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Eighth Semester B.E. Degree Examination, Jan./Feb. 2023 Electrical Estimation and Costing

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Define estimating and explain the purpose of estimation of costing. (06 Marks)
- b. Mention the different modes of Tendering and explain them. (08 Marks)
- c. Explain the following : i) Catalogues ii) Contingencies iii) Purchase system. (06 Marks)

OR

- 2 a. List the guidelines for inviting tenders. (08 Marks)
- b. Write any 6 rules of Indian Electricity Act. (06 Marks)
- c. Write a short notes on : (06 Marks)
 - i) Electrical schedule
 - ii) Overhead charges
 - iii) Profit.

Module-2

- 3 a. Write the different types of wiring systems and explain them briefly. (08 Marks)
- b. Draw the electrical circuit and estimate the quantity of materials required for the wiring system. Chosen in a house plan shown in Fig Q3(b). Assume the height of ceiling as 3.6m and one plug point (60W) has to be provided in each room. All dimensions in m.

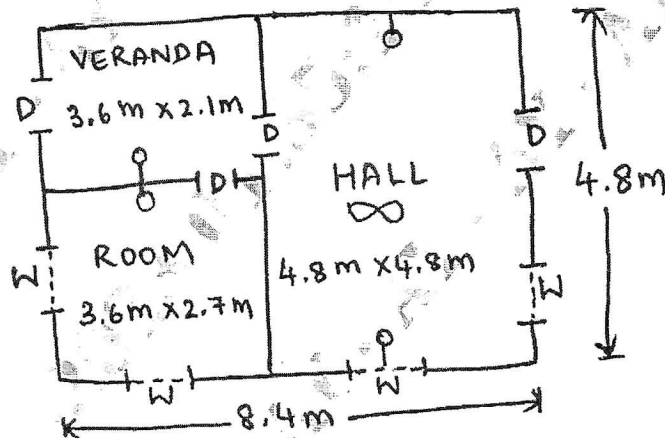


Fig Q3(b)

(12 Marks)

OR

- 4 a. Write the general rules to be considered for wiring system. (08 Marks)
- b. With reference to internal electrification of building, explain how to determine the following: (06 Marks)
 - i) Total load
 - ii) Number of sub circuits
 - iii) Rating of main switch and distribution boards.
- c. Explain the three essential points which must be considered while determining the size of the conductor for internal wiring for a given circuit. (06 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and/or equations written eg, 42+8 = 50, will be treated as malpractice.



Module-3

- 5 a. Write the important consideration regarding motor installation wiring. (08 Marks)
 b. What do you understand by service line? Write down the various methods of installing service lines. (04 Marks)
 c. With simple sketches, explain any two methods of installation of overhead service lines based on the prevailing conditions of the building. (08 Marks)

OR

- 6 a. Explain the determination of input power, size of conduct, distribution board, main switch, starter size of the cable and rating of the fuse. (10 Marks)
 b. A 10HP, 415V, 3 ϕ , 50Hz, Induction motor is to be installed in a workshop the plan of which is shown in Fig Q6(b). Draw the layout of the wiring and estimate the quantity of material required. Assume motor efficiency as 85% and power factor as 0.8 lagging.

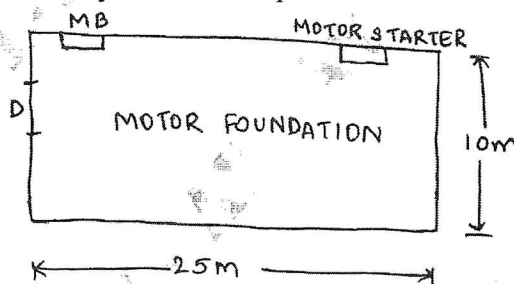


Fig Q6(b)

(10 Marks)

Module-4

- 7 a. With neat diagram, explain different types of cross arms. (06 Marks)
 b. List out the various points to be considered at the time of erection of overhead lines. (08 Marks)
 c. Explain the following: i) Guys and Stays ii) Lighting arrestors iii) Bird Guards. (06 Marks)

OR

- 8 a. Write the different types of insulators. Explain any one of them. (06 Marks)
 b. Explain the function of the following in relevance of OH transmission and distribution
 i) Phase plates ii) Beads of jumpers. (06 Marks)
 c. A pole for an overhead 11kV, 3 ϕ , 50Hz line is to be earthed and a stay is to be provided. Prepare a list of materials required. (08 Marks)

Module-5

- 9 a. Describe briefly the requirement that must be available in a substation. (10 Marks)
 b. Draw the key diagram of typical 33kV substation. (10 Marks)

OR

- 10 a. Explain the function of the following in a substation :
 i) Isolators ii) Earthing switch substation iii) Batteries. (06 Marks)
 b. Explain the purpose of substation earthing. (06 Marks)
 c. Draw the single line diagram for 10MVA, 33/11kV, substation and prepare an estimation of materials required, with their complete specification. (08 Marks)



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Electrical Estimation and Costing
 Jan/Feb 2023 - Question Paper
 8th Sem -

Module-1

1(a) Define estimating and explain purpose of estimation of costing (cost)

Estimation is an art of assessment of quantities of different items and cost thereof to plan the amount required for executing a work before carrying out the actual work. It will help take a good decision about work to be carried

Purpose of Estimation

- 1) It gives idea about material required specifically and quantity of them for the required project.
- 2) It requires to go according to plan of work which is through drawing, minor changes in plans can be made if estimated values are more.
- 3) Purpose of Estimate is select good quality of material, save the money and save overall project cost to complete within time.
- 4) If a loan is to be taken for project then this estimate helps for applying the loan.



1 (b) mention the different modes of Tendering and explain them (any)

Tendering is an offer made by one company for doing a work on the conditions as quoted under.

mode

i) Open Tendering: Non-registered Dealers are free to participate in this type of Tendering. Giving an advertisement in English News-papers, open tenders can be called.

ii) Global Tender: Global Tenders can be called by sending add in leading National newspapers and also in Indian Trade Journals. A foreign company can get contract work or project allotted to them by Global Tendering.

iii) Limited Tender: At least five or six companies are to be given information about tendering. Selection is based on experience or past service and tender approach.

iv) Single Tender: Single source or party is offering and purchase is made for them only.

v) Proprietary Tender: A proprietary manager who is having agent is going to get this Proprietary Tender.

vi) Spot Tender: It is only raised when emergency requirements are there. Assembly of 3 or 4 sources are immediately made and one source is selected.



1 (c) Explain the following

- i) Catalogues ii) Contingency iii) Purchase System (06)

i) Catalogues: Catalogues provide updated technical specifications of products and purchase Rates and help for Estimators.

Standard Catalogues are prepared by Estimators and it saves his Time.

ex: Books Catalogue, Electrical wiring materials, Catalogues of different firms and Lamps.

ii) Contingency: These are for unforeseen items. It will cover unexpected expenditure like delay in delivery minor accidents, variation from plans from Estimators or planners. Contingency Cost fully covers material cost, Labour Cost and other allied expenses like natural calamities, earthquakes.

iii) Purchase System: This system is divided into 3 or Purchase Objective Purchase Procedure and set up.

Purchase Objective are met by engineers to get required quantity of material for specifications. Fair and Healthy system of Purchase is to be developed. Budgets are provided with decision exchange flexibility for good Purchase. Environment made on inventory to be at optimum level. If training is required of material knowledge, a person should be given training.



(u)

Purchase Policy

Purchase Department will make vendor evaluation and Record of Ratings as per required format. Issue of purchase order in Tissue. It will normalize make of contracts for stock of iteam. Purchase Dept has to maintain updated rules, govt Laws on sales tax excise duty etc.

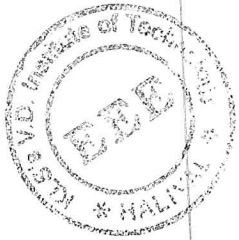
For Large projects, Tenders are called, Suitable Bidders are selected for specified portion of work. A good Estimation will help purchase dept to make good purchase to carry out work.



2 (a) List the guidelines for inviting Tenders

Guidelines for Inviting Tenders

- * Tenders refer to Inviting to a Bid for a project.
- * Tenders are invited on Tender Form. Those are in sealed format are open for public.
- * Report content, place, date, all will be informed for tenders.
- * The information will be given for who is authorised to accept tenders.
- * Errors made of unsuccessful tenders is returned to tenders.
- * Now a days E-Tendering is also available for Govt work like, Telephone Exchange office, Laptop Installation, Substation repair, etc.
- * Tender Opening session is to be informed.
- * Tenders has to be evaluated by conducting meetings.
- * examples LIT, ABB obtained large tenders for construction substation.
- * The Govt, Tender opening, closing, all are with sequence for carrying the or allowing the work.



(6)

2 (b) Write any 6 Rules of Indian Electricity Act - (06 m)

I.E Rule 29 - It covers about industry or organization installation will be installed, protected and worked and maintained in accordance with B.E.S. Cross-sectional Rating of wire should not exceed cross-sectional rating of smallest cable in circuit.

I.E Rule 30 - Specifies ensured that all the electric lines, wires, fittings and apparatus belonging to him or under his control which are on a consumer's premises are in a safe condition.

I.E Rule 55: It imposes about standard Frequency \pm (50 Hz A.C) and deviation allowed are only less than 3%.

I.E Rule 77: It stipulates clearances above ground of the lowest conductors of a overhead line and service wires.

I.E Rule 79: It gives instructions about clearance from building of low and medium voltage lines and service lines.

So like this we have I.E Rules for Voltage standards, Insulation level, Earthing, Circuit Breaker, Neutral Conductor, Height of Tower of Transmission line, Lighting Apparatus, Service line Rules.



2 (c) Write a short note on
 i) Electrical Schedule ii) Overhead charges
 iii) Profit - (66m)

i) Electrical Schedule: It involves about clear planning about nature of work, planned Budget, work specification, ex: A schedule of maintenance of 5 Feeds
 ex: A schedule of making a wiring of Residential home. Estimator will give Rate card plan to Contractor. Contractor Schedules the work.

ii) Overhead charges: These are the charges of business covers all expenditure necessary to carry out the work.
 i) Rent of office ii) Allowance for wear and tear of Buildings iii) Plant & machinery wages, iv) Lighting and Heating v) Advertising vi) Insurance vii) Postage and Telephone viii) Travelling Expenses

These charges cannot be charged against any of the contract, it must be spread all against jobs. (10-15%) cost can be added for Overall cost.

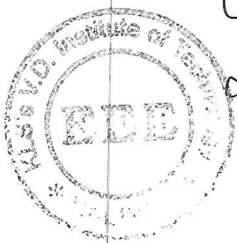


iii) Profit:

It is added to Gross Cost of Job in the form of percentage in order to determine selling price of job. This amount is purely on discretion of contractor and his decision is usually governed by following factors.

