CBCS SCHEME

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17EE553

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021
Estimation and Costing

Time: 3 hrs. Max. Marks: 100

Note: *1. Answer any FIVE full questions, choosing ONE full question from each module.*
2. Cable rating of Aluminum and copper conductor chart not be permitted.

Module-1

1 a. What is the meaning of estimating? Write the purpose of estimating and costing. **(06 Marks)**
b. Write the information required for purchase order. **(06 Marks)**
c. Write any four rules of Indian electricity. **(08 Marks)**

OR

2 a. Write the different modes of tender and briefly explain. **(08 Marks)**
b. Explain the following :
i) Contingencies
ii) Overhead charges
iii) Profit. **(06 Marks)**
c. Write the objectives of purchase system. **(06 Marks)**

Module-2

3 a. Write the general rule to be consider for wring system. **(08 Marks)**
b. Fig.Q3(b) shows the plan of residential building, which has to be wire up with casing and cupping wiring system calculate the following :
i) Show the wiring plan
ii) Propose load calculation
iii) Find the length of wire for wiring
iv) List the materials and find the cost.

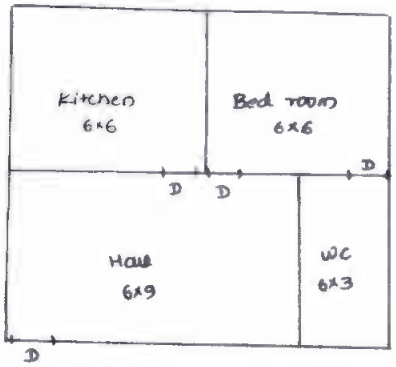


Fig.Q3(b) All dimensions are in meter **(12 Marks)**

OR

4 a. Write the different types of wiring system explain briefly. **(06 Marks)**
b. Fig.Q3(b) shows the plan of residential building which has to be wire up with conduit wiring system calculate the following :
i) Show the wiring plan with 1KW heating load in WC
ii) Propose the load calculation for heating and lighting
iii) Find the length of wire for wiring
iv) List the material and find the cost. **(14 Marks)**

Module-3

5 a. What are the different types of service connections, list the advantages and disadvantages. **(06 Marks)**

b. Prepare materials required for over head service connection to home of 1.5KW load at 230V, 50Hz supply. The supply is to be given from 15m away from the home. Assume diversity factor as 1.66 and future load as 100%. **(10 Marks)**

c. Find the input currents for the following machines.
i) 2Hp, 1ϕAC, 240V at 70% efficiency and 0.8pf
ii) 20Hp, 3ϕAC, 415V at 85% efficiency and 0.85 pf. **(04 Marks)**

OR

6 a. Write the important consideration regarding motor installation wiring. **(08 Marks)**

b. A 10Hp, 415V, 3 phase, 50Hz induction motor is to be insulated in a workshop the plan of which is shown in Fig.Q6(b). Draw the layout of the wiring and estimate the materials required the wiring is to be surface conduct. Assume motor efficiency as 85% and power factor as 0.8 lagging.

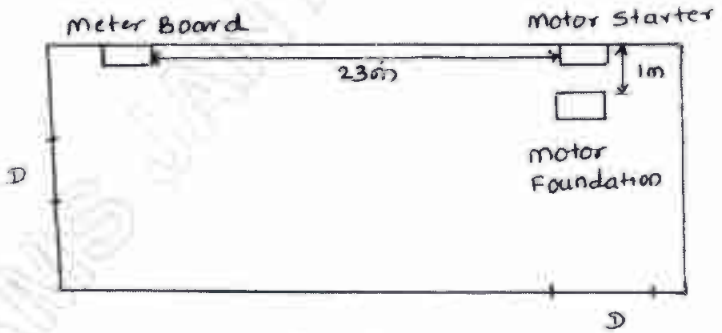


Fig.Q6(b) **(12 Marks)**

Module-4

7 a. With neat diagram, explain different types of cross arms. **(06 Marks)**

b. Write the different types of insulator explain any one of them. **(06 Marks)**

c. A pole for an over head 11KV, 3ϕ, 50Hz line is to be earthed and a stay is to be provided prepare a list of material required with quantity required. **(08 Marks)**

OR

8 a. Briefly explain erection of conductor for transmission line. **(08 Marks)**

b. A overhead, 3ϕ, 415V distributor is to be laid along a straight route 300meter long. The end supports are terminal poles with 50m span in between prepare the list of material. The following data may be used.
Conductor : ACSR 6/1 × 2.11mm for phase, neutral and street light.
LT cable : 4 core, 60mm^2, 1100V grade
Distance of first terminal pole form the substation is 12m. **(12 Marks)**

Module-5

9 a. Draw the key diagram of 66KV substation with following details and also list the matiral required :
66/33KV out going line : 1number
66/11KV out going line : 7 number
66/33KV transformer : 16 MVA
66/11KV transformer : 16 MVA.
Substation transformer : 1 number capacitor bank : 3.024 MVAR.
Missing data may be assumed. **(12 Marks)**

b. Write the main purpose of substation earthing. **(08 Marks)**

OR

10 a. Draw the key diagram of 33KV substation with following details and also list the materials required.
Double bus bar with outgoing
11KV lines : 3 number each
33KV /11KV transformer : 2 number, 5 MVA
Substation transformer : 1 number
Capacitor bank : 1.2 MVAR
Messing data may be assumed. **(08 Marks)**

b. Briefly explain instrument transformers used in substation. **(12 Marks)**

* * * * *

Estimation and costing(17EE553)

Scheme

MODULE I

1. **a)What is the meaning of estimation? Write the purpose of estimation and costing**.

   Estimation: An art of assessment of quantities of different items and cost thereof to plan the amount required for executing a work before actually carrying out the work.

