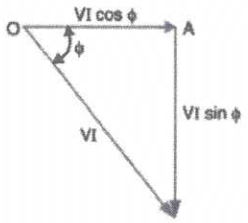
100

April-24
Pageno-12

5032 ELECTRICITY GENERATION TRANSMISSION & DISTRIBUTION SET NO:I

QID: 2109230057

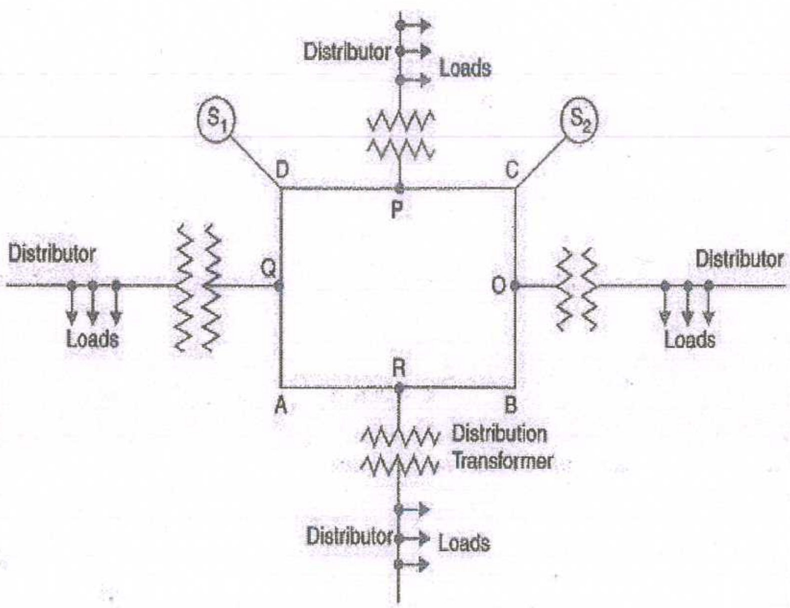
Scoring Indicators

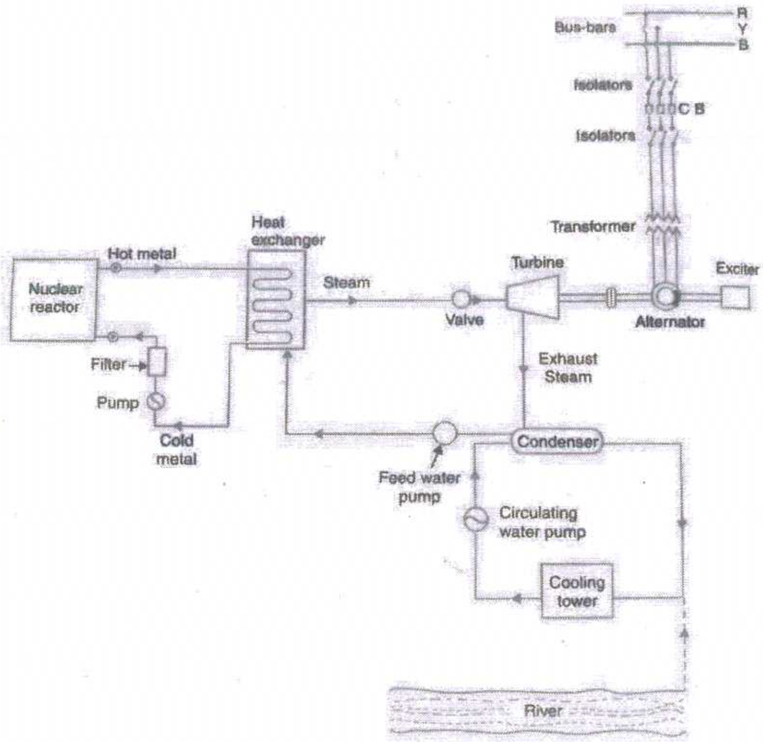
Q No	Scoring Indicators	Split score	Sub Total	Total Score
	PART A			
I. 1	Solar, wind, geo thermal, hydro, tidal	0.5x2	1	1
I. 2	Penstocks are open or closed conduits which carry water to the turbines.	1	1	1
I. 3	Sum of individual maximum demands to maximum demand on power station	1	1	1
I. 4		1	1	1
I. 5	Domestic	1	1	1
I. 6	decreases	1	1	1
I. 7	The difference in level between points of supports and the lowest point on the conductor is called sag	1	1	1
I. 8	Current carrying capacity	1	1	1
I. 9	The ratio of voltage across the whole string to the product of number of discs and the voltage across the disc nearest to the conductor.	1	1	1