- i) Size of Job with him.
- ii) Degree of competition.
- iii) State of Turnover
- iv) His anxiety to secure a particular job and so on.

If Estimate is accurate, definite %age has been allowed for contingency and standing charges, then small %age of Profit is added.



3(a) Write the different types of wiring systems and explain them briefly — (08 m)

The network of wires connecting various accessories for distribution of electrical energy from supplies meter board to numerous electrical devices is known as wiring. Supplier service cable feeding an installation terminates called Service Cutout.

Point at which consumer wiring are connected into cut out is known as Consumer's terminals

Load Rules

No of Points ≤ 10

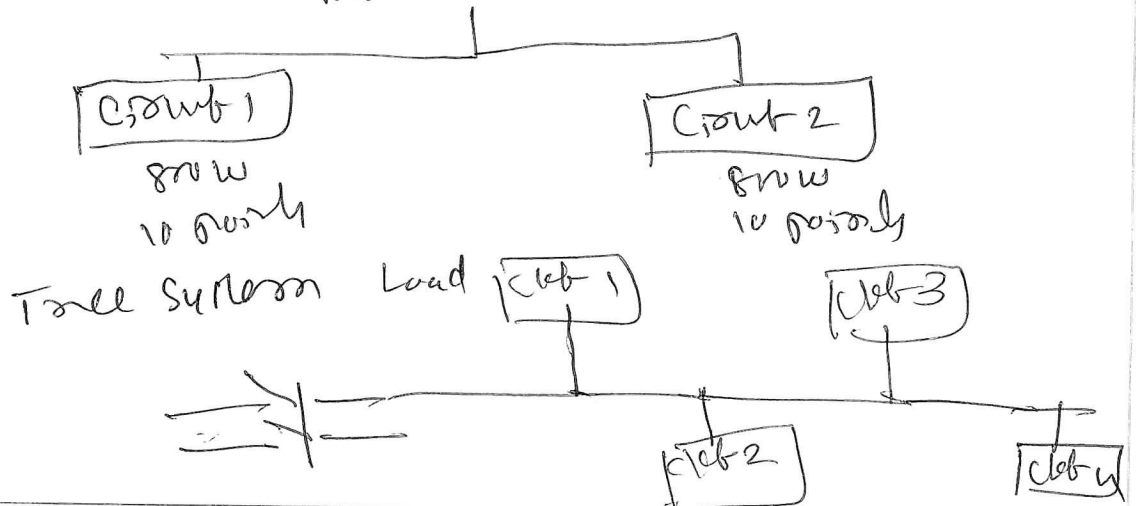
maximum load = 800 watts

more points of more loads

more than one circuit

Distribution Board system, Tree System

Distribution Board



Types of wiring

- 1) Cleat wiring , 2) wooden casing & capping
- 3) CTS wiring or VTRs wiring
- 4) Batten wiring
- 5) metal sheathed wiring or lead sheathed wiring
- 6) Conduit wiring

Conduit wiring - PVC or VTR cables run through metallic or PVC pipes providing good protection against mechanical injury. Conduits are buried inside walls or under gutters. Best suited for public building, industry and workshop.

Casing and capping - It is preferred for residential wiring. PVC pipes are used durability is good. It is seen from open eyes. (for connecting inside).

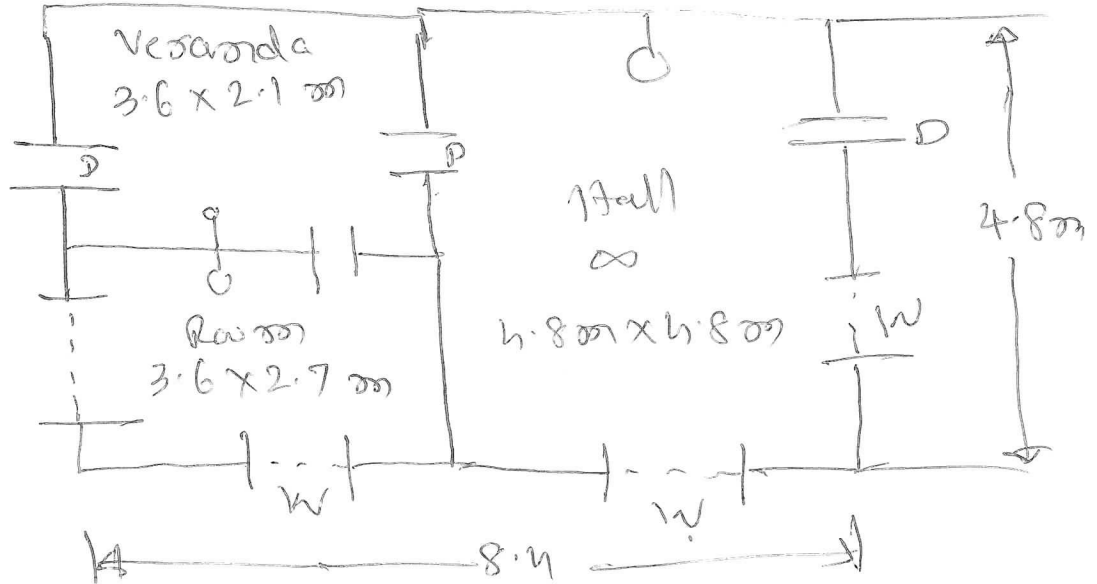
For External wiring single core, twin core, three core, two core with earth continuity conductors are used.

For large voltage levels PVC cables, XLPE cables are used.

Cleat and wooden casing are old methods, nowadays these are not used. TRS cables wiring cheaper.



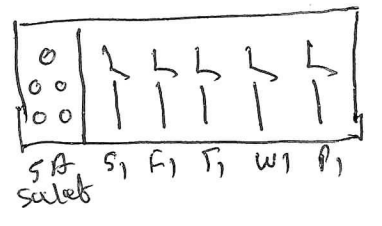
3 (b) Draw Electrical Circuit and estimate the quantity of materials required for wiring system. Choose in a house plan as shown in Fig (b). Assume height of ceiling as 3.6m and one plug point (60w) has to be provided in each room. All Dimension in m (12m)



Load Calculation

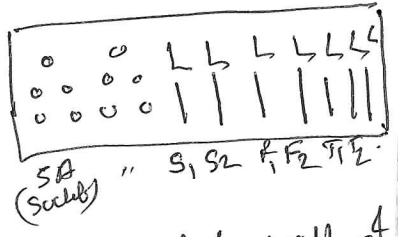
- Room →
- 1 Wall Plug (Sec) → 60 w
 - 1 Plug point → 60 w
 - 1 Fan → 100 w
 - 1 Tube light → 40 w
 - 1 socket → 60 w

Board in Room



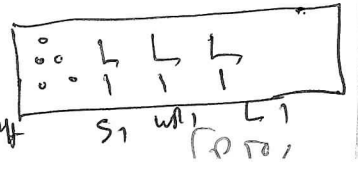
- Hall →
- 1 Wall Plug → 60 w
 - 1 Plug point → 60 w
 - 2 Fan → 200 w
 - 2 Tube light → 80 w
 - 1 socket → 60 w

Board in Hall



- Veranda →
- 1 Wall Plug → 60 w
 - 1 Lamp → 60 w
 - 1 socket → 60 w

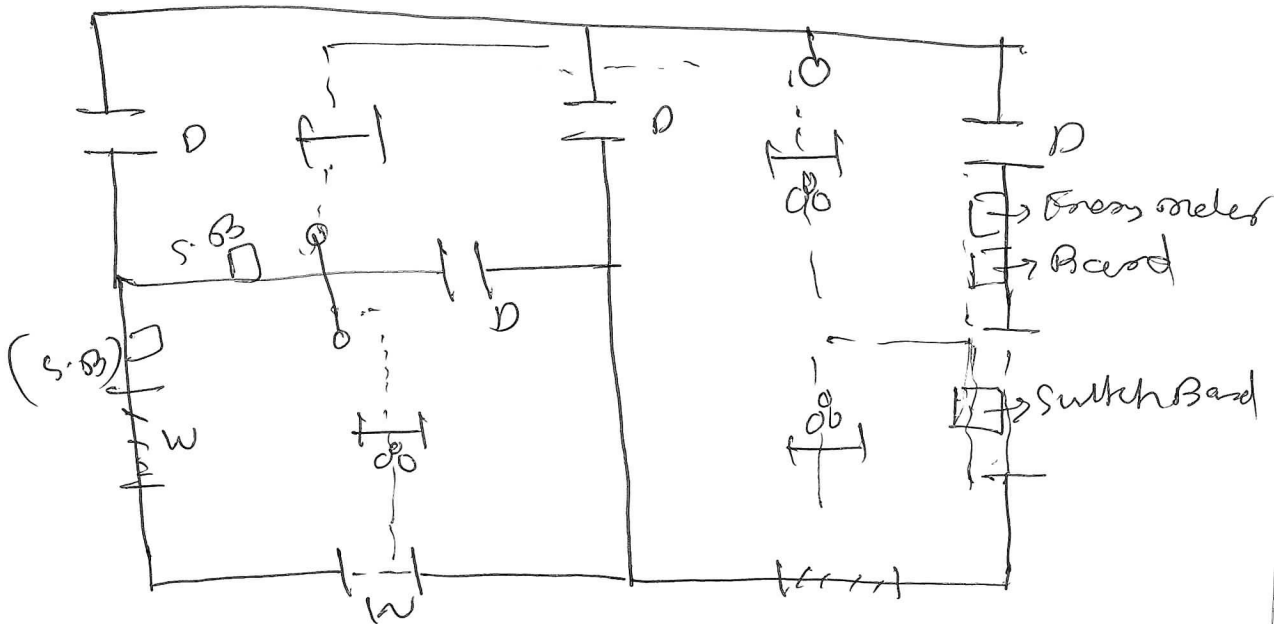
Board to wall of veranda



Total load = 320 + 460 + 180 = 960 w



Discussion for Length of Pipe



Length of pipe \Rightarrow height of Ceiling 3.6m
 2.5m (Horizontal) + 4.4m (Horizontal) + 2.6 (vertical
 for Board + (2.4 + 1) (Horizontal) + 2 (vertical)
 + 4m (Horizontal) + (2.6m (vertical)
 \Rightarrow 22m + 5m Extra = 27m

So for purchase, Length of Pipe $\hat{=}$ 30m
 Length of Wire = 2 x Length of Pipe
 $= 30m \times 2 = 60m$

No of Ceiling Rose = 3

No of Regulators = 3

No of Switch Boards = 3 - (500W x 500W each)

Total Load = 960 W

$$I = 960 / 230V = 4.17 A$$

Factor of safety = 2

$$I_{load} = 4.17 \times 2 = 8.34 A$$

MCB Required = main switch = 16A

List of Material

Total No of Fan = 3

" of Socket = 4

" of Tube light = 4

" wall plug \Rightarrow 3

14 SWG Cu wire
 is selected for
 main switch.



4 (a) Write general rules considered for wiring system. (08m)

- 1) Protection for every installation near point of entry of supply & cable by 2-linked main switch and fuse comb.
- 2) Conductor should carry Load Current safely.
Factor of safety $\geq 1.5, 2, 2.5, 3.0$
- 3) Sub-circuit is connected in Distribution Fuse-Board.
- 4) Every phase protected by fuse of suitable rating.
- 5) Switch Board installed from ground floor at least 1.25 m height or more than that.
- 6) Plugs & Sockets are of 3-pin Type
- 7) All incandescent lamps hung at 2.5 m above the floor.
- 8) No fuse or switch is provided in earthed conductors.
- 9) Lighting load and power load are kept separately.
- 10) 15 A socket is provided for domestic purpose.
- 11) In case of 3 ϕ -4 wire, Load is equally Distributed.