   Purpose of estimating and costing**:**

- Good management practice
  - Material required and cost to be incurred
- To prepare a complete project report
- It will act as a guide in successful implementation
- Provides accurate assessment of the amount of money required
  - Otherwise impossible to complete work uninterruptedly because shortage of money.

b) Write the information required for purchase order?

Purchase order should carry the following information:

I. Purchase order number and date
II. Detailed specification of the items as quoted by the tenderer
III. Value of purchase order
IV. Name of the supplier
V. Due date of delivery
VI. Quantity of items ordered
VII. Taxes if any to be specified in the order
VIII. Dispatch details as agreed to.
IX. Mode of payment
X. Inspection system

c) Write four rules of Indian electricity.

I. Rule11.Application for license
II. Rule29.Construction installation, protection, operation and maintenance of electric supply lines and apparatus
III. Rule 30.Service lines and apparatus on consumer's premises
IV. Rule 55.Declared frequency of supply to consumer

2. **a) Write the different modes of tenders and briefly explain them**.

I. Open/ public tendering:

- Even non registered dealers are free to participate
- Advertisement

- Addressing all the known and likely sources for a particular product

II.Global tendering

- Indian trade journal/ Indian export services bulletin

III.Limited tender

- Only the most likely and suitable tenders are addressed
- Atleast 5 sources

IV.Single tender

- An offer from a single source is invited
- This required when Market research reveals only one reliable source
- Standardises on a particular band
- Manufacturer/government canalised supply only through a single source.

V.Proprietary tender

- Tender is addressed only to a proprietary manufacturer/authorised agent
- No equivalent or near equivalent is available from any other source

VI. Spot tendering

- Only for emergency requirements
- Vendors are requested to assemble
- Their offers are obtained after the requirement is explained to them on the spot

2. b) Explain the following :

i. Contingencies:

- For vague and unforeseen items
- Like extra costs for delays in delivery, minor accidents and unforeseen variations from estimating department, need for exceptional measures such as overtime.
- For natural calamities such as floods, earthquakes
- Usually expressed as a % of total cost (material + labour cost), say, 5%

ii. **Overhead charges:**

- Expenditure necessary to carry out the business, except for direct labour, direct materials, and direct expenses
- Rent of offices and workshop
- Allowances for wear and tear of buildings, plant and machinery(depriciation)
- Wages of clerical staff
- General expenses
- Rates and taxes
- Lighting and heating
- Advertising
- Insurance
- Postage and telephone
- Carriage and general travelling expences
- Legal costs

iii. **Profit:**

- It is added in the form of percentage to the gross cost of the job in order to determine the selling price of the job
- This amount is purely on discretion of the contractor which is governed by
  - Size of the job with him
  - Degree of competition
  - The state of turnover
  - His anxiety to secure a particular job and so on

2. c) Write the objectives of Purchase system?

- To purchase competitively and wisely
- To ensure that fair and open purchase practices are followed
- To ensure timely formulation and commitment of purchase
- To serve as information centre on materials knowledge
- To ensure that investment made on inventory is at an optimum level
- Training of purchase personnel in latest techniques of materials management
- To keep management appraised of the likely shortfalls in purchase performance by introducing appropriate reporting system

MODULE II

3. a) Write the general rules to be consider for wiring system.

- Every installation is to be properly protected near the point of entry of supply cables by a two pole linked main switch and a fuse unit.
- The conductor used is to be of such a size that it may carry load current safely.
- Every sub-circuit is to be connected to a distribution fuse board
- Every line is to be protected by a fuse of suitable rating as per requirements
- A switch board is to be installed so that its bottom lies 1.25- 1.5 metre above the floor.
- All plugs and socket outlets are to be 3-pin type, the appropriate pin of socket being connected permanently to the earthing system.
- Adequate number of socket outlets are to be provided at suitable places in all rooms so as to avoid use of long lengths of flexible cords
- Only 3-pin,5A socket outlets are to be used in all light and fan sub-circuits and only 3-pin, 15A socket outlets are to be used in all power sub-circuits
- Individual switches for socket outlets are to be controlled by individual switches, which are to be located immediately adjacent to it.
- No socket outlet is to be provided in the bathroom at a height less than 1.30 metres.
- Depending on the size of the kitchen, one or two 3-pin 15A socket outlets are to be provided.
- Dining rooms, bedrooms, living rooms, if required, each is to be provided with at least one 3-pin 15A socket outlet.

- All incandescent lamps, unless otherwise required, are to be hung at a height of 2.5 meter above the floor level and all ceiling fans are to be hung 2.75 metre above the floor level

3..b)

Fig.Q3(b) shows the plan of residential building, which has to be wire up with casing and cupping wiring system calculate the following :

i) Show the wiring plan
ii) Propose load calculation
iii) Find the length of wire for wiring
iv) List the materials and find the cost.

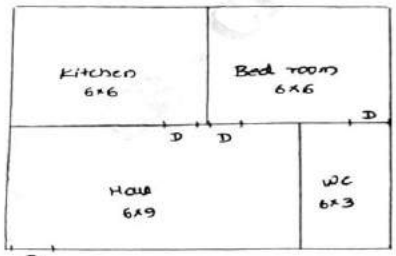


Fig.Q3(b) All dimensions are in meter **(12 Marks)**

For the given layout using casing capping

i) Layout of wiring — 3m

ii) Load table consist of, light, fan, socket -3m
current calculation, sub circuit more than 8000

iii) length of wire — 3m

iv) list of material - 3m

4.a) Write the different type of wiring system explain in briefly.

