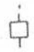
ANSWER KEY –Version B

1 Draw the graphical symbols of the followings:

a) Circuit breaker b) Two way switch c) Fan regulator

Circuit Breaker. 

Two way switch 

Fan Regulator 

2 List the selection criteria of cables?

a. voltage rating
b. Current rating
c. Conductivity,
d. Weight
e. Temperature
f. Required flexibility
g. Tensile strength
h. Type of insulation

3 Define the following?

a) Solid angle

**Solid angle ($\omega$)**

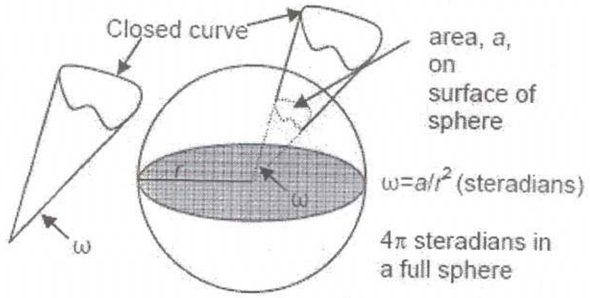
Consider an area A which is a part of a sphere of radius r. the solid angle subtended by this area at the centre of the sphere is

$\omega = A/r^2$ Steradian.

Where Steradian is the unit of solid angle. If $A=r^2$ in the above equation then

$\omega = 1$ Steradian.

Solid angle for whole sphere $= 4\pi r^2/r^2 = 4\pi$ Steradian




b) Luminous flux

It is the light energy radiated out per second from the hot body in the form of luminous light waves. The unit of luminous flux is lumen ( lm).

c) Luminous Intensity

Luminous intensity of a point source in any particular direction is given by The Luminous flux radiated out per unit solid angle in that direction. It is solid angular flux density of a source in a specified direction. The flux is measured in lumen and solid angle is measured in steradian. So unit of luminous intensity is lumen per steradian or candela.

4 Define utilisation factor and what are the conditions affecting its value.

Utilisation factor or Coefficient of utilisation ($\eta$)

It is the ratio of the lumen actually received by a particular surface to the total lumen emitted by the Luminous source. The value of this factor depends on

1. Type of lighting system.
2. Type of mounting height.
3. The colour and surface of Wall.
4. Shape and dimension of room.

5 List any three points to be earthed.

According to IE rules and IEE (Institute of Electrical Engineers) regulations,

- Earth pin of 3-pin lighting plug sockets and 4-pin power plug should be efficiently and permanently earthed.

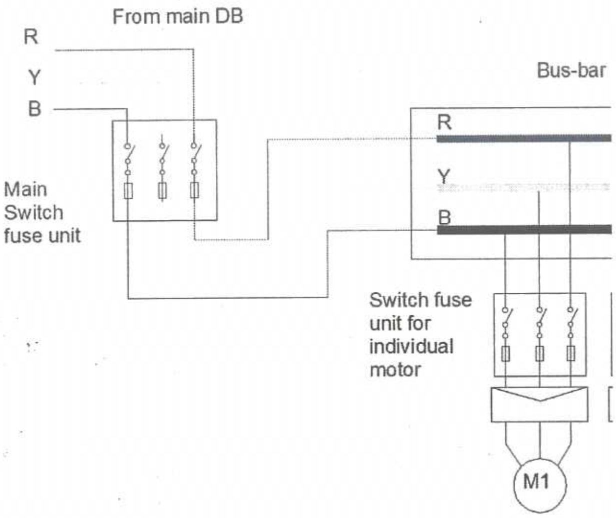
- All metal casing or metallic coverings containing or protecting any electric supply line or apparatus such as GI pipes and conduits enclosing VIR or PVC cables, iron clad switches, iron clad distribution fuse boards etc should be earthed (connected to earth).

- The frame of every generator, stationary motors and metallic parts of all transformers used for controlling energy should be earthed by two separate and yet distinct connections with the earth.

- In a dc 3-wire system, the middle conductors should be earthed at the generating station.

- Stay wires that are for overhead lines should be connected to earth by connecting at least one strand to the earth wires.

6 Draw line diagram of industrial bus bar arrangement for 3nos of three phase motors.




7 List any three advantages and disadvantages of Outdoor substation.

**Advantages of Outdoor Substation**

- All the equipment in the outdoor substations is within view, and therefore fault location is easier.
- The expansion of the installation is easier in the outdoor substations.
- The time requires in the construction of such substations is lesser.

- The smaller amount of building material like steel, concrete is required.
- The construction work required is comparatively less, and the cost of the switchgear installation is also very low.
- Repairing work is easy, and proper space is provided between the apparatus so that the fault occur at one point will not be carried over to another point.

**Disadvantages of Outdoor Substation**

- More space is required for the outdoor substations.
- Protection devices are required to be installed for the protection against lightning surges.
- The length of the control cables increases which increase the cost of the substation.
- Equipment designed for outdoor substation are more costly because outdoor door substation equipment required additional protection from the dirt and dust.
- In spite of the disadvantage, outdoor substations are very widely used in the power system.

PART B

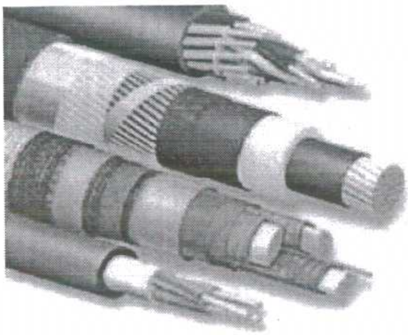
Answer ONE question from each set. Each question carries 15 marks

II.

Explain the details of the following cables used in domestic wiring system.

a. **VIR Cables** (5 marks)

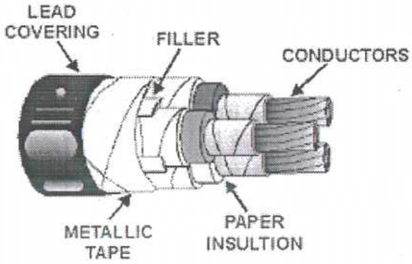
- VIR cables are available in 240/415 volt as well as in 650/1100 volt grade.
- VIR cables consists of either tinned copper conductor covered with a layer of vulcanised India rubber insulation.
- Over the rubber insulation cotton tape sheathed covering is provided with moisture resistant bitumen wax.
- The thickness of rubber insulation depends upon the voltage grade.