4 (b) With reference to internal electrification of building, explain how to determine the following

- i) Total load ii) No of Sub-Circuits
- iii) Rating of main switch and Distribution Board — (06m)

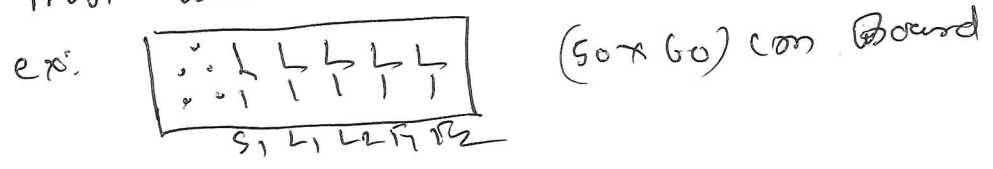
i) Total Load \Rightarrow For home 1kw, 2kw, 3kw installed Load Capacity

Total Load of home = (Room, + Porch + Hall + Kitchen + Bathroom + veranda) Load

Load of Commercial Building $>$, 1kw
30 supply needed.

ii) No of Sub Circuits

If load exceeds $>$ 800 watty
or no of points $>$, 10
then one sub-circuit will be added.

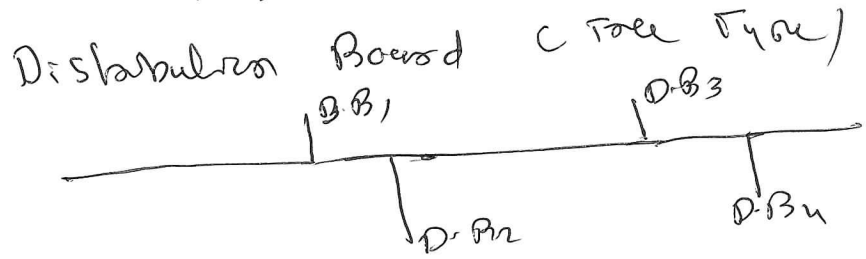


iii) Rating of main switch \Rightarrow 16A, 32A
64A, TPSE switch.

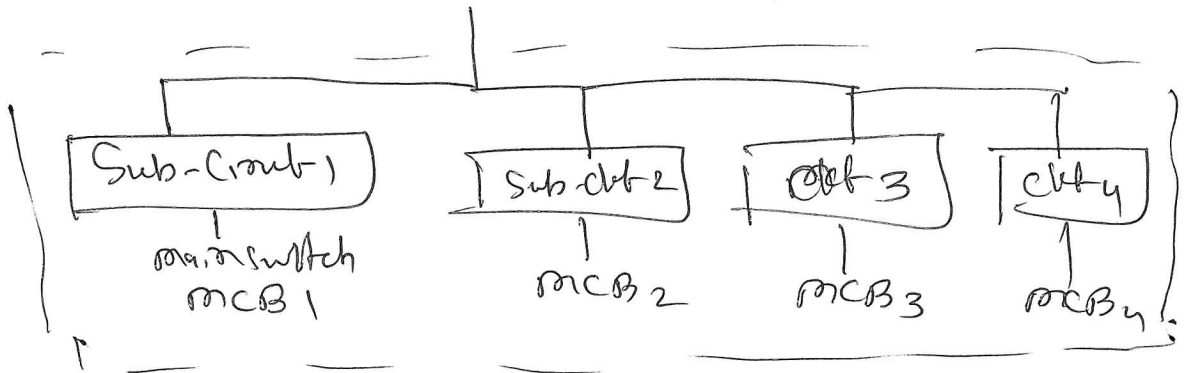
$$I_{load} = \frac{\text{Total load}}{230V} \text{ for } 1\phi$$

$$I_{load} = \frac{\text{Total load}}{1.5 \times V_{ph}} \text{ for } 3\phi$$

Depending upon Rules of Safety Rule of main switch is selected



Distribution Board



Distribution Board carry input current and load is distributed through Sub-Circuit Boards provided with MCBs Bus-Bar is included.

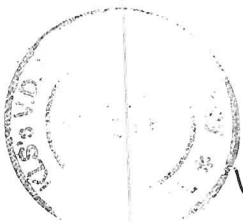


4(c) Explain 3 essential points which must be considered while determining the size of conductors for internal wiring for a given circuit. (06m)

Solution:

- i) Type of wiring \rightarrow Casing & Casing or Conduit type of wiring.
- ii) Load Calculation and current value.

$$I_{\text{required}} = \text{Factor of safety} \times I_{\text{load}}$$
 Usual size of conductor 5A, 10A, 16A, 32A, 40mm², 60mm², 100mm², 160mm²
 size of Copper conductor.
- iii) Insulation level of wire.
- iv) Conductor size of Commercial Building is still high.
- v) As size of conductor is taken higher, cost increases, so this factor is also main.
- vi) Current density is also considered.

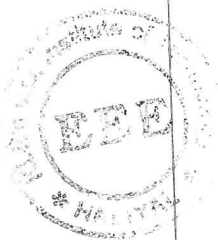


Module - 3

5(a) Write important considerations regarding motor installation wiring - (8 marks)

- 1) All equipment used shall be of iron clad construction and wiring shall be with armoured cable or conduit type.
- 2) Lapping of conductors and use of joints shall not be done.
- 3) Length of flexible conduit shall not exceed 1.25 meters.
- 4) Every motor, regardless of size shall be provided with a switch fuse placed near it.
- 5) Conduit laid and covered in trenches.
- 6) If group of n motors are considered current Rating of main switch = $I_{st} [I_{H} + I_{F.L.2} + I_{F.L.3} + I_{F.L.4}]$
- 7) Conductor used for power wiring are 2.5 mm^2 (Cu) and 1.25 mm^2 (Al) cables.
- 8) Fuse Rating depends on standby current of motor. But current rating of cable may be based on normal full load current.
- 9) Conduit is continuous and connected in sequence of order.
- 10) Two separate earth conductors are to be provided and connected earthing.

$$\text{Input Current} = \frac{\text{Rated hp} \times 735}{\eta \times v \times \cos \phi}$$



5(b) What do you understand by Service line? Write down various methods of installation of service lines — (04 marks)

Service line can be defined as

- 1) A L.T (Low Tension) line which is used to provide electricity from an electric pole up to energy meter installed on premises is known as service line.

Types of Service Connectors

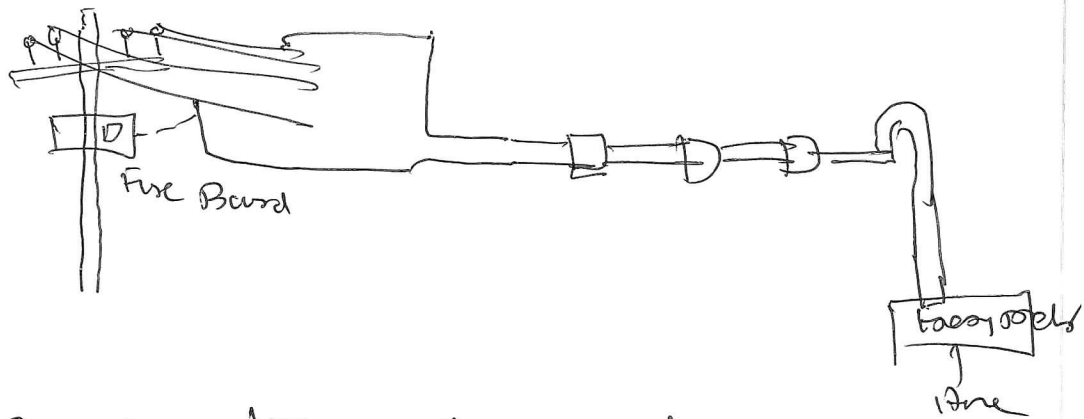
- 1) Overhead Service Connector

1φ → 230V 50Hz Supply Domestic Load

3φ → 380-440V → Building & Industrial

Conductor used AAC, CRN Aluminium Conductors 8SWG, 10SWG Cu Conductors

To connector 12kw load → 6SWG Cables



- 2) Service line with angle iron Bracket to double storey Building.
- 3) weatherproof Cable Connection