1. Cleat wiring
2. Wooden casing and capping wiring
3. C.T.S or T.R.S wiring
4. Lead sheathed and metal sheathed wiring
5. Conduit wiring

i. Surface or open type
ii. Recessed or concealed type

4.b)

b. Fig.Q3(b) shows the plan of residential building which has to be wire up with conduit wiring system calculate the following :
   i) Show the wiring plan with 1KW heating load in WC
   ii) Propose the load calculation for heating and lighting
   iii) Find the length of wire for wiring
   iv) List the material and find the cost. **(14 Marks)**

For given lay out diagram using conduit wiring system.

a) lay out plan of lighting & heating - 4m

b) load calculation consisting light fan socket 3m
Current calculation
Heating circuit = $\frac{1000}{230}$ = 4.3A × 2 [Factor of safety] - 1m
= 8.69 A.

c) length of lighting and heating wire = 3m

d) List of materials - 3m

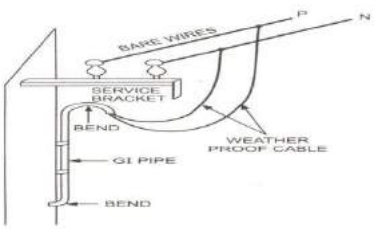
Module III

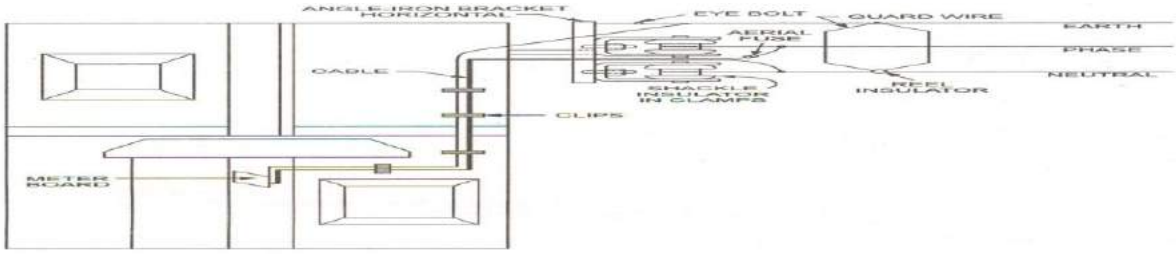
5. a) What are the different types of service connections, list the advantages and disadvantages.

Service connection: An electric supply line through which energy is supplied to a consumer
Types:

1. Over head service connection (OH)

- For high roof building
- For low roof or single storeyed building
- Weather proof cable method
- Use of junction or joint box





5.b)

Prepare materials required for over head service connection to home of 1.5KW load at 230V, 50Hz supply. The supply is to be given from 15m away from the home. Assume diversity factor as 1.66 and future load as 100%. **(10 Marks)**

Find the input currents for the following machines.

$$\text{Ip Current} = \frac{1500}{1.66\ (D.F)} = \frac{903.6W}{230} = 3.92A$$

$$\text{Future Expansion} = 3.92 \times 2 = \boxed{7.85\ A}$$

2m

$$\text{No. of real insulators} = \frac{15m}{0.75m} = 20 \times 2 = 40\ \text{no.}$$

$\simeq$ 42 or 48 no.

2m

List of materials ——————— 6m

5.c)

Find the input currents for the following machines.

i) 2Hp, 1ϕAC, 240V at 70% efficiency and 0.8pf

ii) 20Hp, 3ϕAC, 415V at 85% efficiency and 0.85 pf.

i) 1-ϕ ac motor:

I=(rated bhp x 735.5)/(η x V x cosϕ)

I=10.95A

ii) 3-ϕ ac motor:

I =(rated bhp x 735.5)/(√3 x η x V x cosϕ)

I= 30.1A

6.a) Write the important consideration regarding motor installation wiring.

1. All equipment used shall be of iron clad construction and wiring shell be of armoured cable or conduit type.
2. Looping of conductors and use of joints shall not be done
3. Length of flexible conduit shall not exceed 1.25metre.
4. Every motor, regardless of its size shall be provided with a switch fuse placed near it.
5. All motors shell be provided with suitable means for starting and stopping placed at convenient places.
6. Conduit should be preferably laid in covered trenches to facilitate safe operator movement.
7. While deciding the current rating of a main switch controlling a group of motors, starting current of one motor (highest rating)+ full load current of remaining motors shall be considered.
8. Laying of cables must be in separate conduit for separate motors.
9. Minimum cross section of conductor that can be used for power wiring is 2.5mm^2 (Cu) and 1.25mm^2 (Al) cables.
10. Current rating of the cable may be based on normal full-load current but fuse rating should be based on starting current
11. In no case rating of fuse be greater than twice the rating of cable
12. Conduit used shall be electrically continuous throughout and connected to the frame of the motor.
13. Frame of the motor shall be earthed by the owner by two separate and distinct connections of earth .
14. Earthing conductor shall be of Cu or GI.
    - Cu—x-sectional area of should not be less than half of the largest current carrying conductor.
    - GI– x-sectional area should be such that its conductivity is not less than that of Cu conductor used in wiring.

b. A 10Hp, 415V, 3 phase, 50Hz induction motor is to be insulated in a workshop the plan of which is shown in Fig.Q6(b). Draw the layout of the wiring and estimate the materials required the wiring is to be surface conduct. Assume motor efficiency as 85% and power factor as 0.8 lagging.