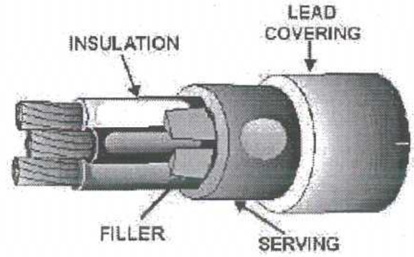


- These cables are available in 250/400 volt or 650/1100 volt and used in CTS wiring.
- TRS cable is nothing but a VIR insulated conductor with an outer protective covering of tuff rubber which provides additional insulation and protection against wear and tear.
- These cables are waterproof hence can be used in wet conditions.
- These cables some available as single core, circular twin core, circular three core, flat three core, twin or three with an earth continuity conductor.

b. **Lead sheathed cables** (5 marks)

- These cables are available in 240/415 voltage grade.
- The lead sheath cable is a vulcanized rubber insulated conductor covered with a continuous sheath of lead.
- Lead sheath provides protection against moisture absorption and mechanical injury.
- It is available as a single core, flat twin core, flat three core and Flat twin or three core with an Earth continuity conductor.



c. **Poly Vinyl Chloride (PVC) cables** (5 marks)

Poly Vinyl Chloride (PVC) cables:-

- These cables are available in 250-440 volt and 650-1100 volt grade and used in casing capping and conduit wiring system.
- PVC is harder than rubber and does not require cotton taping.

PVC are better than VIR insulation because

- PVC has better insulation properties.
- PVC is more flexible.
- PVC has no chemical effect on conductors.
- PVC has small diameter so more number of wires can be accommodated in a conduit.

OR

III.

A residential building is to be provided with electrical wiring. Fifure-2 shows the plan of the building. The load requirement is as shown in table -1

a. Draw the schematic representation of the wiring installation (3 marks)

With proper justification find the number of sub-circuits required (3 marks)

Estimate the quantity of materials required for PVC open conduit system. (9 marks)

| Location | Light (60W) | Fan (80W) | 5A Socket (80W) | 15A Socket (1000W) |
|---|---|---|---|---|
| Room-1 | 1 | 1 | 1 | 1 |
| Room-2 | 1 | 1 | 1 | 1 |
| Room-3 | 2 | 1 | 1 | Nil |

| | | | | |
|---|---|---|---|---|
| Room-4 | 2 | 1 | 1 | Nil |
| Open yard | 1 | Nil | Nil | Nil |
| W.C & bath | 1 | Nil | Nil | Nil |

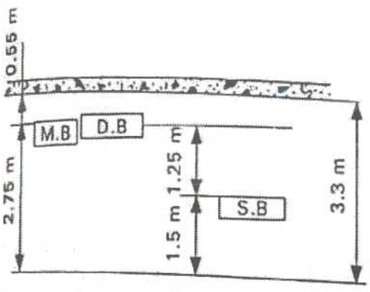
| | | |
|---|---|---|
| Total wattage of light points | = | $8 \times 60 = 480$ W |
| Total wattage of fan points | = | $4 \times 80 = 320$ W |
| Total wattage of 5A socket points | = | $4 \times 80 = 320$ W |
| | | 16 No. 1120 W |

Total no. of outlets 16 (>10) and total light/fan load is 1120 (> 800 W). Therefore we need two/sub-circuits. The division of outlets on each sub-circuit is made more or less uniform (i.e 8, 8) rather than 10, 6 as shown in Fig. 2.12.

One sub-circuit for power-loads is sufficient as shown in Fig. 2.12.

| DISTRIBUTION BOARD | | |
|---|---|---|
| | → SUB - CIRCUIT - 1 | $L_4, L_5, L_6, L_8, F_3, F_4, S_3, S_4$ |
| | → SUB - CIRCUIT - 2 | $L_1, L_2, L_3, L_7, F_1, F_2, S_1, S_2$ |
| | → SUB - CIRCUIT - 3 | $P_1, P_2$ |

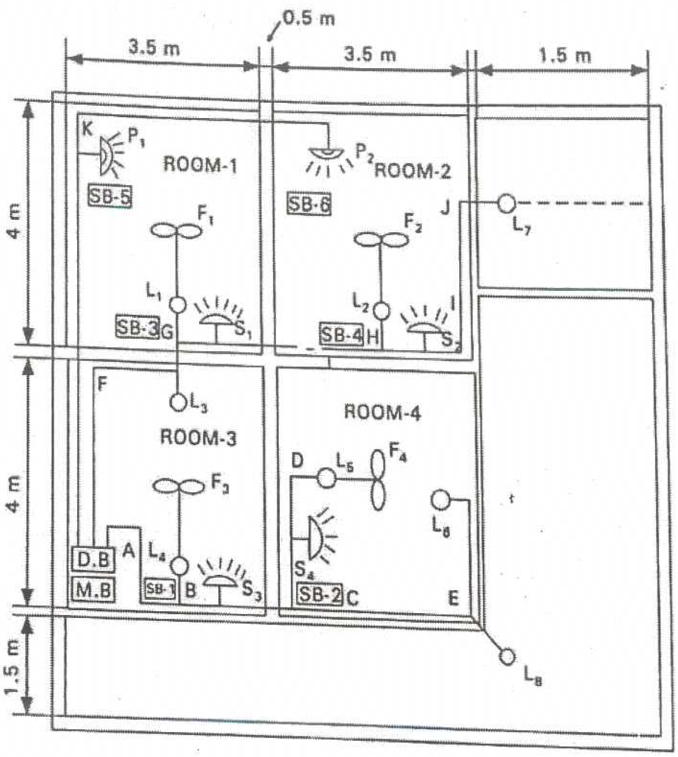
Fig. 2.12




(a)

$S_1, S_2, S_3, S_4$ = 5A SOCKETS

$P_1, P_2$ = 15A SOCKETS




(b)

**(b) Size of cable**

Current through Sub-circuit - 1 (light/fan) $= \dfrac{(4\times60)+(2\times80)+(2\times80)}{230}$

$= 2.44$ A

Current through Sub-circuit - 2 (light/fan) $= \dfrac{(4\times60)+(2\times80)+(2\times80)}{230}$

$= 2.44$ A

Current through Sub-circuit - 3 (power load) $= \dfrac{2000}{230} = 8.696$ A

The cable for sub-circuit no's 1 and 2 should minimum size i.e 1.0 mm² multi strand copper or 1/1.4 mm Aluminium or 1/1.15 Copper cable be used.