- 4) Under Ground Cable Connection

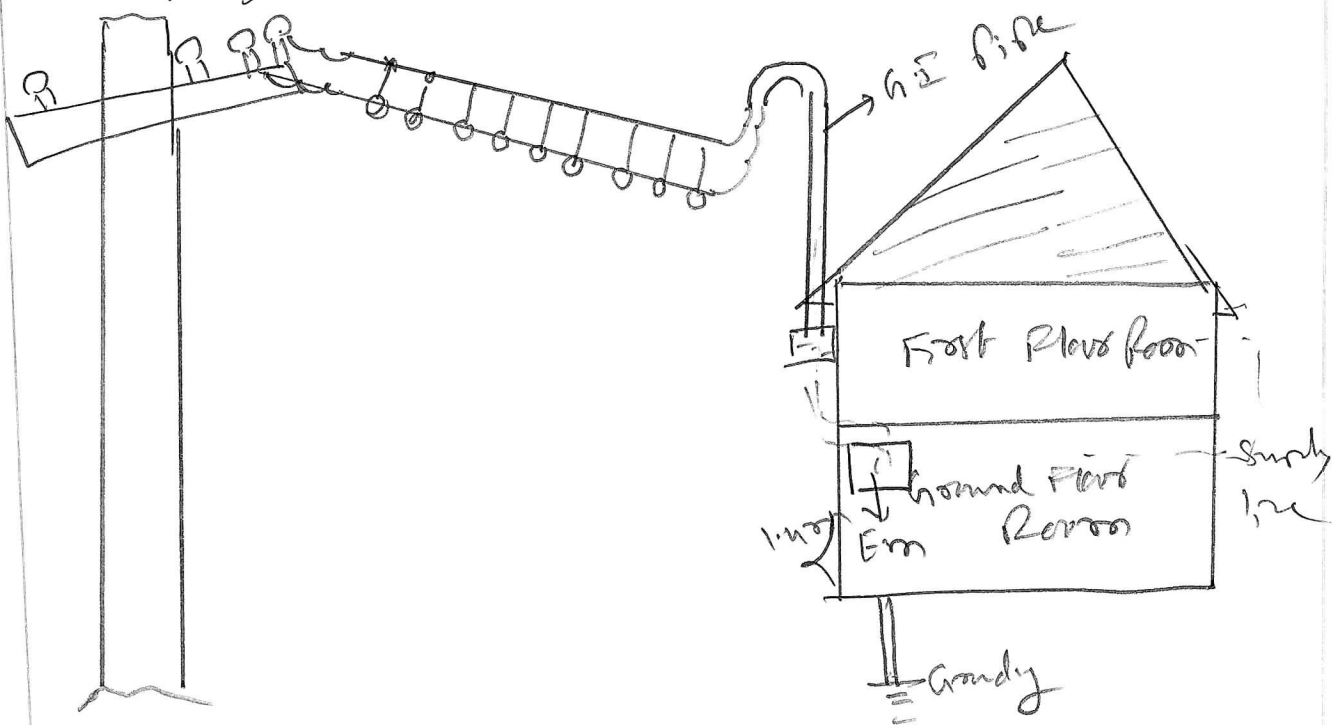
If load is Greater than 25kw Single insulated Cable is used along with Pipe.



5(c) With simple sketches, explain any two methods of installation of overhead service lines based on prevailing condition of building - (08m)

1) Overhead Connection for High Roof Building or multi-storey Building.

Diagram:



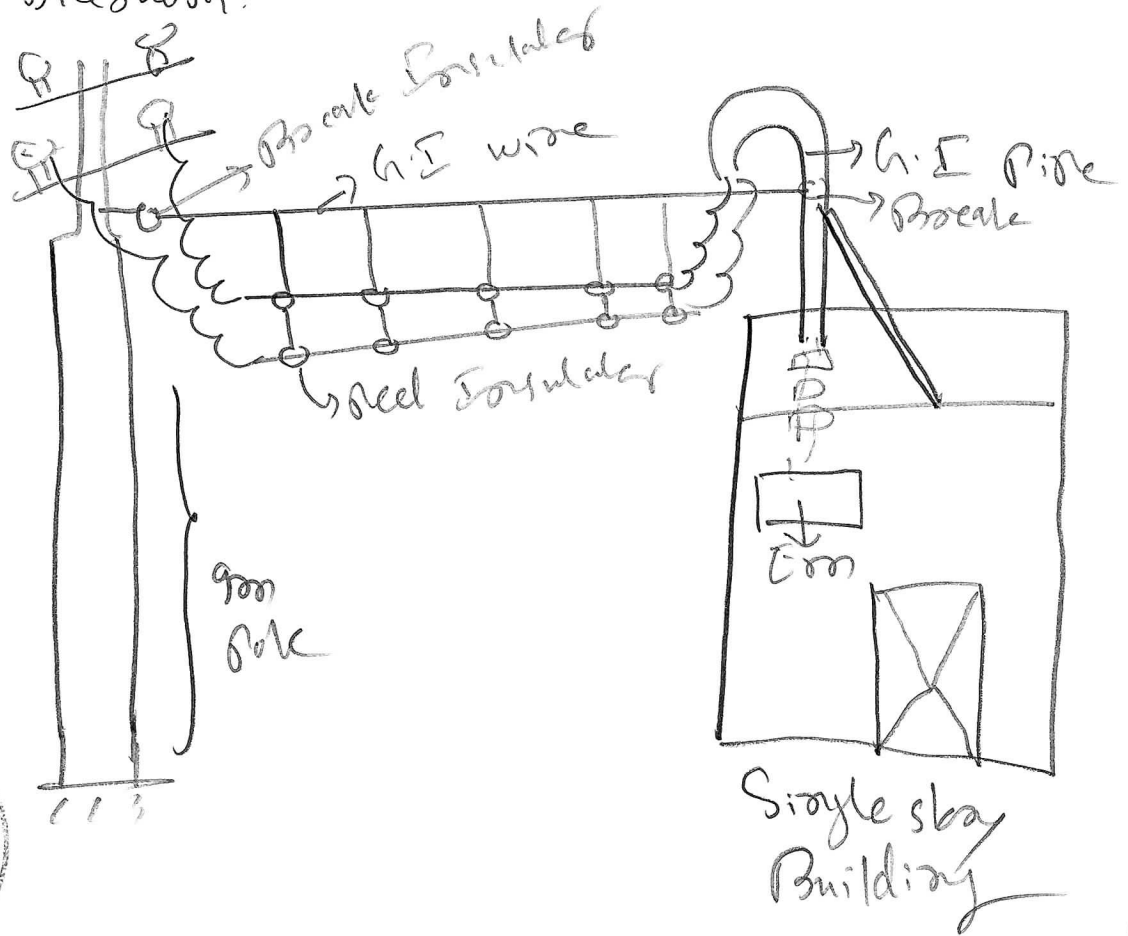
Explanation:

- * Service Bracket fixed on to wall at suitable height.
- * On this Bracket schackle style or pin insulators are used.
- * For 3 ϕ , \rightarrow 4 wires are needed.
- * Earth wire is joined with angle iron through eye bolt.
- * Cable is passed in Galvanized Pipe and carried in service Board.



2) For Low Roof or Single sloped Building

Diagram:



Explanation:

- * Service Bracket is not fitted as well.
- * Roof Pole Connection or G.I. pipe Connection case done.
- * Height of Roof pole should not exceed 3 meters otherwise Tensile strength of wire increase.
- * Strong support is provided.
- + One end of PVC pipe is connected to service line, its other end is connected up to service Board.

Module-3

6(a) Explain the determination of input power size of conductors, distribution board main switch, starter size of cable and rating of fuse. (1000)

$$\text{Input current of motor} = \frac{\text{Rated bHP} \times 735.5}{\eta \times V \times 1.9 \phi}$$

$$\eta_{\text{m}} = \frac{\text{Output}}{\text{input}}$$

$$\text{For } 3 \phi \text{ Input current } I_L = \frac{\text{Rated bHP} \times 735.5}{\sqrt{3} \times \eta_{\text{m}} \times V_L \times 1.9 \phi}$$

Rating of Fuse $\leq 2 \times$ Rating of Cable.

$$I_{\text{st}} = \text{Starter Current} = 1.5 \times I_{F.L}$$

$$1 \text{ H.P.} = 735.5 \text{ W}$$

$$\text{Input in watts} = \frac{\text{Output in watts}}{\text{order efficiency}}$$

Size of Conductors or Rating of Cable is selected based on full load current of motor.

$$\text{For } I_{F.L} = 15 \text{ A} \rightarrow 6 \text{ mm}^2, 1100 \text{ V}$$

MVC approved cable is used.

$$I_{F.L} \Rightarrow 38 \text{ A} \Rightarrow 25 \text{ mm}^2, 1100 \text{ V.}$$

Grade (SHA) Capacity cable is

used.

Main Switch

\Rightarrow For Group of n motors

$$I_{\text{main switch}} = \left(I_{\text{st}} \text{ of highest Rating} + I_{F.L2} + I_{F.L3} + I_{F.L4} \right)$$

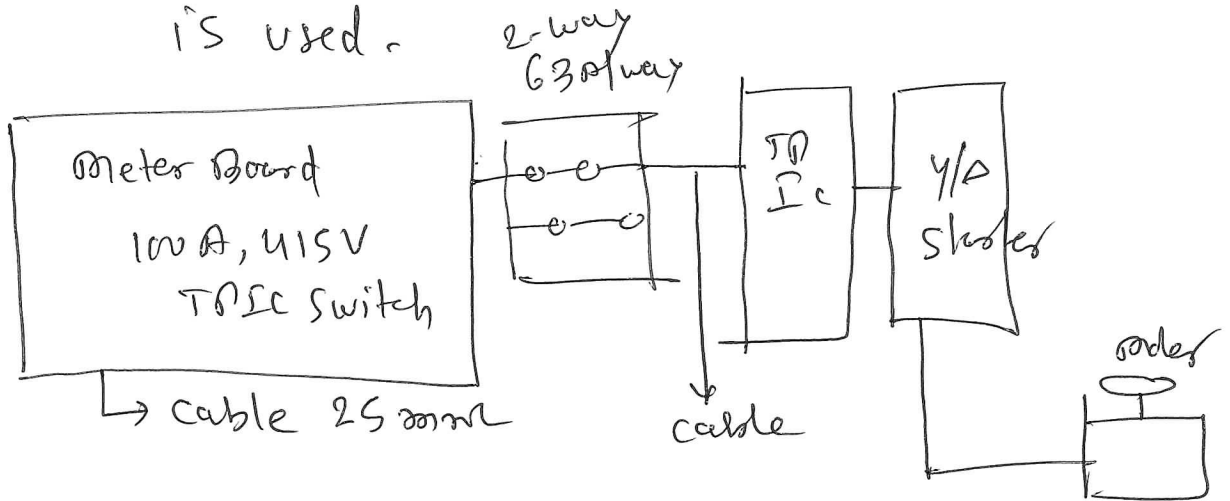
For $60 \text{ A} \Rightarrow 100 \text{ A, 415V Grade}$

TRIC Switch is used.



Distribution Board

→ If it is USA, then
 2-way 415V, 630A way ICPB
 is used.



Size of Ith Conduit from main
 D.B. to Conduit board as required
 Ith of motor (15 HP sample)
 25 mm² is used. → 3 Core cable.
 Through Y/D Starter - for motor
 connection, Flexible Conduit is
 used.

Length of 3 Core cable

1) length from meter Board to
 main Board.

2) length from main Board
 to motor Switch

3) length from motor Switch
 to motor Starter

4) 2 lengths from motor Starter
 to terminal of motor

Length of Earth wire

= 2 { length of Conduit + Flexible
 Conduit length }



(23)

Q (b) A 10 H.P., 415V, 3 ϕ , 50Hz, Induction motor, is to be installed in a workshop, the plan of which is shown in Fig Q (b). Draw layout of wiring and estimate the quantity of material required. Assume motor efficiency as 85% and power factor 0.8 lagging.

