Straight through joints	10	do	90	00	do	900	00	
	Aerial fuse 32 A	1	do	55	00	do	55	00	
	Black tape 19 mm	1	roll	75	00	each roll	75	00	
	Sundries to complete the job such as nuts & bolts, cement, sand, wooden bushes, thimbles etc.						500	00	Lump-sum provision
	Total						20,498	00	
	Storage and transportation charges 5%						1,024	90	
	Labour charges 10%						2,049	80	
	Contingencies 1%						204	98	
	Grand total						23,777	68	Say ₹ 23,800.00

5).

Design and Estimation of Power circuits:

↳ two main categories

Power cee 1 | Power Cct 2

Power cee 1
↓
Heaters
Coolers
Refrigerators
Ac
s
other similar
load

Power Cct 2
↓
Motors
Generators
Air conditioning equipment
Air ventillation equipment
mechine tools
s
other special purpose
large loads.

⇒ lighting load ⇒ 50 watts & 10 points.
⇒ Power load ⇒ 3000 watts (IS4648-1968).

Switch

Flexible conduit

Starter
Earthing

Motor terminal box.

⇒ PVC / XLPE
↓
based on load.

R
Y
B

Power intake distribution board

Main fuse switch

Busines channel

Mcb's starter

Mcb's starter

Fc Business fly Distribution motor set
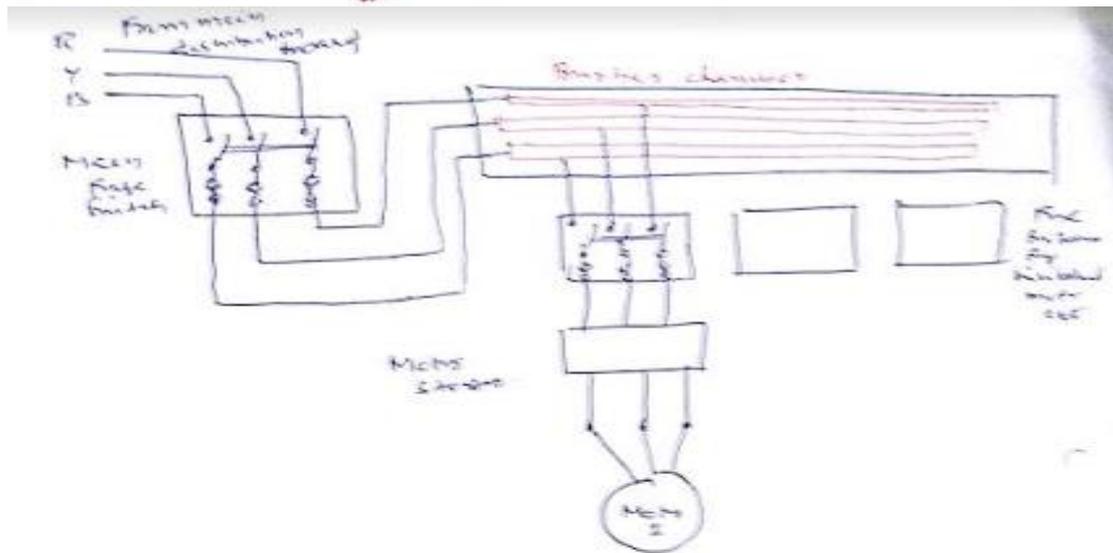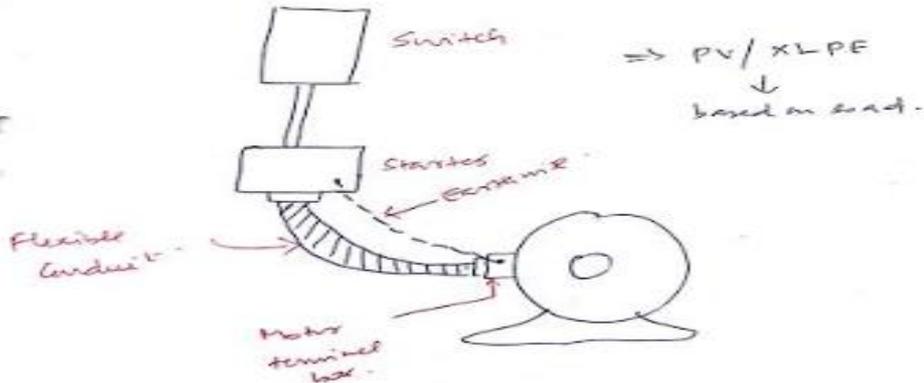
Motor I

Determination of I/p Power:

⇒ large m/cs loss will be there
⇒ load also we have to calculate.
50% to 60% η   below ±HP
70% to 75% η   1 to 2HP
75% to 80%   2-5 to 5HP $\eta = \frac{o/p}{I/p}$
90% for large motors.