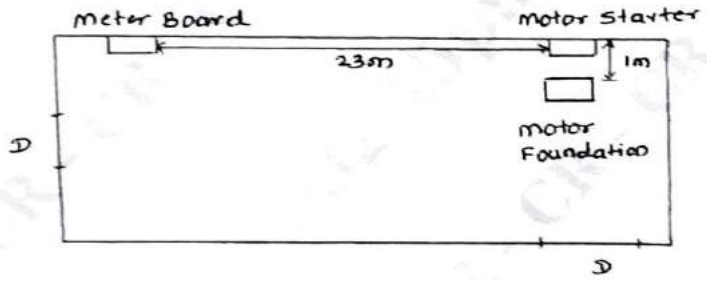


Fig.Q6(b) **(12 Marks)**

Solution: Assumptions made:

1. **The motor and starter are to be procured through separate contract.**
2. **Motor disconnect switches and main switches are to be supplied by wiring contractor.**
3. **All the conduits are to be run exposed on walls.**

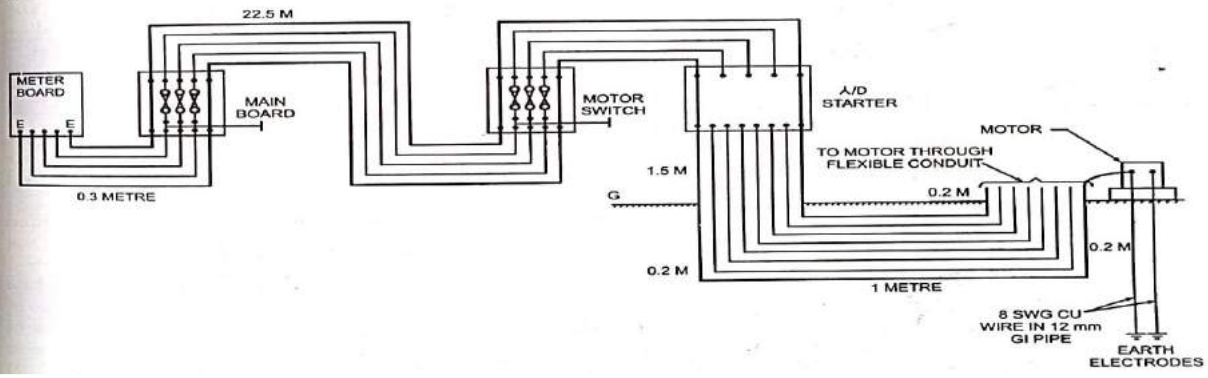
4. The main switch, motor switch and starter shall be mounted at a height of 1.5 metres from ground level.
5. Two earth wires will be run side by side for earthing the motor, starter and switches.
6. The motor shall be installed on suitable foundation, 0.2 m above the floor level.
7. Motor efficiency 85% and power factor 0.8 (lagging).

$$\text{Full load current} = \frac{10 \times 735.5}{\sqrt{3} \times 415 \times 0.8 \times 0.85} = 15.05 \text{ A}$$

Starting current = 1.5 times full-load current = 1.5 × 15.05 = 22.6 A. Hence three-core PVC 1100 V grade, 6 mm^2 aluminium conductor cable of current carrying capacity 24 A may be used.

The main switch and motor switch to be used will be 32 A, 415 V TPIC switches.

As from meter board to main board and main board to motor control board only one 3-core cable is to be run so a HG conduit of size 25 mm will be run from meter board to main board and from main board to motor control board. From motor starter to motor two 3-core cables carried so HG conduit of size 31 mm will be used. Flexible conduit of size 25 mm will be used for connecting motor switch and motor starter and of size 31 mm will be used for connecting heavy gauge conduit to motor.



Length of 25 mm HG Rigid Conduit

From meter board to main board = 0.3 m

From main board to motor switch (mounted on control board) = 22.5 metres

Total = 22.8 metres

Wastage 10% = 2.3 metres

Total = 25.1 metres = 25 metres (say)

Length of 31 mm HG Conduit

From motor starter to ground = 1.5 metres

Below ground level = 0.2 metre

Along ground up to foundation = 1.0 metre

Up to top of motor foundation = 0.2 + 0.2 = 0.4 metre

Total = 1.5 + 0.2 + 1.0 + 0.4 = 3.1 metres

Wastage 10% = 0.31 metre

Total = 3.1 + 0.31 = 3.41 = 3.5 metres (say)

Length of 25 mm flexible conduit required for connecting motor switch to motor starter = 0.25 metre

Length of 31 mm flexible conduit required for connecting heavy gauge conduit to motor = 1 metre

Length of 3 core, 1100 V grade, 1/2.80 mm (6 mm^2) aluminium conductor PVC cable

(*i*) 1 Length from meter board to main board = 0.3 m

(*ii*) 1 Length from main board to motor switch = 22.5 m

(*iii*) 1 Length from motor switch to motor starter = 0.25 m

(*iv*) 2 Lengths from motor starter to motor terminal box = 2 (3.2 + 1) = 8.2 m

Total Length = 31.25 m

Wastage and for connections, 10 % = 3.13 m

Total = 34.38 = 35 metres (say)

Length of Earth Wire According to IE rules, the motor frame, motor switch, motor starter, main switch are to be earthed by means of two separate and distinct connections. Hence two separate earth electrodes will be provided for earthing purpose.

From the table for size of earth wire, for 10 HP motor 8 SWG GI wire will be required as earth wire.

Length of earth wire required

= 2 × length of conduit including length of flexible conduit

= 2 (25 + 3.5 + 0.25 + 1) = 59.5 metres = 60 metres (say) or 6 kg.