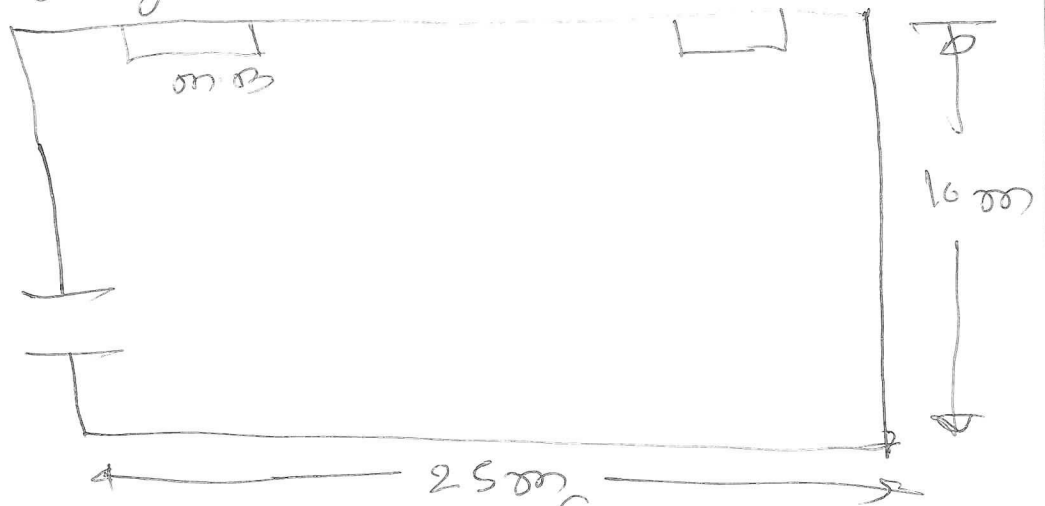


Fig Q (b)

- 1) Main switch, motor switch and starter shall be mounted at a height of 1.5 meters from ground level.
- 2) Two earth wires will be run side by side for earthing motor, starter and switches.

$$IFL = \frac{10 \text{ H.P.} \times 735.5}{\sqrt{3} \times 415 \times 0.8 \times 0.85} = 15.22 \text{ A}$$

$$E_{\text{wt}} = 1.5 \times 15.22 = 22.83 \text{ Ampm}$$

(10)

So 3 Core PVC 1100 V Grade, 10 mm² aluminium Conductor is used

Main Switch \Rightarrow 32 A, 415 V TPE switch

Distance between Meter and Distribution Board is 0.3 meters. From main Board distance to meter switch is 22.5 m. From meter switch to Meter Two 3 Core cables covered by 14G Conduit of size 31 mm. Flexible Conduit of 25 mm is used.

Length of 25 mm 14G rigid Conduit including 10% wastage = $0.3 + 22.5 + 2.3 = 25$ meter

Length of 31 mm 14G Conduit

= 1.5 meter from (Ground level)
 + 0.2 meter C below ground,
 + 1 + 0.4 \rightarrow up to meter
 Distribution + 10% wastage
 \Rightarrow 3.5 m

Length of 3 Core, 1100 V, 1/2.8 mm aluminium conductor (PVC)
 (6 mm²) \Rightarrow 35 meters

For 10 H.P. Motor, 8 SWG GI wire is used for Earth wire.

Length of Earth wire

= 2 x length of Conduit including length of Flexible Conduit
 $2 \times (25 + 3.5 + 0.15 + 1)$
 = 60 meters



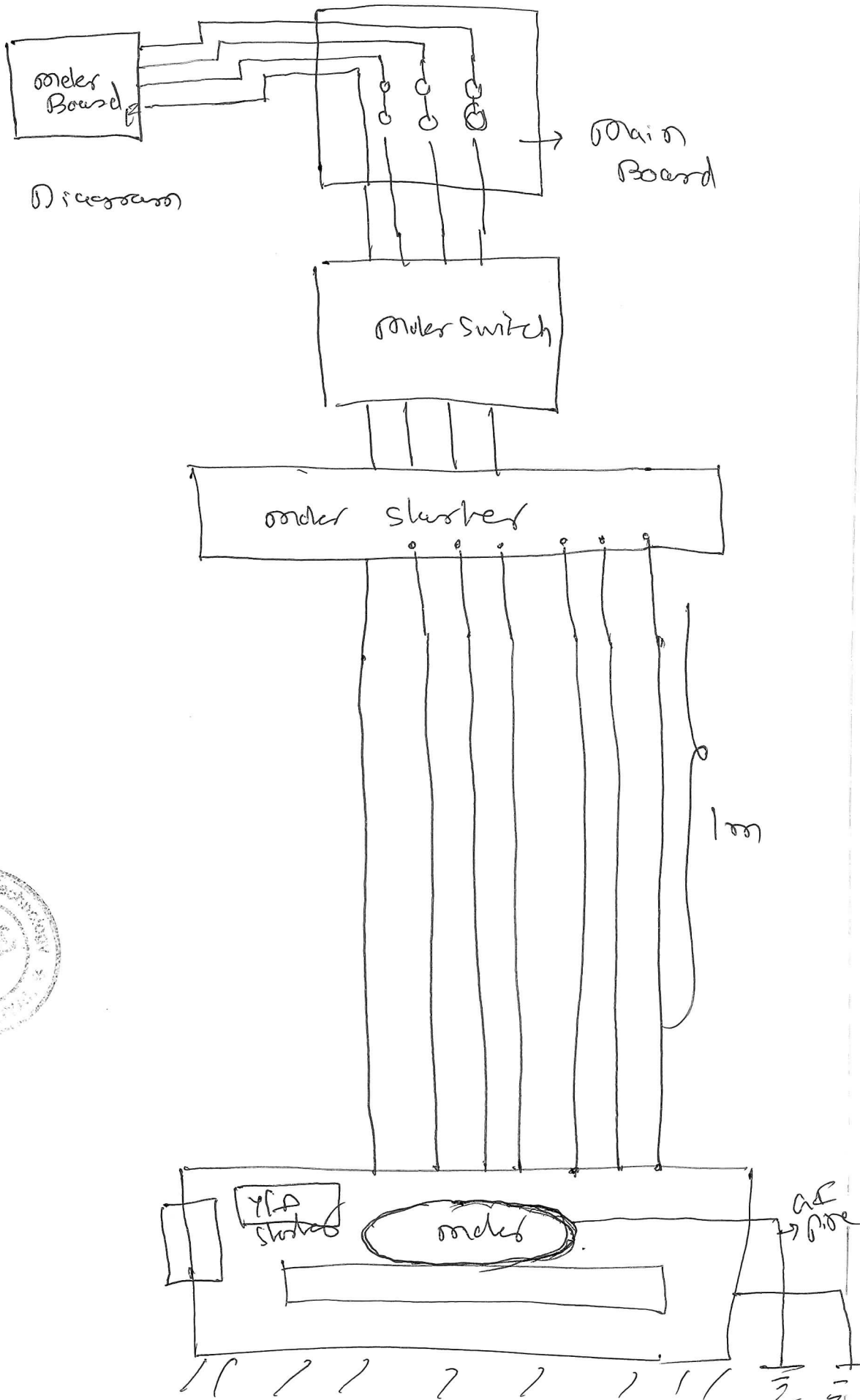
(24+1)

6 b → Continued

- | List of Materials | Quantity |
|--|----------|
| 1) 32A, 115V TOIC rewirable type switch fuse unit
near energy meter and board
near meter | → 2 |
| 2) IC Board
25 cm x 30 cm - 1
45 cm x 60 cm - 1 | |
| 3) Heavy Gauge (A/G) 16 SWG
31 mm → 3.5
25 mm → 2.5 | |
| 4) Flexible Conduit
31 mm → 1
25 mm → 0.25 | |
| 5) 3 Core, 1100 V, 10 mm ² Grade Aluminium Conductors PVC Cable - 35 | |
| 6) Conduit bendy
i) 31 mm → 2
ii) 25 mm → 6 | |
| 7) Conduit Saddles → 2 + 2.5
(31 mm + 25 mm) | |
| 8) Flexible pipe Coupling
+ Locking (31 mm + 25 mm) → 4 | |
| 9) Teak wood Gutty → 200 | |
| 10) 8 SWG GI wire → 6 kg | |
| 11) GI pipe 19 mm → 5 m order | |
| 12) GI plate
(600 mm x 600 mm) → 2 | |



Gb - Combined (24+2)



Module - 4

7(a) With neat diagrams, explain different types of Con Array - (6m)

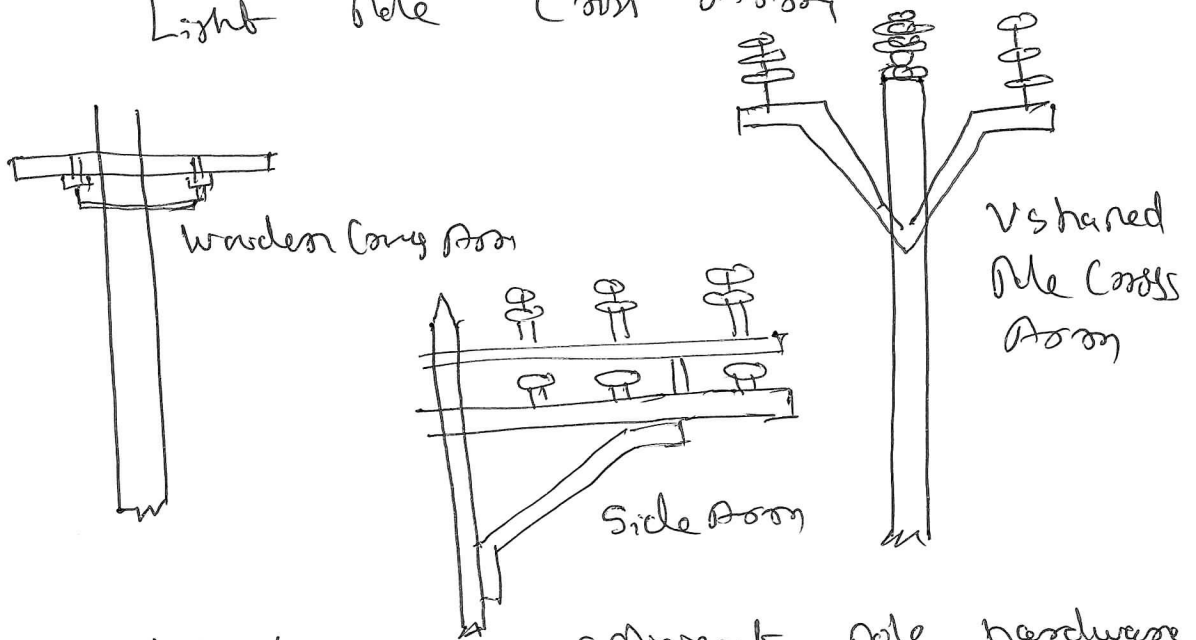
Power Pole Con Array

Line Con Array

Side Array

Telephone pole Con Array

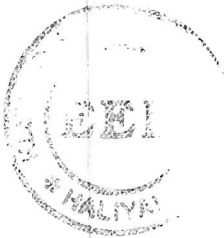
Light Pole Con Array



- * It is strong and sufficient pole hardware fitting used for secondary conductor.
- * Con Array is made of galvanized steel. This protects from rust, corrosion.
- * Dimension are measured in terms of Top face, length and side depth.
- * ex: 6-35 mm height, 76 mm breadth, 180-30 mm length.
- * Light Pole Con Array used for street light or traffic lights.
- * Con Array supports isolating link, fuse, work as link between cable of tower and insulator.