$I/p \text{ in watts} = \frac{o/p \text{ in watts}}{\text{Motor } \eta} = \frac{\text{Rated HP} \times 746}{\%}$

Determination of I/p current:

For ex, 500V, 10 HP dc motor of 80% η is

$$\frac{10 \times 746}{500 \times 0.8} = 18.4 \, A.$$

In case of 1φ AC motor, Pf usually 0.75 - 0.9

$$I = \frac{Rated \; HP \times 746}{\eta_m \times V \times \cos\phi} \qquad \text{depends upon type \& size of the motor.}$$

For ex, 2HP, 240V, 70% η, 0.8 Pf,

$$I = \frac{2 \times 746.6}{0.8 \times 240 \times 0.7} = 11 \, A$$

For 3φ AC motors:

$$I_L = \frac{Rated \; HP \times 746}{\sqrt{3} \times \eta_m \times V_L \, \cos\phi}$$

For ex, 3φ, 415V, 10HP, 80%, 0.85 Pf

$$I_L = \frac{10 \times 746}{\sqrt{3} \times 0.8 \times 415 \times 0.85} \simeq 16 \, A.$$

Determination of Rating cables:

As per table after calculating the load current.

cu / Al
3/20, 7/20, 7/14, 19/20 cu
4, 6, 10, 25, 35, 30, 95 Sq.mm in case of
Al.

Determination of Rating of Fuses:

↳ Fuse - Introduction
↳ Starting current safely but no care
↳ rating of fuse should be greater than
twice the rating cables.

Determination of Size of Conduit, distribution Board
main switch and Starter

Ref. table 2.3 ⟹ knowing size of cable &
no. of cables
                              ↓ decides conduit size.
Size = 15mm, 20mm, 25mm, 30mm, 40mm.
Thickness = 2mm or 3mm.

Distribution Boards
        ↳ no of ways supply rating
        ↳ voltage & current
        ↳ S.C circuit level highest current rating

Main Switch:
        ↳ starting current + full load current of
          of one motor rating] remaining motors.
          [highest rating]

Starters   Sq. cage IM
        DOL — 0.75 kw
        Y-Δ — 0.75 — 11 kw
        Autotransf? - above 11kw.
                Starters
        Rotor Resistance } for slip ring IM.
                Starter

6).

Important considerations Regarding Motor Installation wiring: (8)

1. All equipment used in power wiring shall be of iron clad construction and wiring shall be of armoured cable (or) conduit type. (IE Rule 51)

2. Wood work shall not be used for mounting of switches.

3. Looping of conductors and use of tee joints shall not be done.

4. The length of flexible conduit used for connections b/w the terminal boxes of motors and starters, switches and motors shall not exceed 1.25 metres.

5. Every motor, regardless of its size shall be provided with a switch fuse placed near it. [IE Rule 50 clan(d)]

6. In addition to switch fuse all motors shall be provided with suitable means for starting and stopping (starters) placed at convenient places. The starters are used to limit the starting current to desired value. DOL, auto tr starters, RR starters, used for ɛɛ motors 0.75kw, 0.75-11kw, abve 11kw etc.

7. The conduit should preferably be layed in covered trenches to facilitate operator movement (safe)

8. Laying of cables must be in separate conduits for separate motors.

9. Mini. c+s of conductor that can be used for power wiring is 2.5mm² for Al conductors & 1.25mm² for cu conductors. Hence PVC / XLPE cables of size lower than 3/0.915 mm cu / 1/1.8 mm al cannot be used for power wiring.

10. The current rating of cables for supply to motor may be based normal full load current of the motor but fuse rating should be based on starting current. In no case should the rating of the fuse be greater than twice the rating of the cable.

.

11. The conduit used in power wiring shall be electrically continuous throughout and connected to the frame of the motor. The frame of the motor shall be earthed by the owner by two separate and distinct connections of the earth. [IE Rule 61]

12. The wire used to earthing conductor shall be of cu or galvanized iron. The x sectional area of the earthing wire should not be smaller than half of the largest current carrying conductor used in wiring.
The x sectional area of GI wire, if used as an earthing wire, should be such that its conductivity is not less than the cu conductor.

13. Since supplier provides and maintains only a suitable earthed terminal at or near the point of commencement of supply at the consumer premises, the consumer is exposed to provide his own earthing system with an independent electrode.