PART B

II. Answer any **eight** questions from the following, each question carries 3 marks

II. 1	a. Supply of fuel: should be located near the coal mines so that transportation cost of fuel is minimum. b. Availability of water: huge amount of water is required for the condenser; so plant should be located at the bank of river or canal. c. Transportation facilities: should be well connected to other parts of the country by rail, road etc. d. Cost and type of land: should be located at a place where land is cheap and further extension if possible. e. Nearness to load centres: to reduce the transmission cost. f. Distance from populated area: should be located at a considerable distance from populated areas since smoke and fumes from burnt coal pollutes the surrounding area.	3x1	3	3
II. 2	1.Exchange of peak loads 2.Use of older plants 3.Ensures economical operation 4.Increases diversity factor 5.Reduces plant reserve capacity	6x0.5	3	3
II. 3	a. Large kVA rating of equipment b. Greater conductor size c. Large copper losses d. Poor voltage regulation e. Reduced handling capacity of the system	3x1	3	3
II. 4	1. Load factor: ratio of average load to the maximum demand during a given period.	1.5	3	3
	2. Load curve: the curve showing the variation of load on the power station with respect to time	1.5		
II. 5	(a)Demand factor $=\frac{Maximum\ demand}{Connected\ load} = \frac{20}{43} = 0.465$	1	3	3
	(b) Average demand$=\frac{units\ generated\ per\ annum}{Hours\ in\ an\ year}$ $= \frac{61.5 \times 10^6}{8760} = 7020kW$	1.5		
	Load factor$=\frac{Average\ demand}{Maximum\ demand} = \frac{7020}{20\times10^3}$=0.351 or 35.1%	0.5		
II. 6	• High electrical conductivity • High tensile strength in order to withstand mechanical stresses • Low cost so that it can be used for long distances • Low specific gravity so that weight per unit volume is small	1+1+1	3	3

II. 7	The tendency of alternating current to concentrate near the surface of a conductor is known as skin effect. • The effective area of cross section of the conductor through which current flows is reduced • The resistance of the conductor is slightly increased when carrying an alternating current	1 1x2	3	3
II. 8	1. Improve power transfer capability. 2. Confining power flow to designated routes. 3. Transient and dynamic stability improvement. 4. Damping of power system oscillations. 5. Better voltage regulation. 6. Flexible operation and control of the system	0.5x6	3	3
II 9	The process of achieving uniform electrostatic stress in the dielectric cables is known as grading of cables	1	3	3
	The unequal stress distribution in a cable is undesirable for two reasons. 1.insulation of greater thickness is required which increases the cable size 2.It may lead to breakdown of insulation. In order to overcome the above disadvantages, it is necessary to have uniform stress distribution in cables.	2*1		
II.10	 	3	3	3

	PART C			
III	 1) Nuclear reactor- It is an apparatus in which nuclear fuel (U^{235}) is subjected to nuclear fission. It controls the chain reaction that starts once the fission is done. 2) Heat exchanger 3) Steam turbine 4) Alternator	4+3	7	7
IV	The constituents of a hydro-electric plant are **(i) Dam.** A dam is a barrier which stores water and creates water head. Dams are built of concrete or stone masonary, earth or rock fill. The type and arrangement depends upon the topography of the site. **(ii) Spillway**. There are times when the river flow exceeds the storage capacity of the reservoir. In order to discharge the surplus water from the storage reservoir into the river on the downstream side of the dam spillways are used. Spillways are constructed of concrete piers on the top of the dam. Gates are provided between these piers and surplus water is discharged over the crest of the dam by opening these gates. **(iii) Headworks.** The headworks consists of the diversion structures at the head of an intake.They generally include booms and racks for diverting floating debris, sluices for by-passing debris and sediments and valves for controlling the	4(fig)+3(explanation)	7	7