7(b) List out various points to be considered at time of erection of overhead lines

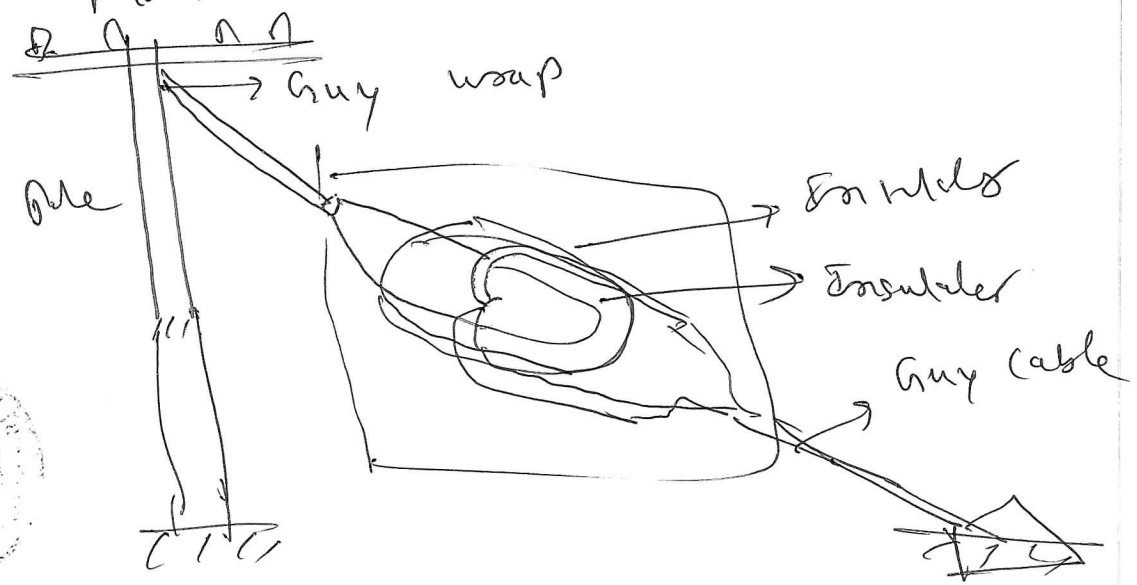
- (8m)
- 1) Voltage levels
11kV, 33kV, 66kV, 110kV, 220kV, 400kV
 - 2) Type and Size of Conductors
132kV of ACSR - 7 strands of steel, 3mm
30 strands of Al, 3mm
400kV (ACSR) - 7 + 54 strands, 3.53mm
 - 3) Efficiency of Transmission line
increases with Supply Voltage and π -f
 - 4) Corona loss: It is affected by smoothness of conductors, distance between conductors. more loss for rough surface
 - 5) Power Flow Capacity and stability
It can be increased by shunt capacitors series Reactor $P = \frac{E \times V}{(X_L - X_C)} \times \sin \phi$
 - 6) Requirement of Cross-arms
Additional conductors needed, Supply structure for deviation of line.
 - 7) Horizontal position of suitable supporting structure
 - 8) Types of Erection Tools, Rental, manual
- a) Build-up method of erection - 132kV, 220kV
 - b) Section method of erection - Assembly on ground
 - c) Ground assembly of erection
 - d) Helicopter method - Raising core section over another.



7(c) Explain following i) Guys and Stays
 ii) Lightning Arrestor ii,) Bird Guard
 (- Guy)

i) Guys and stay
 - Both are used to 'stay' the power poles and tower structures. Stay wire has different pattern of stranding, tension and design. Coating, result, level of coating Adherence.

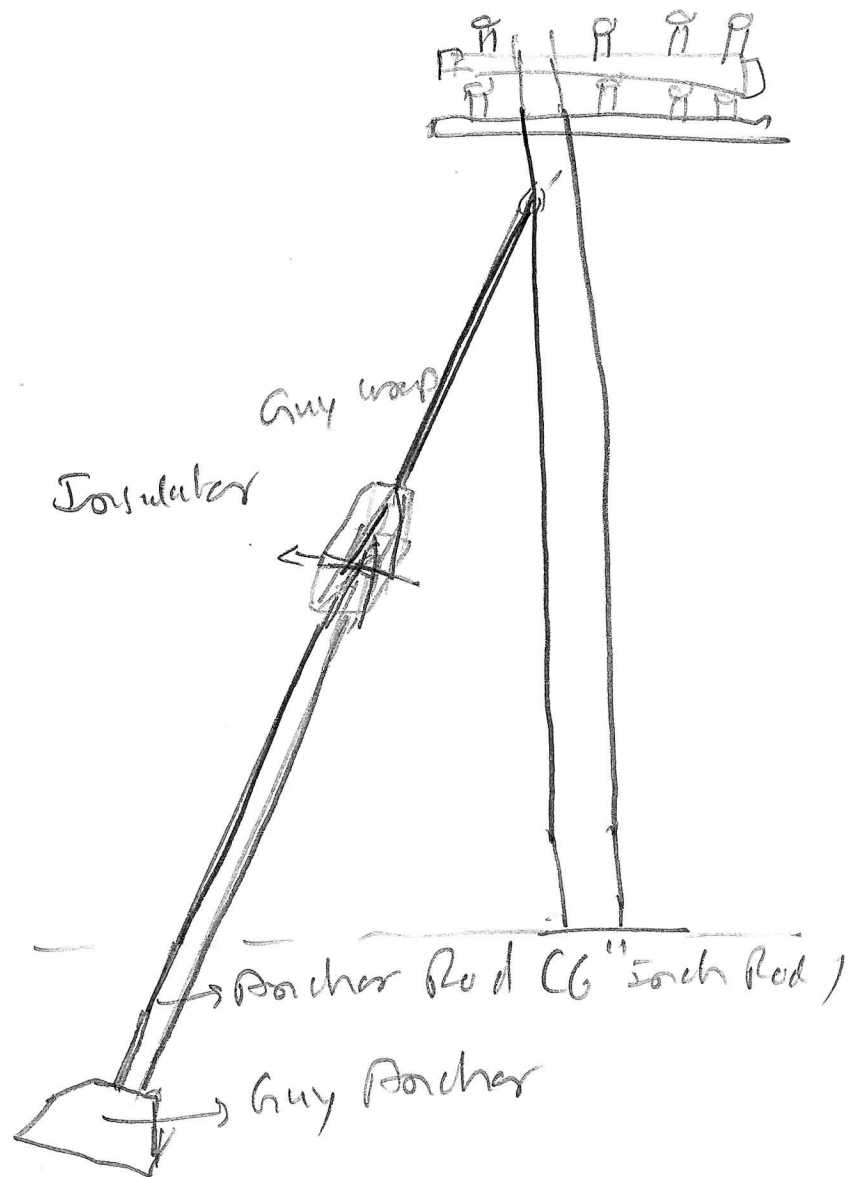
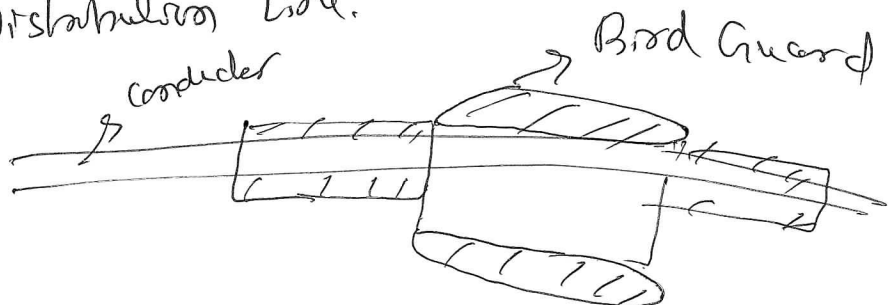
Guy wire support power pole, for wind and storms. No current flows through them.



1) Guy wire can be used by Dead End Anchor. Stay Insulation have higher Compressive strength.

iii) Guard - (Bird Guard)

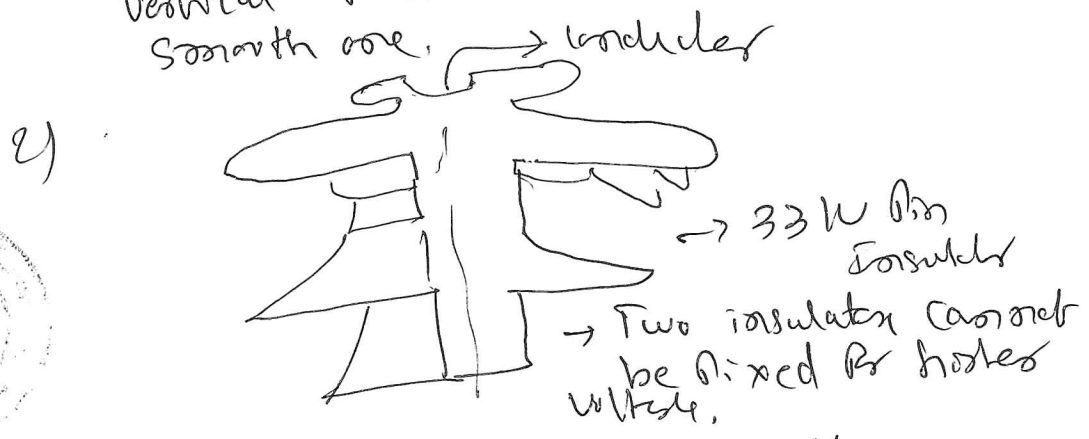
Bird Guard serves purpose of savings from electrocution and fire. These are provided in both transmission line as well as Distribution line.