**(c) Length of conduit and cable :**

**For sub-circuit - 1**

*Horizontal runs :*

Length ABC E $L_6$ ........ = (3.5 + 3.5 + 2) = 9.0

Length B $F_3$ ............... = 2.0 m

Length CD $F_4$ .............. = (2 + 1.75) = 3.75 → 14.75 m

*Vertical downs :*

Length from B to SBI .... .... .... = 1.25 m

Length D to $SB_2$ .... .... .... = 1.25 → 2.5 m

*Vertical Up's :*

Length from B to roof .... .... .... = 0.55

Length from D to roof .... .... .... = 0.55 m → 1.1 m

18.35 m

**For sub-circuit - 2**

*Horizontal runs :*

Length A F G H I J (4 + 3.5 + 3.5 + 3.5) = 14.5

Length G $F_1$ .... .... .... = 2.0 m

Length $HF_2$ .... .... .... = 2.0 m → 18.5 m

*Vertical down drops :*

Length from G to $SB_3$ .... .... .... = 1.25 m

Length from H to $SB_4$ .... .... .... = 1.25 m → 2.5 m

*Vertical Up's :*

Length from G to roof .... .... .... = 0.55 m

Length from H to roof .... .... .... = 0.55 m → 1.1 m

22.1 m

Estim-

**For Sub - Circuit - 3**

*Horizontal Runs :*

Length AFK (4 + 4) .... .... .... = 8.0 m

Length $KP_2$ (3.5 + 1) .... .... ... = 4.5 m → 12.5 m

*Vertical down drops :*

Length from K to $SB_5$ .... .... .... = 1.25 m

Length from $P_2$ to $SB_6$ .... .... .... = 1.25 m → 2.5 m

15.0 m

Total length of 25mm conduit =(18.35 + 22.1 + 15) = 55.45

Allowing 10% wastage 5.54

60.99

Say 61.00 m

Length of 12mm conduit (wall thickness) at C, E, F, G, J, $P_2$, H = 7 × 0.3 = 2.1= 3.0 m

*Cable length :*

The length of cable required for sub-circuit no's 1 & 2 =

= (18.35 + 22.1) × 3 = 121.35 m

15% wastage, joints, wall thickness .... .... .... = 18.2 m

139.55

say 140.00 m

The length of cable required for sub-circuit – 3 = 15 × 3 = 45.0 m

15% wastage, joints, wall thickness etc. = 6.75 m

51.75 m

say 52.00 m

*(d) Labour cost*

| | |
|---|---|
| Meter board equal to | 2 points |
| Distribution board equal to | 2 points |
| Light & fan (8 + 4) | 12 points |
| Power | 2 points |
| Total points to be wired | 18 |

Total Labour cost @ Rs 300 per point

= Rs 300 × 18 = Rs 5400-00

## Material of Schedule and Cost

| S. No. | Material specification | Qty. Rs. Ps. | Rate Per | Rate Rs. Ps. | Cost | Remarks |
|---|---|---|---|---|---|---|
| 1. | D.P Main switch, 15 A 250-V, | 1 No | 100-00 | each | 100-00 | |
| 2. | I.C Cutout, 15A, 250-A | 1 No. | 20-00 | each | 00-00 | |
| 3. | Flush type fuse unit 15 A, 250-V | 1 No. | 15-00 | each | 15-00 | For power load |
| 4. | Flush type fuse units 5A, 250V | 2 No. | 10-00 | each | 20-00 | |
| 5. | PVC conduit 25mm | 61 m | 300-00 | 100m | 183-00 | |
| 6. | PVC Conduit...... 12 mm | 3m | 200-00 | 100m | 6-00 | |
| 7. | 1.0mm² multistrand copper, VIR cable | 140m | 300-00 | 100m | 420-00 | |
| 8. | 1/1.8 mm Aluminium VIR cable (2.5 mm²) | 52m | 400-00 | 100m | 208-20 | |
| 9. | 1/1.8 mm Copper VIR cable (2.5 mm²) | 2m | 450-00 | 100m | 5-00 | From M.B to D.B |
| 10. | Switches flush type 5A, 250-V. (8 + 4) | 12 No. | 10-00 | each | 120-00 | |
| 11. | 3-pin sockets (2 in 1) 5A, 250-V. | 4 No. | 10-00 | each | 40-00 | |
| 12. | 3-pin sockets 15A, 250-V flush type, with switch control & neon. | 2 No. | 25-00 | each | 50-00 | |
| 13. | Ceiling rose 2-plate 5A. | 6 No. | 5-00 | each | 30-00 | For fans & tube light |
| 14. | Lamp holders batten type | 6 No. | 7-00 | each | 42-00 | |
| 15. | Wooden boards : a) 30 × 20 cm | 1 No. | 18-00 | each | 18-00 | For M.B. |
| | b) 30 × 30 cm | 1 No. | 20-00 | each | 20-00 | For D.B. |
| | c) 18 × 10 cm | 6 No. | 5-00 | each | 30-00 | For S.B.'s |
| 16. | Round blocks (4 + 2) | 6 No. | 1-50 | each | 9-00 | |
| 17. | Wooden gutties/plugs 9 cm² × 4 cm² 50 mm | 12 doz | 4-00 | doz | 48-00 | |
| 18. | Saddles..... 25 mm | 4 box | 3-00 | box | 12-00. | |
| 19. | Nails............. 12 mm | 1/2 Kg | 50-00 | Kg | 25-00 | For clips |
| | 25 mm | 1Kg | 50-00 | Kg | 50-00 | For batten |
| 20. | Wooden Screws : 60 mm | 30 No. | 50-00 | 100 | 15-00 | For boards |
| | 12 mm | 25 No. | 15-00 | 100 | 3-75 | For switches |
| 21. | Cement..... | 5 Kg | 3-00 | Kg | 15-00 | For gutties |
| 22. | Earth wire 16 SWG copper | 1 Kg | 100-00 | Kg | 100-00 | |
| 23. | Earth Set (Pipe, salt, coal etc.) | 1 set | 200-00 | set | 200-00 | |
| | Labour cost | - | - | - | 5400-00 | |
| | Total | | | | 7215.8 | |
| | 10% Contingency | | | | 721.6 | |
| | Grand Total | | | Rs. | 7937.41 | |
| | Say | | | | 7940=00/- | |

IV.