ESTIMATE 9.1 ON THE BASIS OF ITEM WISE RATES

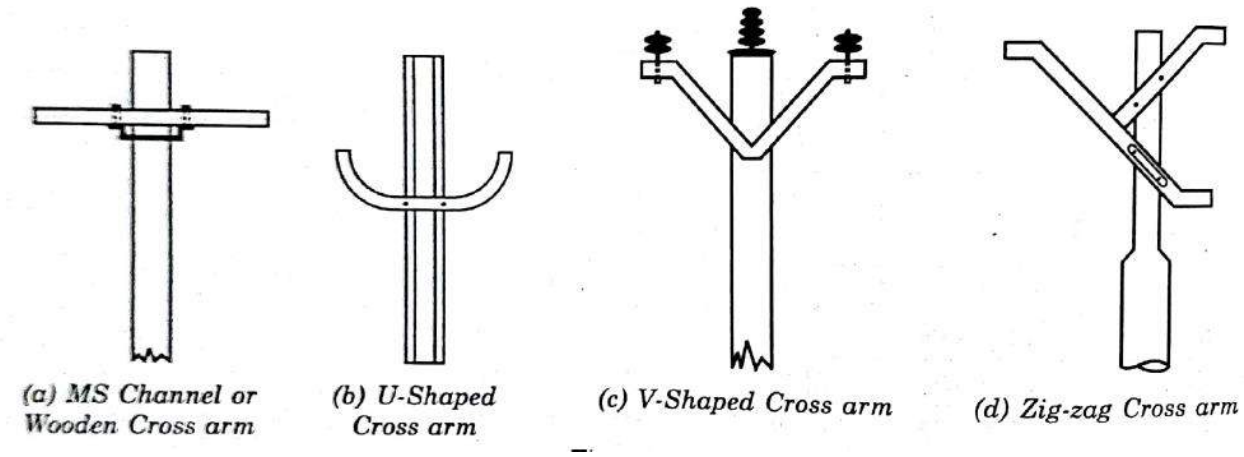
S. No.	Description of Material With Full Specifications	Quantity Required		Rate			Amount		Remarks
		Quantity	Unit	₹	P	Per	₹	P	
1.	32 A, 415 V, TPIC rewirable type switch fuse unit	2	nos	1,500	00	each	3,000	00	
2.	IC boards complete with locking arrangement etc.								
	(*i*) 25 cm × 30 cm	1	no	375	00	do	375	00	
	(*ii*) 45 cm × 60 cm	1	do	900	00	do	900	00	
3.	Heavy gauge (HG) 16 SWG conduit								
	(*i*) 31 mm	3.5	m	38	00	m	133	00	
	(*ii*) 25 mm	25	do	27	00	do	675	00	
4.	Flexible conduit								
	(*i*) 31 mm	1	do	38	00	do	38	00	
	(*ii*) 25 mm	0.25	do	27	00	do	6	75	
5.	3 core, 1100 V grade 6 mm^2 aluminium conductor PVC cable	35	do	60	00	do	2,100	00	
6.	Conduit bends								
	(*i*) 31 mm	2	nos	10	50	each	21	00	
	(*ii*) 25 mm	6	do	9	00	do	54	00	
7.	Conduit Saddles								
	(*i*) 31 mm	4	do	4	00	do	16	00	
	(*ii*) 25 mm	25	do	3	00	do	75	00	
8.	Lock nuts								
	(*i*) 31 mm	6	do	7	50	do	45	00	
	(*ii*) 25 mm	2	do	6	00	do	12	00	
9.	Flexible pipe coupling complete with locknuts								
	(*i*) 31 mm	2	do	15	00	do	30	00	
	(*ii*) 25 mm	2	do	12	00	do	24	00	
10.	Wooden bushings								
	(*i*) 31 mm	2	do	3	00	do	6	00	Lump sum provision
	(*ii*) 25 mm	6	do	3	00	do	18	00	

Contd...

7.a) With neat diagram, explain different types of cross arms.

- Function of line support is to support the line conductors at a safe distance from ground whereas the function of cross arms is keep the conductors at a safe distance from each other and from pole.
- Cross arm is cross-piece fitted to pole top end portion by means of brackets(pole bracket) for supporting insulators
- Various types
- MS channel/angle iron/wooden
- Straight,U-shaped, V-shaped, zig-zag shaped

Working Voltage	Spacing
6.6kV	76mm
11kV	101mm
33kV	190mm and so on

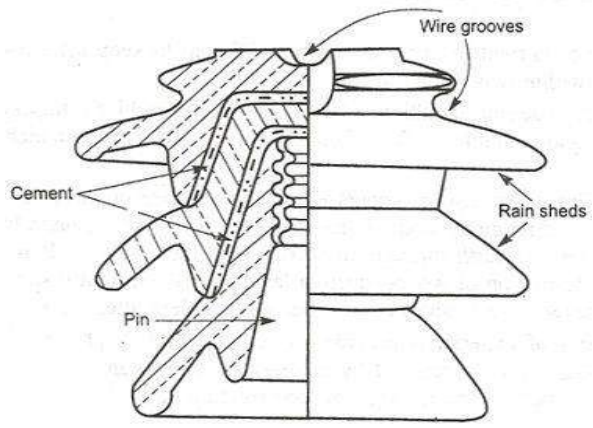


(a) MS Channel or Wooden Cross arm (b) U-Shaped Cross arm (c) V-Shaped Cross arm (d) Zig-zag Cross arm

7.b) Write different types of insulator and explain any one of them.