8 (a) Write the different types of insulators explain any one of them (6m)

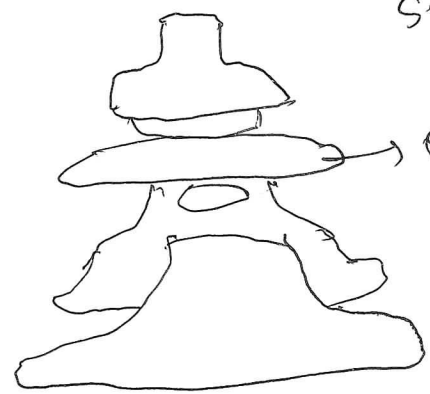
- 1) Pin Insulator ≤ 33 kV - Distribution system
- 2) Post Insulators 11 kV TO 265 kV Substation
- 3) Suspension Insulator > 11 kV Transmission
- 4) Shackle " ≤ 33 kV Distribution

1) Pin insulator \rightarrow Porcelain Vertical path increased for leakage path smooth one.



2) Post Insulators \rightarrow For higher voltage It uses two or more insulators

3) Suspension Insulator

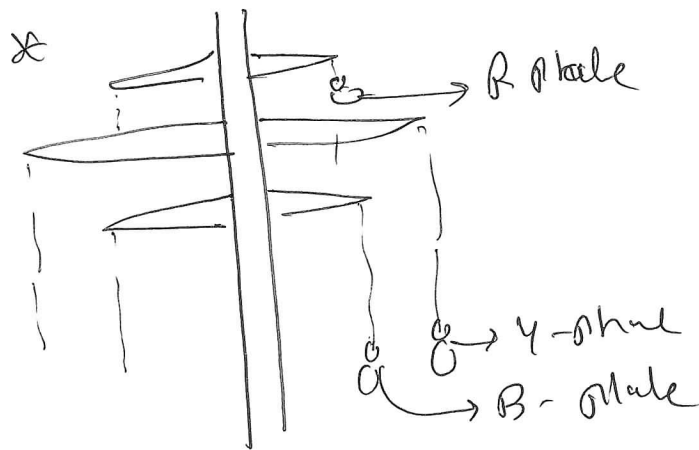


Suspension Insulation is used for high voltage and where line deviations are available. and Dead end Bay.



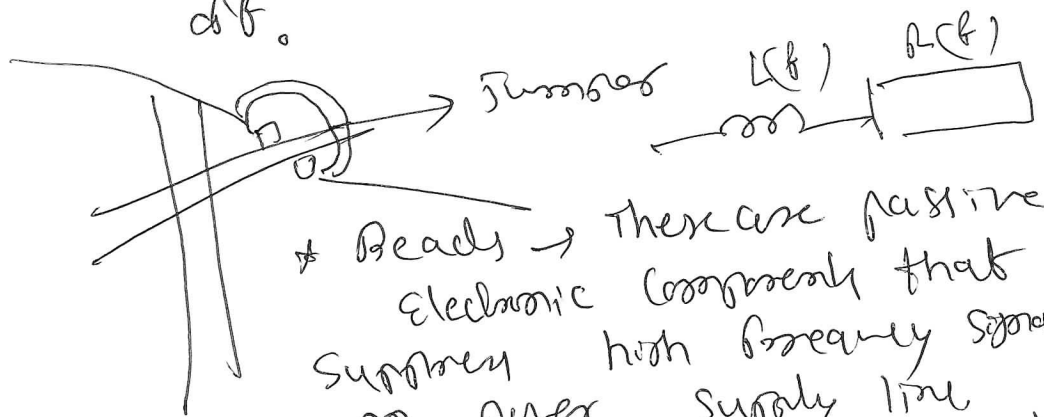
8(b) Explain the function of following
 relevance do of Transmission line
 i) Phase Plate ii) Beads of Jumper
 - 600

- 1) Function of Phase Plate
 * used for identification of phase of line.
 * excellent tensile strength.



2) Function of Beads and Jumper

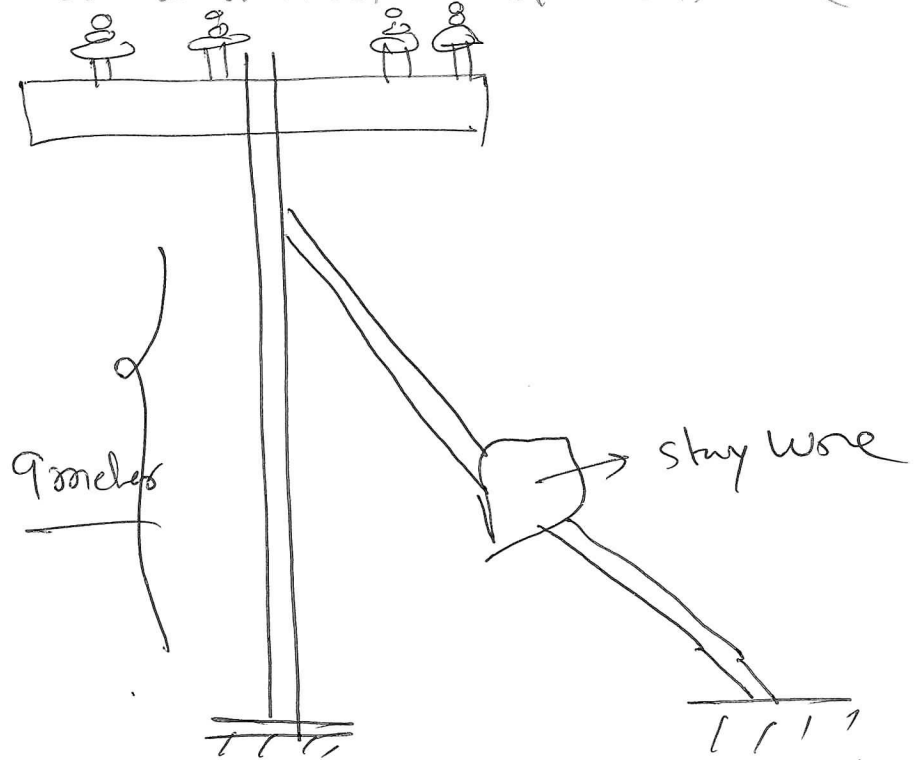
* Function of Jumper is to make line or conductor connection available or during emergency work Jumper can be removed and line is cut off.



* Beads → These are passive electronic components that support high frequency signals on power supply line
 Ferrite material with hollow cylinders
 $\mu_r = 2000$



8(c) A pole for overhead 11 kV, 3φ, 50 Hz line is to be earthed and a stay is to be provided. Prepare list of materials required. (08m)



* Earthing shall be with 2.5m long and 25mm Internal Diameter GI pipe. 00S Class should be used.

* 2.5m Diameter GI pipe
19mm and 12mm GI pipe
6 SWH or 8 SWH GI wire
for earthing purpose.

* Charcoal 10kg, Cement Concrete
0.15m² area,

* 12mm Diameter GI bolts 2
nos stay Rod → 16mm Diameter
2.4m long

nos stay 7/8 SWH GI wire
nos Archers Male 45cm x 65cm (1)

Module - 5

9(a) Describe briefly requirements that must be available in Substation (any)

Example 1 → 11 kV Substation → 11 kV / 415 V
 250 kVA Transformers
 D.O.L Unit
 Secondary Circuit Breaker → To OFF of Load and Protection.

Substation Yard: Foundation for Bed, Poles Neutral & Earthing Conductors, Name Plate, Power Plate, Phase plate or Bed Plate, Energy Meter, G.O.S Switch at secondary of Transformers do have seen or witnessed emergency work to carry.

Example 2: 220 kV / 110 kV / 66 kV / 11 kV Substation

Requirements examples.
 Transformers 100 MVA → Two arranged. 11 kV conductors

Incoming Bus Bars, 2 → Bus I, Bus II (220 kV), Lightning arrester, Circuit Breaker Protection, Suitable yard for Incoming conductors. Isolating Switch / C.B for Bus I & 2. C.T & P.T

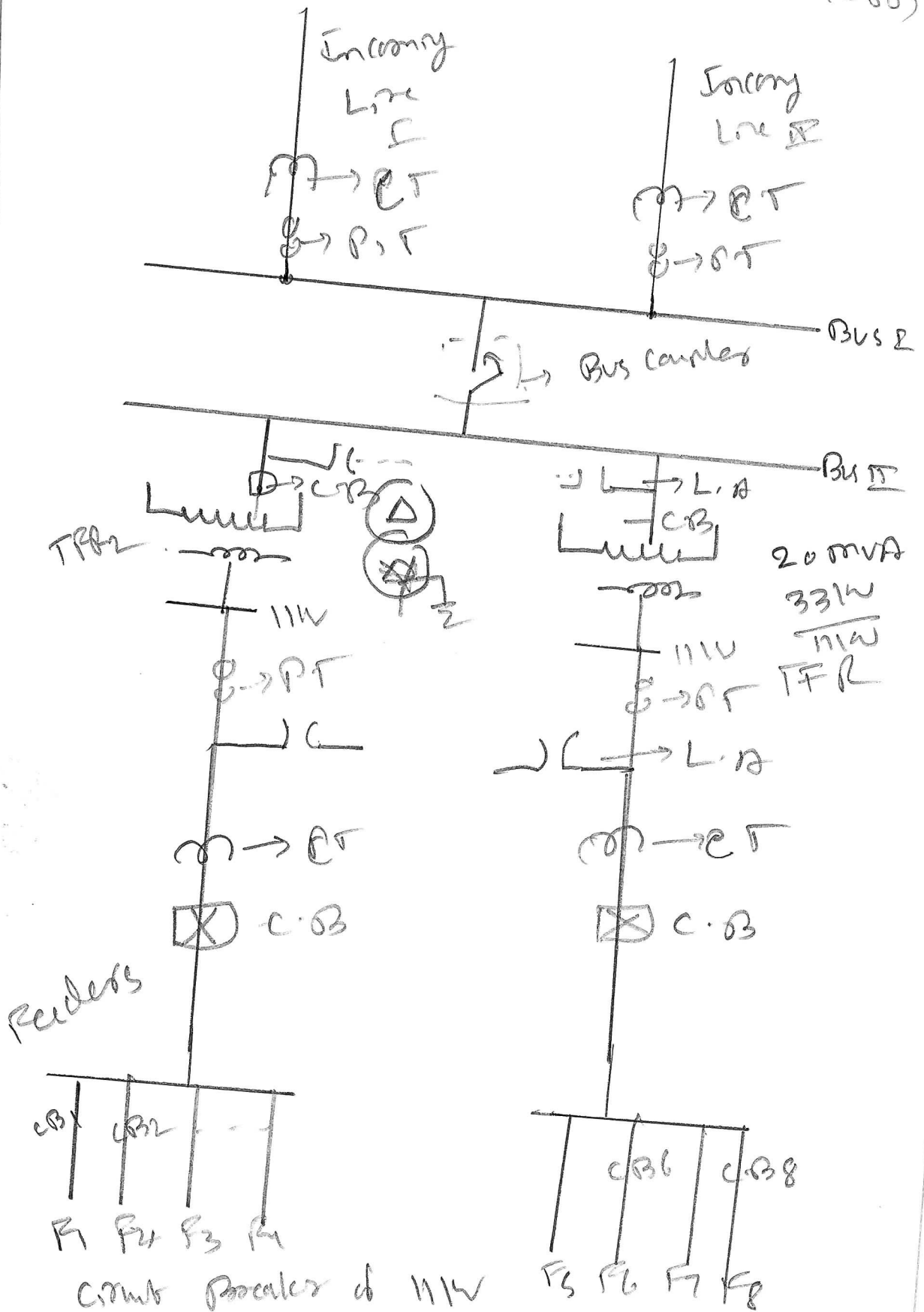
Outgoing Bus bar → Bus I, Bus II
 110 kV → Outgoing line, 66 kV - Outgoing line
 200 MVA → Transformers - 2 in number
 Circuit Breaker, C.T & P.T. Suitable Area for Outgoing lines. G.O.S switched C.B.