A drawing Hall 30m x 13m with ceiling height of 5m is to be provided with general illumination of 120 lux. Taking coefficient of utilisation is 0.5 and depreciation factor=0.7143, assume Mounting Height = 3m and space height ratio = 1 . Luminous efficiency of 80W fluorescent lamp is 40 lm/watts.

a. Determine the number of fluorescent lamps required. (5 marks)

b. Show the disposition of lamps with sketch (7 marks)

c. Calculate the no of sub circuits required for electrification (3 marks)

<table>
<tr><td>

Luminous efficiency of one lamp =η= 40 lm/watt

Lumen output of one lamp = η * watts

= 40 X 80=3200 lm

*Total Flux ( lumen)=A.E*

*=(30 x 13) x 120*

*= 46800 lumen*

$$Flux\ required = \Phi = \frac{Total\ flux}{CU * MF}$$

$$= \frac{46800}{0.5 * 0.7143}$$

= *131037.3739 lumen*

$$N = \frac{Flux\ Required}{Lumen\ Output\ Of\ 1\ Lamp}$$

$$= \frac{131037.3793}{3200}$$

$$= 40.95. = 41$$

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<tr><td>(b)Disposition of Lamps</td></tr>
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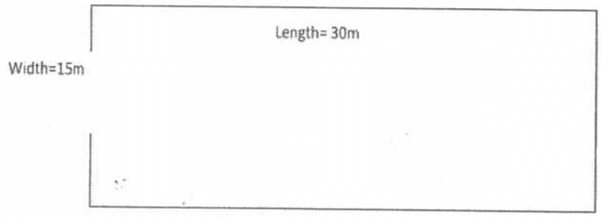



$$Space\ height\ ratio = 1.5$$

$$mounting\ \ height\ = 2m$$

$$\frac{Space}{Mounting\ Height} = 1.5$$

$$Space =?$$

$$Space = 1.5 * mounting\ height$$

$$= 15 * 2 = 3\ m$$

$$No\ of\ lamps\ fitted\ along\ width$$

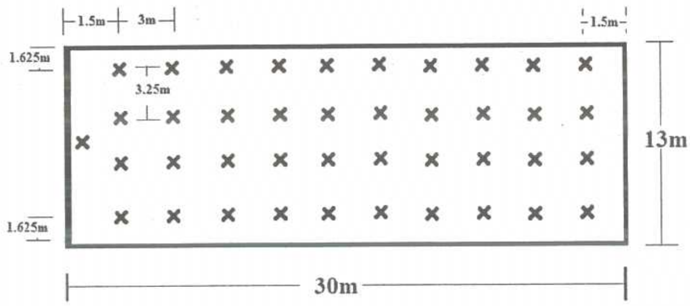
$$N_W = \frac{width}{space} = \frac{13}{3} = 4.3 = 4$$

$$No\ of\ lamps\ fitted\ along\ Length$$

$$N_L = \frac{Total\ lamps}{N_w}$$

$$= \frac{41}{4} = 10.25 = \ 10$$

arrange 40 lamps uniformly and 1 lamp separately




$$L_1 = \frac{Length}{N_L} = \frac{30}{10} = 3$$

$$L_2 = \frac{L_1}{2} = \frac{3}{2} = 1.5$$

$$W_1 = \frac{Width}{N_W} = \frac{13}{4} = 3.25$$

$$W_2 = \frac{W_1}{2} = \frac{3.25}{2} = 1.625$$

**(c)No of sub circuits**

*No of Lamps = N=41*

*Watt rating of 1 lamp= W = 80 W*

*Total wattage= N*W= 41x80 =3280 W*

*As per IE rules Load on Each sub circuit is restricted to 800 W Or 10 outlets*

$$No\ of\ Subcircuits = \frac{Total\ Watts}{800} \quad or \quad \frac{Total\ points}{10}$$

$$= \frac{3280}{800} \quad or \quad \frac{41}{10}$$

$$= 4.1\ or\ 4.1$$

$$= 5$$

OR

V.

Differentiate the working of tungsten filament lamps with fluorescent tubes and Compare the following lighting schemes with neat sketches. (7 marks)

| **Tungsten filament** | **Fluorescent tube** |
|---|---|
| Light output is affected by voltage fluctuations. | Fluctuations have comparatively less effect on light output. |
| Luminous efficiency increases with increase in applied voltage | Luminous efficiency increases with increase in what increase in wattage |
| It gives light close to natural light | It does not give light close to natural light therefore colour rendering is defective. |
| Heat radiations are present due to hi working temperature | Heat radiations are negligible. |
| It's brightness is more | Its brightness is less |
| Average lamp efficiency is 1000 hours | Average lamp efficiency is 6,000 hours |
| Increase in voltage may damage it | Increase in voltage does not create large variations |
| Light output of the lamp reduces with the passage of time | Output reduces more rapidly as compared to lamp. |
| Initial cost per lamp is low | Initial cost per lamp is more. |
| For same light output large number of lamps are required. | For same light output number of tubes required are less. |

a. Direct lighting. (2 marks)

It is the most commonly used type of lighting schemes in this mother more than 90 percentage of total light flux is made to fall directly on the working playing with the help of deep are reflected it creates Hard glare and shadows. It is mainly used for Industrial and general outdoor lighting.

b. Indirect lighting. (2 marks)

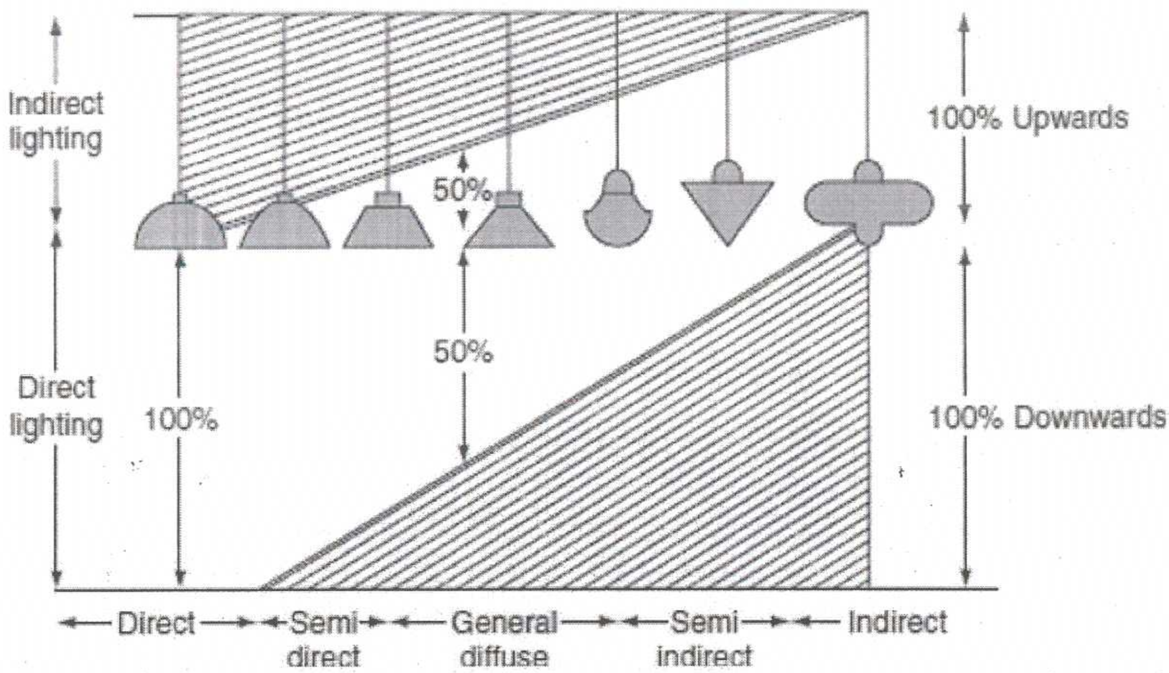
In this lighting scheme more than 90 percentage of total light flux is thrown upwards to the ceiling for diffuse reflection in such a system the ceiling act as the light source and glare is reduced to minimum. It is used for decoration purpose in cinema theatres and hotels etc

c. Semidirect lighting. (2 marks)