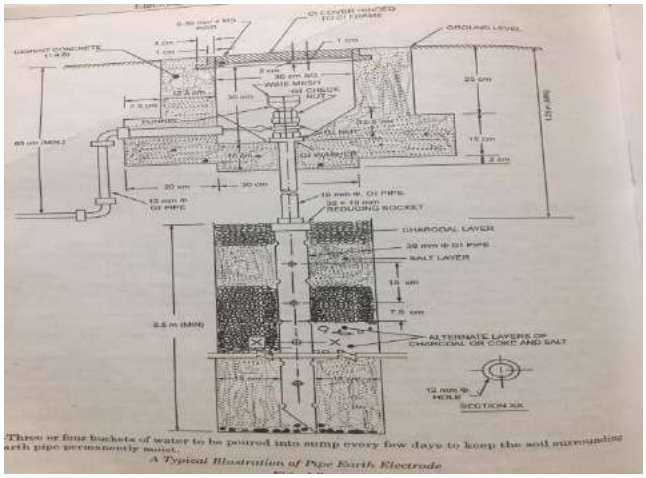
I. Pin type insulator
II. Suspension type insulator
    - Hewlett or interlinking type
    - Core and link type
    - Cemented-Cap type
III. Strain insulators
IV. Shackle Insulators
V. Stay Insulators

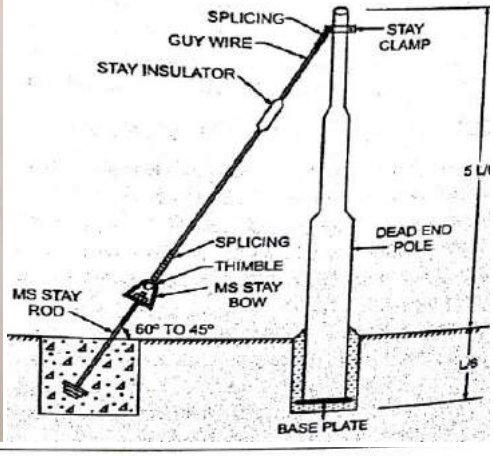
Pin type insulator: A **pin insulator** is a device that isolates a wire from a physical support such as a **pin** (a wooden or metal dowel of about 3 cm diameter with screw threads) on a telegraph or utility pole. It is a formed, single layer shape that is made out of a non-conducting material, usually porcelain or glass.



Pin-type insulator

- 7.c) A pole for an overhead 11kV, 3-phase, 50 Hz line is required to be earthed and a stay is to be provided. Make a neat sketch showing how it should be done. Prepare a list of materials required.





S. No.	Description of Material With Complete Specifications	Quantity Required		Rate		Amount			Remarks
		Quantity	Unit	₹	P	Per	₹	P	
A	**EARTHING (Pipe Earthing)**								
1.	25 mm diameter GI pipe	2.5	m	120	00	m	300	00	
2.	19 mm diameter GI pipe	1.5	do	90	00	do	135	00	
3.	12 mm diameter GI pipe	4.0	do	75	00	do	300	00	
4.	GI wire 6 SWG	12 (1.2)	do kg	27	00	kg	32	40	
5.	GI lugs	2	nos	15	00	each	30	00	
6.	10 mm diameter, 32 mm long GI bolts and nuts	2	nos	15	00	do	30	00	
7.	16 mm diameter, 40 mm long GI bolts, nuts and washers	2	do	18	00	do	36	00	
8.	12 mm diameter GI bends	1	do	15	00	do	15	00	
9.	30 cm square cast iron frame	1	no	150	00	each	150	00	
10.	30 cm square cast iron cover	1	do	75	00	do	75	00	
11.	Funnel with wire mesh	1	do	75	00	do	75	00	
12.	Charcoal	10	kg	15	00	kg	150	00	
13.	Common salt	10	do	5	00	do	50	00	
14.	Cement concrete 1 : 4 : 8	0.15	m^3	1,500	00	m^3	225	00	

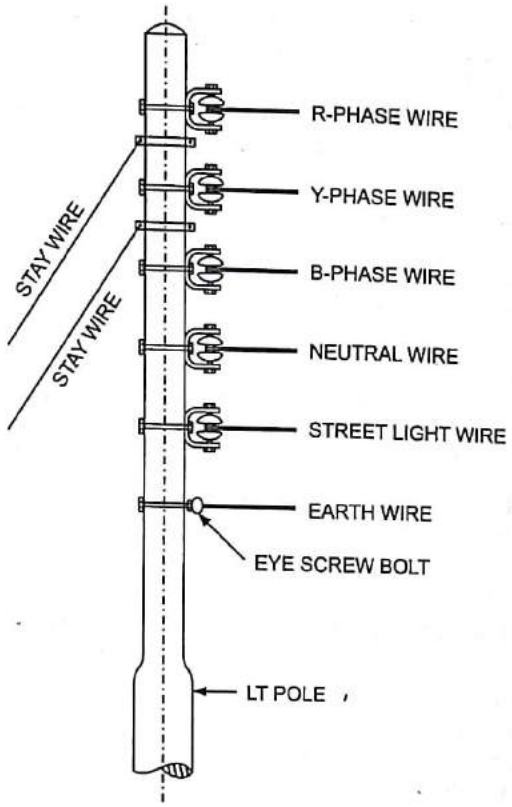
B.	STAYING							
1.	MS anchor plate 45 cm × 45 cm × 6.0 cm (not galvanised)	1	no	675	00	each	675	00
2.	MS stay rod 16 mm diameter and 2.42 m long	1	do	675	00	do	675	00
3.	Stay bow made of MS rod 12 mm diameter	1	do	450	00	do	450	00
4.	Stay insulator	1	do	150	00	do	150	00
5.	Stay wire (7/8 SWG GI wire)	7.5 (4.5)	m kg	270	00	kg	1,215	00
6.	Stay clamp	1	no	80	00	each	80	00
7.	16 mm diameter, 76 mm long bolts and nuts for fixing	2	do	50	00	do	100	00
8.	MS thimbles	2	do	15	00	do	30	00
9.	Cement concrete 1 : 4 : 8	0.2	m^3	1,500	00	m^3	300	00
						Total	5,278	40

8. a) Briefly explain erection of conductors for transmission line.