66/11 kV, 200 MVA Transformers
 Circuit Breaker or Feeder for 11 kV Incoming line, Capacitor Bank for Incoming Voltage
 Battery Charging Room, Reducing / Torque Chamber Room,
 Parente Control Room, Antenna for Load Distribution Center Communication.
 Control Room with Alarm Indication, Relay Room,



(33)

9(b) Draw the key diagram of typical 33kV Substation. — 1000



33kV - Incoming Line or higher voltage level
 200MVA - 33kV/11kV - T.F.R. - 2 - Load phase
 C, T, P, T → measurement purpose. Relay on Busbar

Module - 5

1 a(a) Explain function of following in a Substation

- i) Isolator ii) Earthing Switch Substation
iii) Batteries - 06m

i) Isolator → Isolators are used for isolating connected Bus line / Incoming or outgoing, do second Bus & connection. or keeping it isolated for Maintenance work. Gas operated switch (G.O.S) is provided for isolating the line. Suitable earthing is made with Earth Rod.

ii) Earthing Switch Substation. Incoming line and outgoing lines are connected with proper protection Earth Mat is used for Substation. Plate earthing is used. Earthing is also provided for lightning arrester, Transformers, Earth Fault Relay - EFR are provided in 11kV Breaker. For Reclosers protection. Over Current and Over Voltage protection are provided.

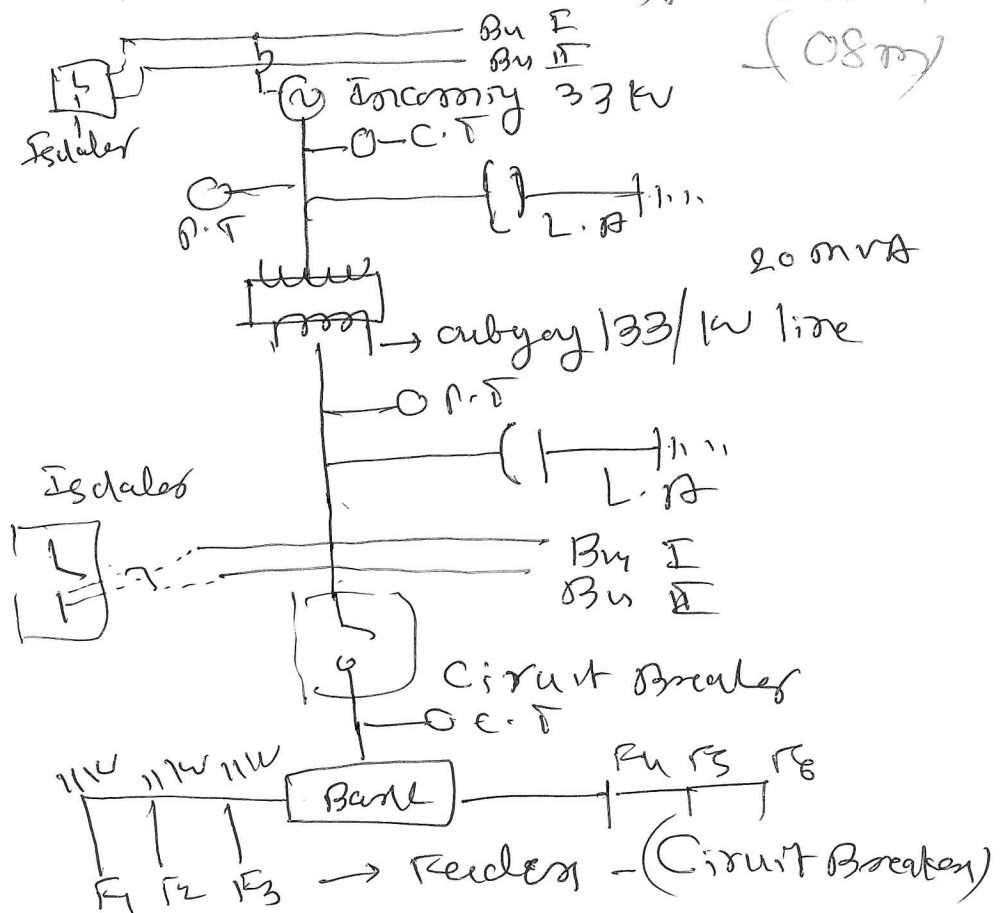
iii) Batteries → Battery System is located at Sub-station, Tripping Command, Alarm, Relay operation, uses D.C Supply. Continuous D.C Supply is needed for every Tripping indication. Each cell is to be monitored daily for required voltage. One separate Room is provided for Battery maintenance.



10 (b) Explanation purpose of Substation Earthing (06/07/2017)

- * Cost of Transformers, Lightning Arresters, Circuit Breakers Cost is also high.
- * Increasing live potential and Outgoing live potential is needed.
- * Conduit based cables are costly. So proper potential and Earthing is necessary.
- * There should not be any flow of current in neutral. So Core is needed.
- * Earth mat is provided. Earth electrodes are used for maintenance work.
- * Line Rectors are provided against earth fault, over voltage and over current.
- * Earthing Services are provided, safety to Substation.
- * If proper earthing is not provided, lightning arrester fail and Circuit Breaker may not trip leading to hazardous condition.

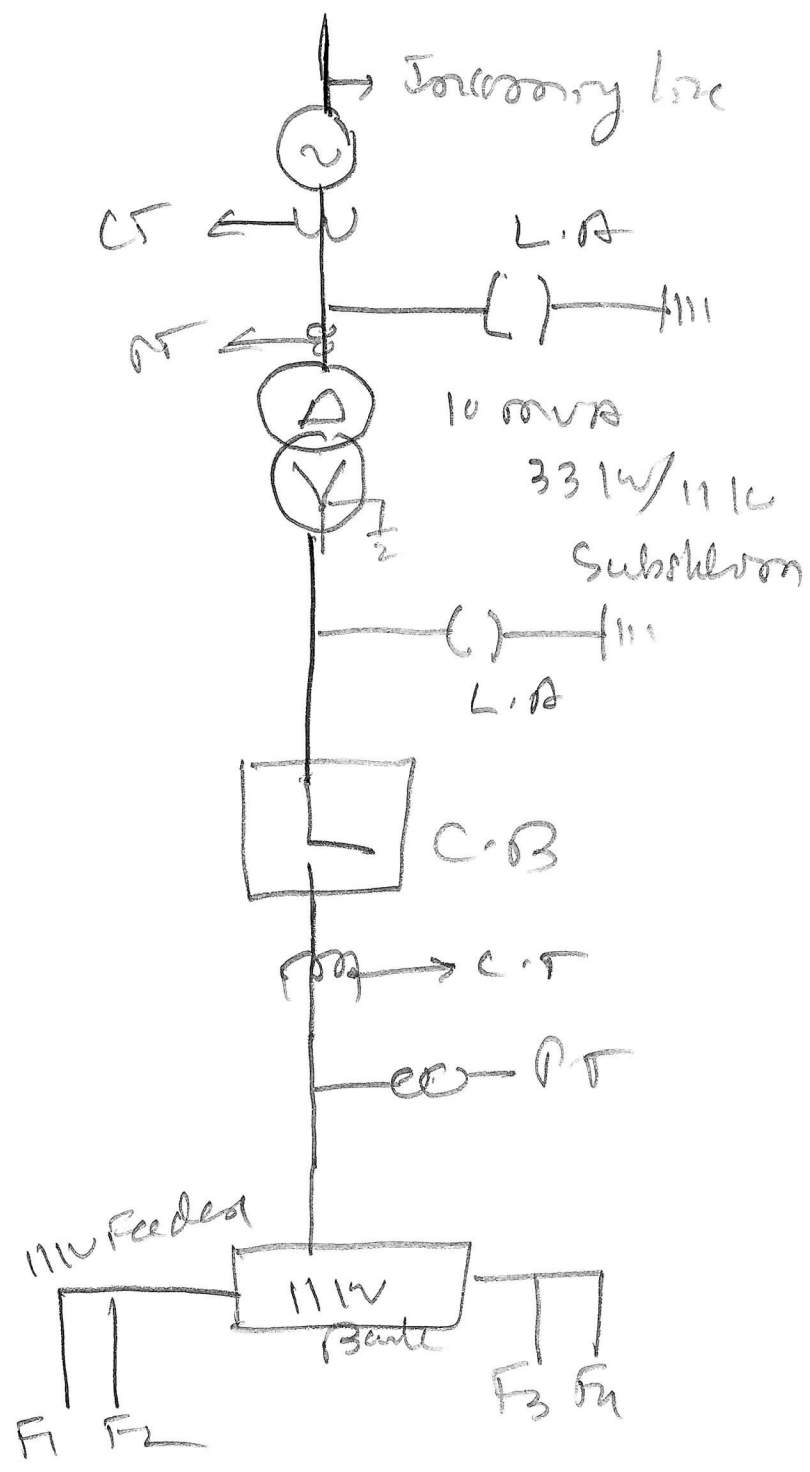
10 (C) Draw Single line Diagram for 10 MV, 33 kV/11 kV, Substation and prepare list of materials required with their specifications (08m)



List of materials

- 1) Isolator, — 2 nos.
- 2) 20 MV Transformer 33/11 kV — 1/2 nos
- 3) C.T & P.T — 2 each
- 4) Lightning Arrester — 33 kV class — 3
- 5) " — 11 kV class — 3
- 6) Circuit Breaker or Feeder — F1/F6 — 6 nos
- 7) Earthing —
- 8) Earthing mat — 10
- 9) Feeder unit — 1
- 10) Battery Maintenance System — 1 Room
- 11) M.C. accessories.





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