In this lighting scheme 60 to90 percentage of the total flux is made to fall down towards directly with the help of semi direct reflectors. Remaining light is used to illuminate the ceiling and walls. Such lighting scheme is situated to rooms with high ceilings where a high level of uniformly distributed illumination is desirable.

d Semi indirect lighting (2 marks)

In this lighting scheme 60 to 90 percentage of total light flux is thrown upwards to the ceiling for diffuse reflection and the rest reaches the working plane directly. This lighting scheme is used with soft shadows and glare free. It is mainly used for indoor lighting decorations.




VI.

A 10 HP, 3 phase induction motor is to be installed in a workshop which is located 25m away from the main distribution panel board.

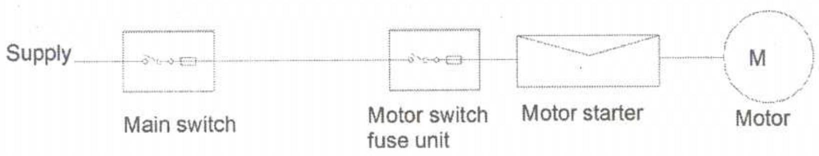
a. Develop installation plan showing location of Main Board and motor etc. Also mark the path of wiring by a thick line. (3 marks)

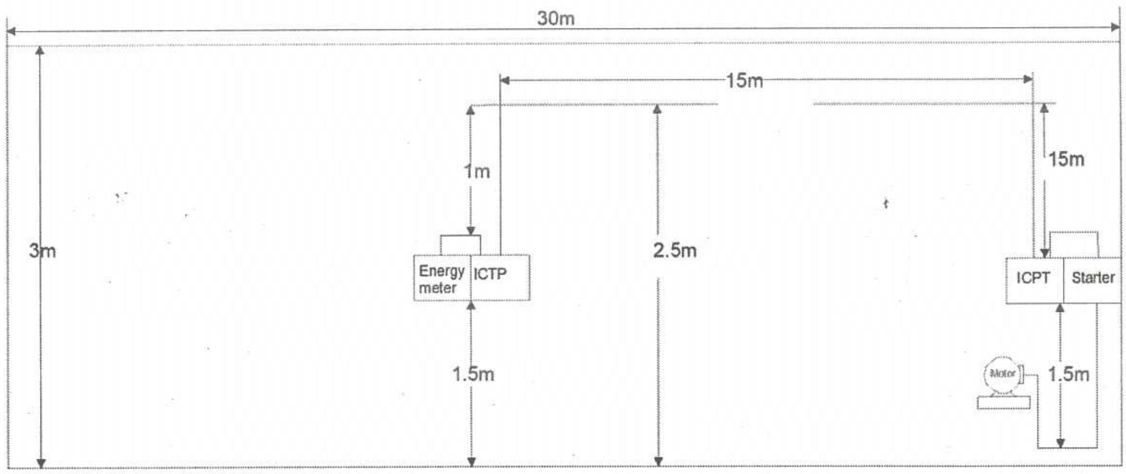
b. Develop the single line diagram? Show earth wires also. (5 marks)

c. Select the rating and specification of important material and Calculate the length of wire, conduit, earth wire etc. and prepare a complete list of material required for wiring the room with complete specification of each item. Also calculate the approximate cost for power wiring

Single line diagram

(7 marks)




Assumptions:-

1. The main switch, motor switch fuse unit, starter etc are mounted 1.5m above ground level.

2. Cable trench is 0.5m deep.

3. The motor will be installed 0.3m above floor level.

4. Efficiency of the motor is 0.85 and power factor is 0.8.

5. From DB to motor switch, 3 core cable is used and from motor starter to motor terminals, two runs of 3 core cable is used.

[I] Selection of starter:-

Since the motor capacity is 10HP, we can select an automatic Star/Delta starter.

[II] Calculation of current:-

Full load current $= (10 * 735.5)/(\sqrt{3} * 0.85 * 415 * 0.8)$

$= 15A$

Since we are using a star/delta starter, the starting current will be 1.5 times of full load current.

Starting current $= 15 * 1.5$

$= 22.5A$

[III] Selection of cable:-

The cable rating shall withstand the starting current. So we can select a 3core, $10mm^2$, Aluminium cable of 1100V grade which can withstand 27A.

[IV] Selection of fuse rating:-

The fuse rating should be greater than the starting current of the motor. Since the starting current of motor is 22.5A, we can select standard fuse rating of 32A.

[V] Selection of main switch:-

The selection of main switch and motor main switch and the motor switch fuse unit can be 32A, 500V grade ie 32A, 500V, ICTPR.

[VI] Size of conduit:-

From meter board to main switch and from main switch to motor main switch, 3core cables are to be run. So 25mm rigid HG conduit is used.

From starter motor to motor terminals, 6 cables are to be run. So we can use 2 runs of 3core cables and for this we can use 38mm HG conduit.