- Important phase in construction
- Appearance and future security depends upon proper erection
- Should have proper Tool and Plants(T&P) , safety of erection personnel may be endangered
- Erection of conductors can be subdivided into four separate activities
  - Delivery of conductors
  - Running out and stringing of conductors
  - Tensioning and sagging of conductors

Jointing of conductors in bow

b. A overhead, 3ϕ, 415V distributor is to be laid along a straight route 300meter long. The end supports are terminal poles with 50m span in between prepare the list of material. The following data may be used.
Conductor : ACSR 6/1 × 2.11mm for phase, neutral and street light.
LT cable : 4 core, 60mm^2, 1100V grade
Distance of first terminal pole form the substation is 12m. **(12 Marks)**



Solution :

Length of line = 300 metres

Average span = 50 metres

$$\text{Number of spans} = \frac{300}{50} = 6$$

Number of 10 metre long rail poles required = 7; 5 intermediate poles and 2 end poles

Length of 4 SWG hard drawn bare copper conductor for 3-phase wire

= 3 × 300 + 2% extra for sag

= 900 + 18 = 918 metres

Weight of copper required for 3-phase wires = 0.24 × 918 = 220.32 kg = 221 kg (say)

Length of 8 SWG hard drawn bare copper conductor for street light and neutral wires

= 2 × 300 + 2% = 612 metres

Weight of copper required for street light and neutral wires

= 0.115 × 612 = 71 kg

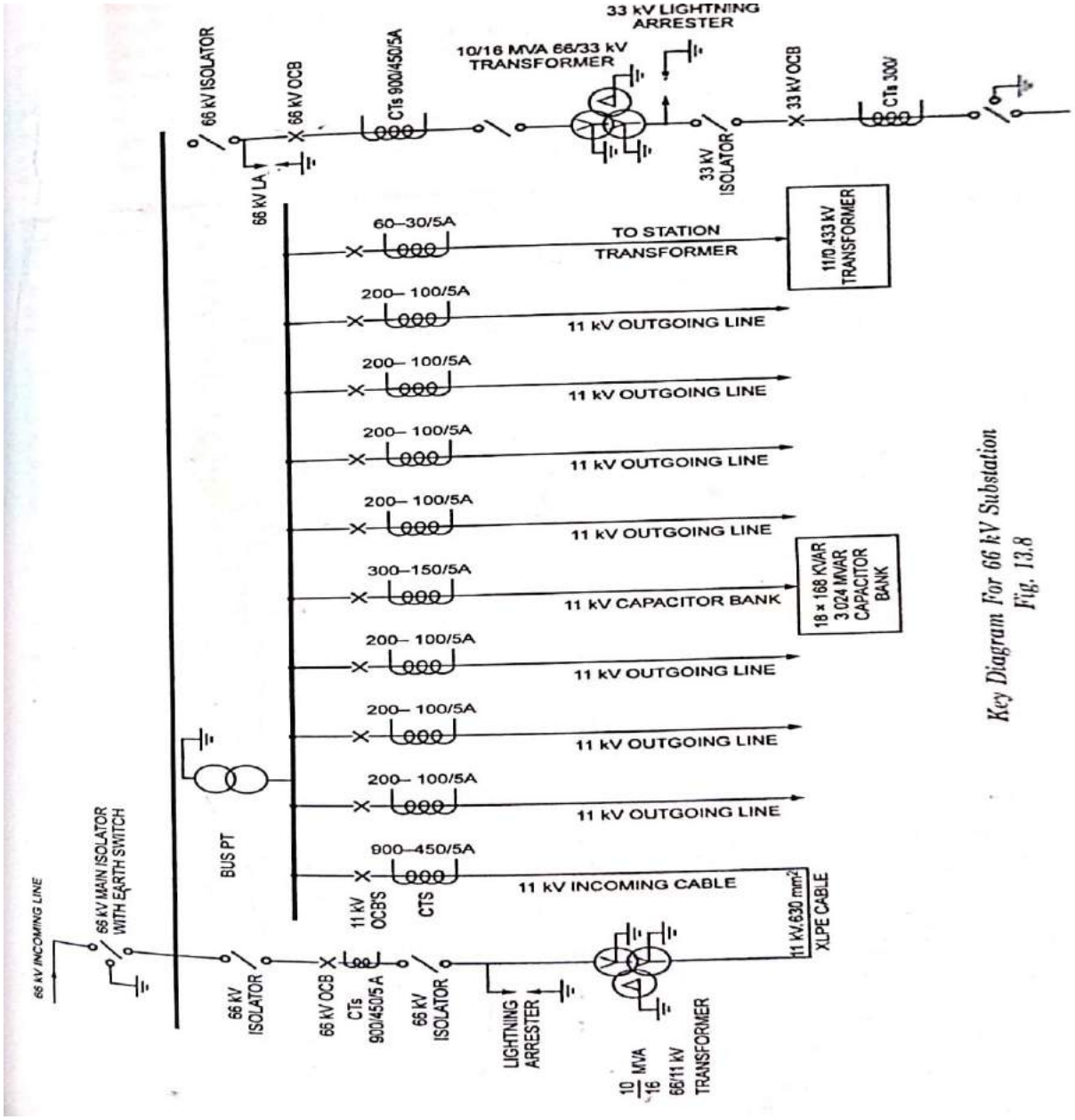
Length of 8 SWG GI wire = 1 × 300 + 2% for sag + 3 metres per candle wire

= 300 + 6 + 18 = 324 metres

9 a. Draw the key diagram of 66KV substation with following details and also list the matiral required :

66/33KV out going line : 1number
66/11KV out going line : 7 number
66/33KV transformer : 16 MVA
66/11KV transformer : 16 MVA.
Substation transformer : 1 number capacitor bank : 3.024 MVAR.

(12 Marks)



Key Diagram For 66 kV Substation
Fig. 13.8

9.b) Write the main purpose of substation earthing.