14. While deciding the current rating of a mains switch controlling a group of motors. Starting current of one motor (highest rating) + full load current of remaining motors is considered.
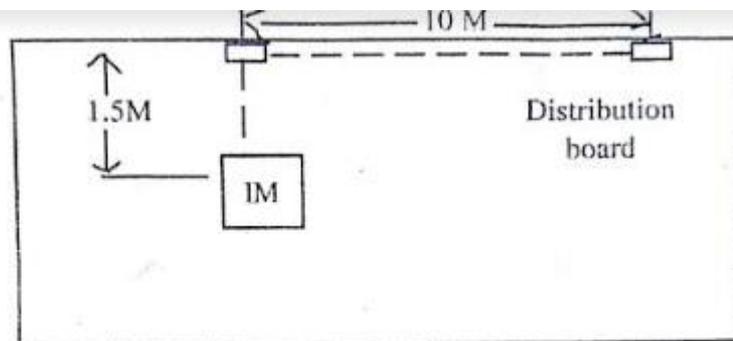
7).

Fig. 14 : wiring plan

Approximate load current = H.P X Current per HP = 15X 1.6 = 24A

The size of wire required corresponding to 24A current with a factor of safety of 2 is 7/16 copper (by wire table).

                                                     V V H L L

The total requirement of this wire upto starter board = 3 (1 + 1 + 10 + 1 + 1) = 42M (Only 3 leads are required since we don't want neutral)

(In the above V for vertical, H for Horizontal and L for Loose wire required for connection)

                               H V V

Length of 25mm PVC pipe = 10 + 1 + 1 = 12M

No. of bends = 2

No. of 25mm saddles = 12/0.75 = 16

The approximate current in each lead (of 6 wires) from starter to motor = $24/\sqrt{3}$ = 13.85A.

Therefore 9 to 14 amps fully automatic star-delta starter with voltage coil of 440 is required

The size of wire required corresponding to 13.85A. with a factor of safety of 2 is 7/20 copper (by wire table)

The total requirement of this wire = 6 (2 + 1.5 + 1.5 + 0.5) = 33M

(Assuming the board being placed at a vertical height of 1.5M from ground level, 0.5M vertical raise is taken in the motor side, 'L' being looseness to be kept in the board)

The length 30mm flexible pipe = 1.5 + 1.5 + 0.5 = 3.5M (0.5M raise in the motor side)

No. of 30mm saddles=3.5/0.75=4.66 or say 5

The current rating of I.C.T.P. required = 24 X 2.5 = 60A. (since Market availability is 60A.Factor of safety taken is 2.5)

As we have to provide space in the board for 60A. I.C.T.P., starter & capacitor, the size of board is 750 X 450 X 45mm.

8SWG G.I. wire required = 2 X 2 = 4Kg.   → 10 mehs = 1½ . Approx. 42
                                                 so 4kg requ

40mm G.I. pipe for 2 earthing each of 2.0M, i.e., totally 4 M

RKVA of capacitor = 15 / 2.5 = 6

9 to 14A Fully automatic Star-Delta starter with coils of 440V range.

Miscellaneous materials such as coal, salt, cement, screws, nuts, bolts, wooden wedges, etc.

Sl. No.	Particulars	Unit	Quantity	Rate Rs.Ps.	Cost Rs.Ps.
	ESTIMATE COST				
1.	60A I.C.T.P Main switch 500Vg.	No.	1No.	1480.00	1480.00
2.	25mm PVC pipe 2mm thick	Length(3M)	12M	25.00	100.00
3.	25mm PVC Bends	Nos.	2Nos.	3.00	6.00
4.	30mm Flexible pipe 3mm thick	M	3.5M	15.00	52.50
5.	Tin Saddles for 25mm Pipe	Gross	16Nos.	144.00	16.00
6.	Tin Saddle for. 30mm pipe	Gross	5Nos.	200.00	6.94
7.	7/18 copper PVC cable 1.1K Vg.	90M(coil)	42M	2400.00	1120.00
8.	7/20 copper PVC cable 1.1K Vg.	90M(coil)	33M	1850.00	678.33
9.	750X500X45mm Varnished T.W. Board	No.	1 No.	650.00	650.00
10.	8 SWG G.I wire for earthing	Kg	4Kg.	60.00	240.00
11.	40mm G.I. pipe for earthing	M	4M	140.00	560.00
12.	6 RKVA Oil type Power capacitor	No.	1No.	1500.00	1500.00
13.	9 to 14A Fully automatic Star-Delta	No.	1No.	4500.00	4500.00
14.	Contingencies & allowance for variation in prices at 5%				575.00
				Grand Total	12075.00

Total Estimate of cost is Rs. Twelve thousand and Seventy five only.