Total length of cable = 30 + (2x5) = 40 m

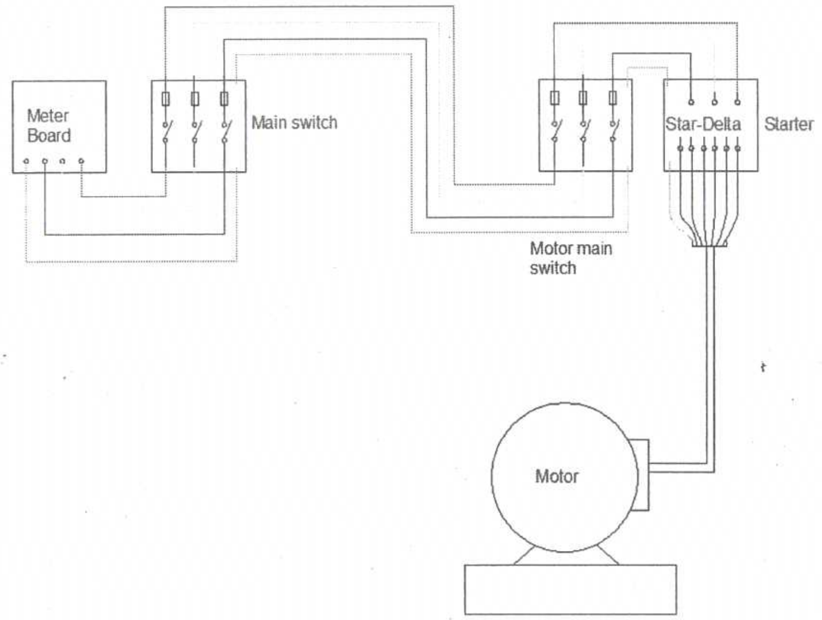
[VII] Earth wire required = 30+5 = 35m

[VIII] Labour charge:-

One electrician and a helper will take 2 days to complete the work

Labour charge = 2*1000 = 2000 rs

Layout of the wiring




| Sl No | Materials required | Unit | Quantity | Rate | Amount |
|---|---|---|---|---|---|
| 1 | 32A, 500V,ICTP | No | 2 | 500 | 1000 |
| 2 | 10HP automatic star-delta starter | No | 1 | 3000 | 3000 |
| 3 | 25mm HG conduit | M | 30 | 15 | 450 |
| 4 | 38mm HG conduit | M | 5 | 20 | 100 |
| 5 | $6mm^2$,Al, 3core cable | M | 40 | 25 | 1000 |
| 6 | Iron frame for fixing starter and board | No | 2 | 250 | 500 |
| 7 | Nails and srews | | Lum sum | | 100 |
| 8 | Earth set (Pipe) | No | 2 | 2000 | 4000 |
| 9 | 8 SWG CU wire for earth | M | 10 | 20 | 200 |
| 10 | Labour charge | Day | 2 | 1000 | 2000 |
| | | | | | |

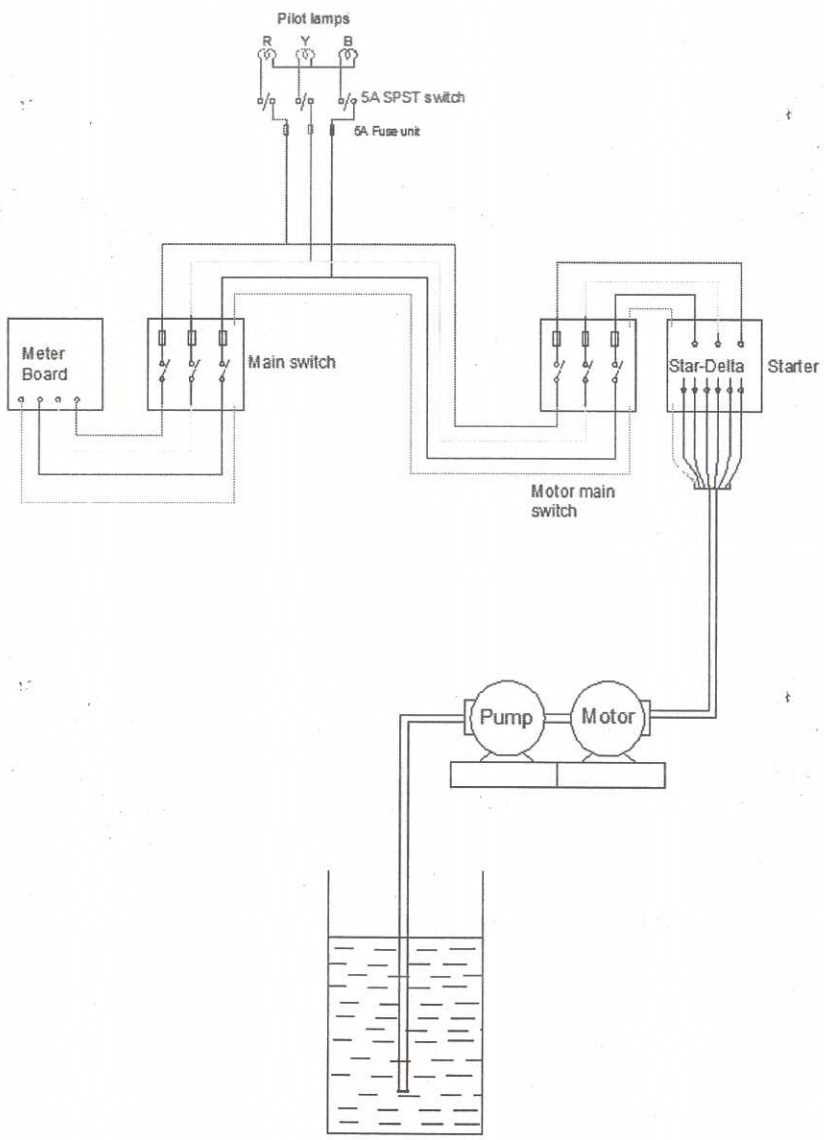
OR

VII.

An agricultural pump set motor 5kw, 400V, 50Hz three phase using star-delta starter including pilot lamps to be installed. The supply to the pump is to be taken from an over head LT, three phase pole 15m away from the pump shed in open conduit system of wiring for motor connection and show the layout of the connection.

a. Construct the sketch of service connection? (6 marks)

b. Prepare a list of material, for giving service connection and also estimate the cost of service connection. (9 marks)




[I] Assumptions:-

1. The efficiency of the pump set is 85% and power factor 0.8.

2. The height of the pumpset house is 3m.

3. Height of starter, switch board is 1.5m above ground.

4. The cost of motor is not included in the estimate.

5. The cost of service wire is not included in the estimate.

Full load current of motor = {5*1000}/{√3*400*0.8*0.85}

= 10.6A

Starting current of motor = 1.5*10.6

= 16A

[III] Selection of cable:-

We can use 3core cable of 6mm$^2$ Al wire having a current carrying capacity of 27A.