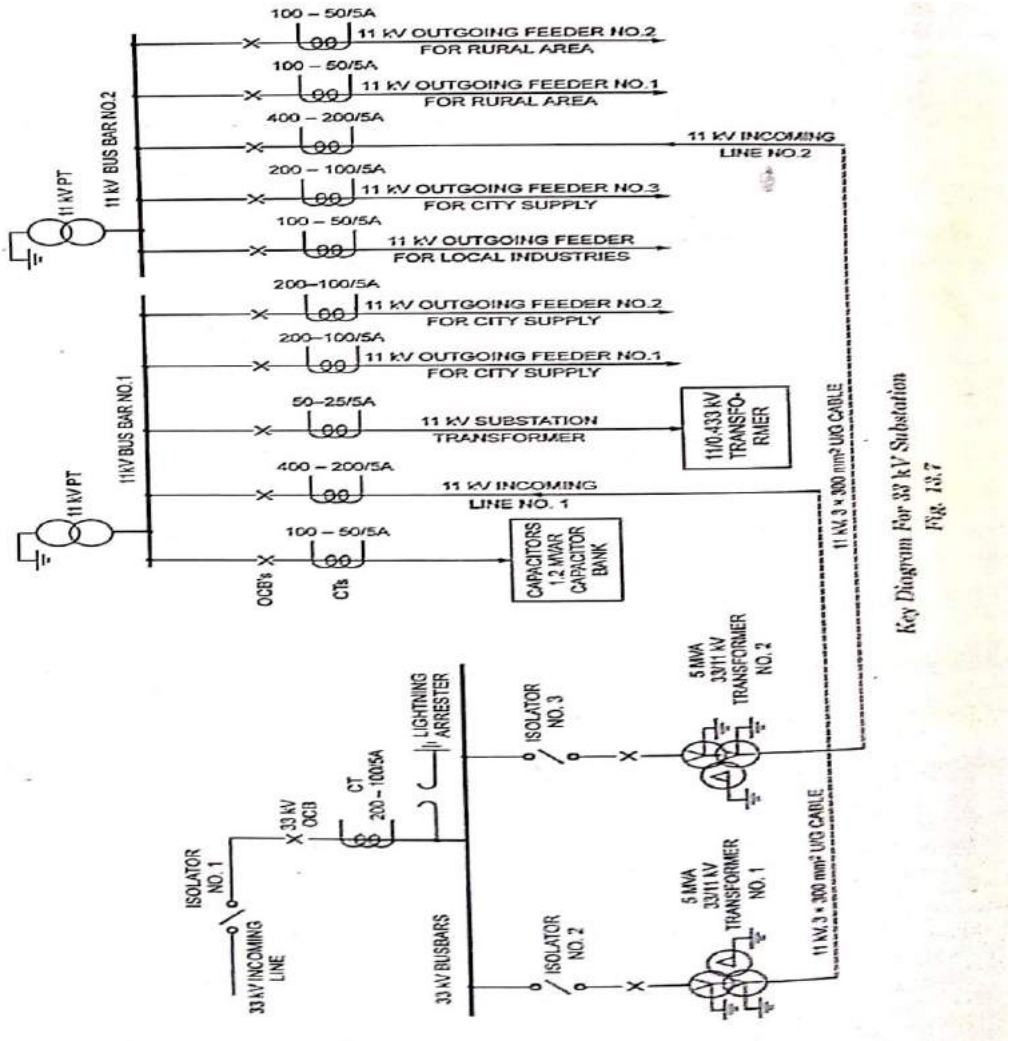
- Safety of operational and Maintenance Staff
- Discharge of electrical charges to ground
- Grounding of overhead Shielding Wires
- Electromagnetic Interference

OR

10 a. Draw the key diagram of 33KV substation with following details and also list the materials required.

Double bus bar with outgoing
11KV lines : 3 number each
33KV /11KV transformer : 2 number, 5 MVA
Substation transformer : 1 number
Capacitor bank : 1.2 MVAR

(08 Marks)



10.b) Briefly explain instrument transformers and used in substation.

9. Instrument Transformers. AC type protective relays are actuated by current and voltage supplied by current and potential (or voltage) transformers, known as *instrument transformers*. The main function of instrument transformers are:

(*i*) To provide insulation against the high voltage of the power circuit and to protect the apparatus and the operating personnels from contact with the high voltages of the power circuits.

(*ii*) To supply protective relays with current and voltage of magnitude proportional to those of the power circuit but sufficiently reduced in magnitude so that the relays can be made relatively small and inexpensive.

(*iii*) Possibility of different types of secondary connections to obtain the required currents and voltages.

For safety purposes, the secondaries of current and potential transformers (CTs and PTs) are grounded.

For the proper applications of CTs and PTs, required considerations are:

Mechanical construction, type of insulation (dry or liquid), ratio in terms of primary and secondary currents or voltages, continuous thermal rating, short-time thermal and mechanical ratings, insulation class, impulse level, service conditions, accuracy and connections.

Current Transformers (CTs). Current transformers are connected in ac power circuits to feed the current coils of indicating and metering instruments (ammeters, wattmeters, watt-hour meters) and protective relays. Thus the CTs broaden the limits of measurements and maintain a watch over the currents flowing in the circuits and over the power loads. In high voltage installations CTs in addition to above, also isolate the indicating and metering instruments and protective relays from high voltage. The current transformer (CT) basically consists of an iron core on which are wound a primary and one or two secondary windings. The primary winding of the CT is connected in series with the load and carries the actual power system current (normal or fault) while the secondary is connected to the measuring circuit or the relay.

Potential Transformers (PTs). The potential transformers are employed for voltages above 380 V to feed the potential coils of indicating and metering instruments (voltmeters, wattmeters, watt-hour meters) and relays. These transformers make the ordinary low voltage instruments suitable for measurement of high voltage and isolate them for high voltage.

The primary winding of the potential transformer