[IV] Selection of conduit:-

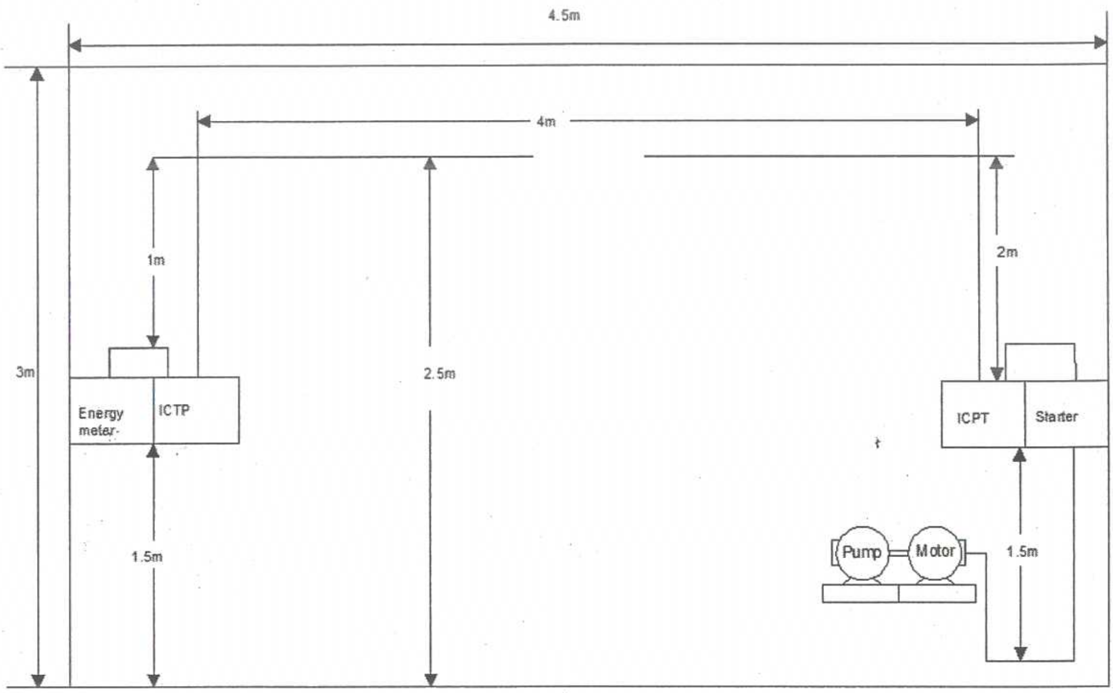
For single run 3core cable, we can use 25mm HG conduit.

For two run of 3 core cable, we can use 38mm HG conduit.

[V] Selection of main switch:-

32A, 500V, ICTP switch can be used.

[VI] Length of conduit:-




Length of 25mm conduit = 1+4+2 = 7m approx- 8m

Length of 38mm conduit = 1.5+1+1.5 = 4m approx.- 5m

[VII] Length of cable required:-

3core cable required = 8+ (2*5)

= 18m

Earth wire required = 8+5 = 13m

[VIII] Labour charge:-

One electrician and a helper will take 2 days to complete the work

Labour charge = 2*1000 = 2000 rs

[VIII] Estimate:-

| Sl No | Materials required | Unit | Quantity | Rate | Amount |
|---|---|---|---|---|---|
| 1 | 32A, 500V,ICTP | No | 2 | 500 | 1000 |
| 2 | 5A, 230V, 15W indicating lamps | No | 3 | 25 | 75 |
| 3 | 5A, 230V porcelain fuse unit | No | 3 | 25 | 75 |
| 4 | 5A, 230V Steady batten holder for lamps | No | 3 | 20 | 60 |
| 5 | 5A, 230V SPST switch | No | 3 | 25 | 75 |
| 6 | 25mm HG conduit | M | 8 | 15 | 120 |
| 7 | 38mm HG conduit | M | 5 | 20 | 100 |
| 8 | $6mm^2$,Al, 3core cable | M | 18 | 25 | 450 |
| 9 | Iron frame for fixing starter and board | No | 2 | 250 | 500 |
| 10 | Nails and srews | | Lum sum | | 100 |
| 11 | Earth set (Pipe) | No | 2 | 2000 | 4000 |
| 12 | Labour charge | Day | 2 | 1000 | 2000 |

VIII.

Estimate the cost and material for extending a single phase distribution line of 230 V, over a distance of 500 m using 9 m PSCC poles. Take span as 100m and use 7/3 AAC conductor.

i. Size of conductor : ACSR 6/1 x 2,59 mm

ii. Tubular pole or supports of 11 metres length.

iii. Size of earth wire : G.S.(Galvanized steel) 8 SWG.

iv. Average span : 100 m

v. No. of earthing sets to be installed : 3 Nos

a. Construct the single line diagram of the line (5 marks)

b. Prepare the estimation table for the overhead line erection. (10 marks)

| | |
|---|---|
| Distance | = 500 m |
| Span | = 100 m |
| No of poles | = 500/100 = 5 |
| Length of AAC conductor | = 2 x 500 + 5% wastage |
| | = 1000x1.05 = 1050 |
| No of cross arms | = 5+1 at existing line = 6 |
| Insulators | |
| Pin type = 4 x2 =8 | |
| Disc type = 2 x2 = 4 | |

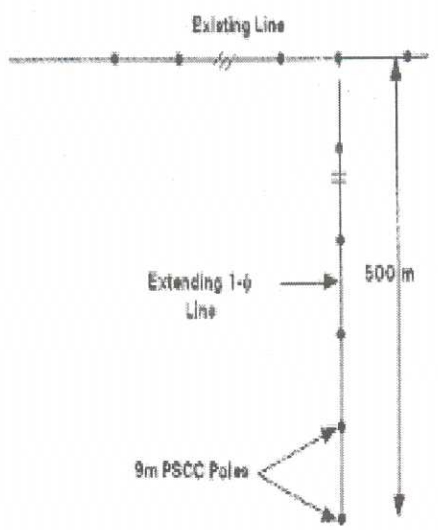



Fig. 4.7

## Schedule of Material

| S. No. | Specification of Material | Qty. | Rate Rs. Ps | Rate Per | Cost | Remarks |
|---|---|---|---|---|---|---|
| 1. | PSCC poles 9 m long | 5 No. | 2000 | each | 10000 | |
| 2. | AAC conductor | 1050 m | 120 | kg | 63000 | 2 m ~ 1 kg |
| 3. | Pin insulators (11 kV) | 8 No. | 250 | each | 2000 | |
| 4. | Disc insulators (11 kV) | 2 No. | 250 | each | 500 | |
| 5. | MS cross arms (1.52 m × 75 mm × 37 mm) | 6 No. | 30 | kg | 540 | 1 cross arm ~ 3 kg |
| 6. | Earth sets | 2 No. | 500 | each | 1000 | |
| 7. | Stay sets including guy insulator and clamps | 3 No. | 1200 | set | 3600 | |
| 8. | Danger plates | 5 No. | 25 | each | 125 | one on each pole |
| 9. | Cement | 10 bags | 110 | each | 550 | for poles & stay set foundation |
| 10. | Concrete (40 mm) | 20 bags | 30 | bag | 600 | |
| 11. | Sand | 2 tons | 350 | ton | 700 | |
| 12. | Binding wire (Aluminium) | 2 kg | 120 | kg | 240 | |
| 13. | M.S fat for cross arm fixing | 6 No. | 30 | kg | 90 | each ~ 500 gm |
| 14. | Silver paint | 10 lit | 150 | lit | 1500 | |
| 15. | Nuts & bolts | 50 kg | 50 | kg | 2500 | |
| 16. | Labour charges | - | - | - | 5000 | Approximately Rs. 1000 per pole including pit OH conductor fix etc.... |
| | | | | | 87845 | |
| | Approximately | | | | 88000/- | |

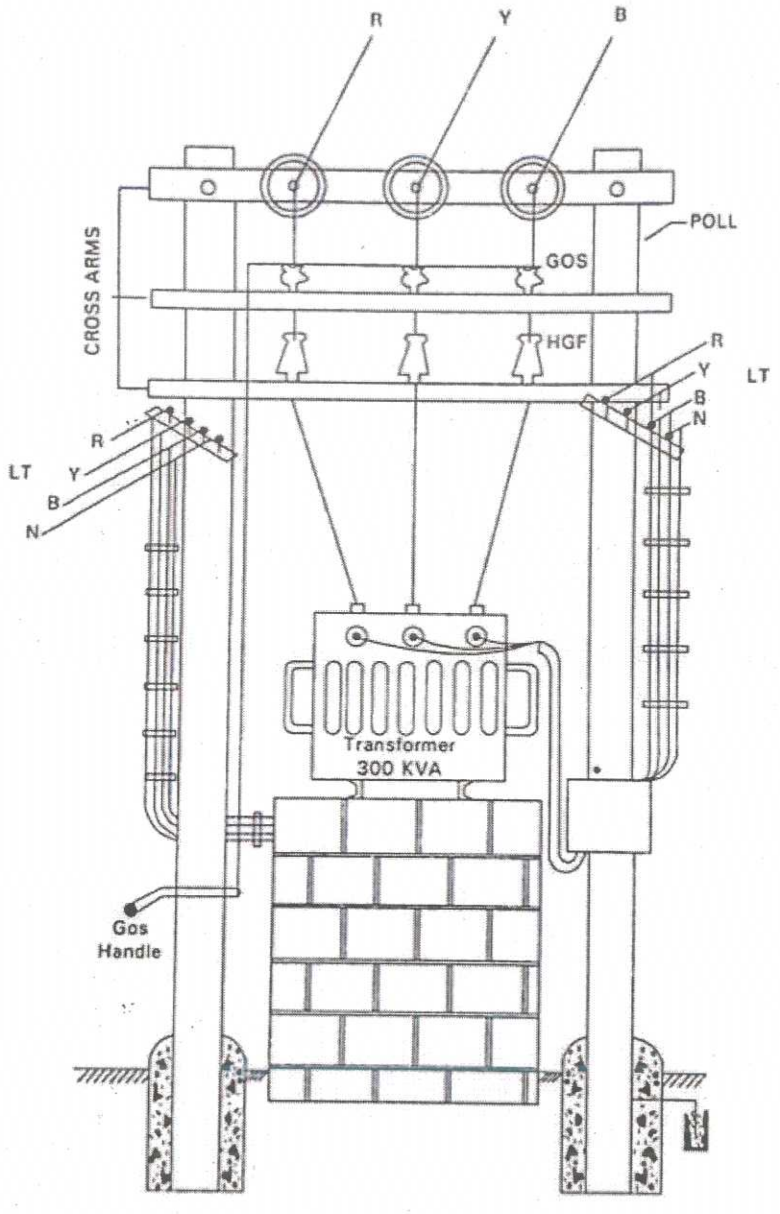
OR

IX.

A foundation mounted substation of capacity 100kVA transformer of rating 11/0.4 kV has to be erected. The HT line is available about 50 metres from the proposed site.

a. Select a suitable structure for this transformer and Construct a neat sketch of the arrangement and label all the items pole mounted substation satisfying above conditions. (9 marks)

b. Prepare a list of materials for erecting this transformer ? (6 marks)




DISTRIBUTION TRANSFORMER MOUNTED ON PLINTH WITH TWO POLES

| S. No. | Specification of Material | Qty. | Remarks |
|---|---|---|---|
| 1. | 100 kVA, 11 kV/400-V transformer unit with mounting & accessories (like bushings & conservator etc). | 1 No. | |
| 2. | PSCC Poles 11 m long | 2 No. | for H-structure |
| 3. | Cross-arms - M.S. channels 100 × 50 × 6 mm – 2m long | 2 No. | For T/F platform |
| 4. | M.S. angles 50 × 50 × 6 mm - 2m long | 3 No. | For fixing GOS, H.G fuses |
| 5. | Cross-arm clamps | 6 No. | |
| 6. | M.S. flat 50 × 6 mm - 2m long | 2 No. | Transformer belting |
| 7. | 11 kV lightning arrestors | 3 No. | |
| 8. | 11 kV gang operating AB switch with 25 mm $\phi$ operating pipe and handle | 1 set | |
| 9. | 11 kV disk insulators | 3 No. | dead end arrangement |
| 10. | 11 kV Horn-gap fuse units | 1 set | For 3-phase |
| 11. | ICTPN 200 A, 500-V, with rewirable fuses. | 1 No. | |
| 12. | AAR or ACSR conductor | 18m | From OH to T/F |
| 13. | Stay sets (complete) | 2 No. | |
| 14. | Earthing sets (complete) | 2 No. | |
| 15. | Earthing wire 8 SWG GI | 6m | For earthing |
| 16. | $3\frac{1}{2}$ core, 120 mm², Aluminium conductor PVC insulated PVC sheathed cable | 10m | From T/F to D.B |
| 17. | 95 mm², single core aluminium conductor, PVC insulated, PVC sheathed cable | 24m | From D.B to L.T line (R-Y-B-N) |
| 18. | Distribution or cable box | 1 No. | |
| 19. | Barbed wire | 25 kg | For fencing |
| 20. | Binding wire aluminium | 1 kg | |
| 21. | Nuts & bolts of different size | L.S. | |
| 22. | Danger plate | 1 No. | |
| 23. | Cement | 1/2 bag | Poles foundation |
| 24. | Aluminium paint | 2 Lit | |
| 25. | Sand | L.S. | |
| 26. | Miscellaneous (red oxide, tape, thimble etc.) | L.S. | |

****************************END************************************