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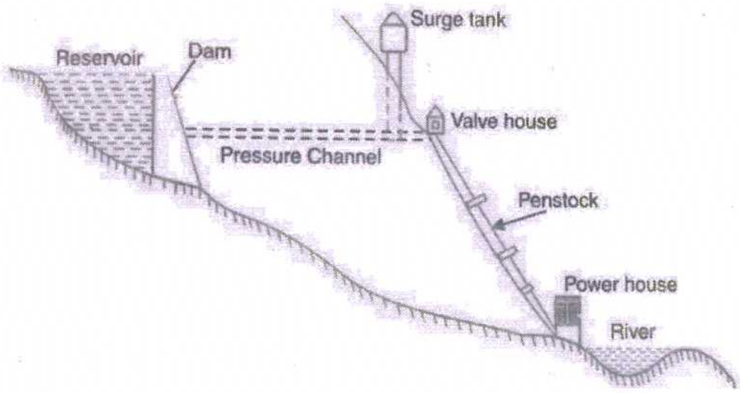
flow of water to the turbine.
(iv)Surge tank- A surge tank is a small reservoir or tank (open at the top) in which water level rises or falls to reduce the pressure swings in the conduit.
(v) Penstocks. Penstocks are open or closed conduits which carry water to the turbines. They are generally made of reinforced concrete or steel. Concrete penstocks are suitable for low heads (<30 m) as greater pressure causes rapid deterioration of concrete. The steel pen- stocks can be designed for any head; the thickness of the penstock increases with the head or working pressure.


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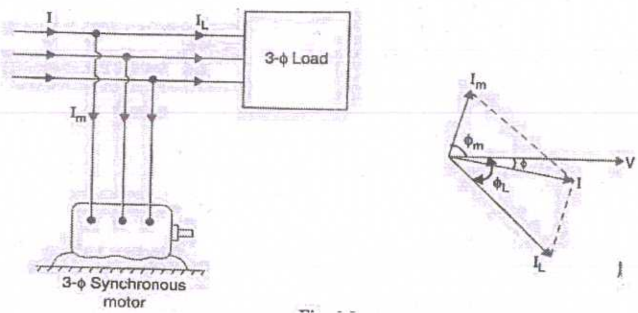
An over-excited synchronous motor running on no load is known as synchronous condenser. When such a machine is connected in parallel with the supply, it takes a leading current which partly neutralizes the lagging reactive component of the load. Thus, the power factor is improved.


The 3phase load takes current I_L , at low lagging power factor cosø. The synchronous condenser takes a current Im which leads the voltage by an angle $ø_m$. The resultant current I is the phasor sum of I_L and Im, and lags behind the voltage by an angle ø. It is clear that ø is less than $Ø_L$, so that cosø is greater than $cosØ_L$. Thus the power factor is increased from $cosØ_L$, to cosø.
Advantages:
By varying the field excitation, the magnitude of
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<td>4(fig)

1(explanation)</td>
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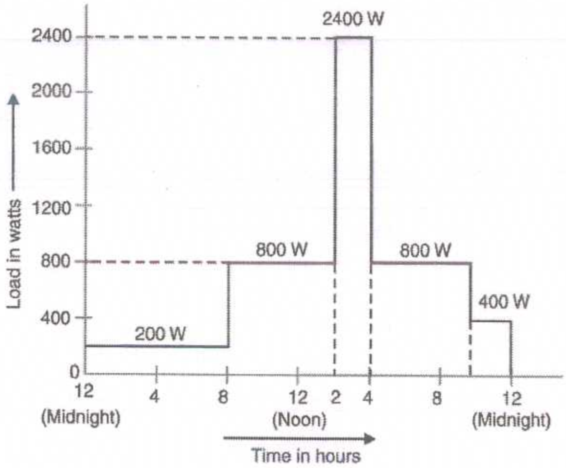
	current drawn by the motor can be change by any amount. This helps in achieving stepless control of power factor. • The motor windings have high thermal stability to short circuit currents. • The faults can be removed easily. **Disadvantages** • There are considerable losses in the motor. • The maintenance cost is high. • Except in sizes above 500 kVA, the cost is greater than that of static capacitors of the same rating. • As a synchronous motor has no self-starting torque, therefore, an auxiliary equipment has to be provided for this purpose.	0.5x2 0.5x2		
VI	**Two-part tariff.** When the rate of electrical energy is charged on the basis of maximum demand of the consumer and the units consumed, it is called a two-part tariff, In two-part tariff, the total charge to be made from the consumer is split into two components viz., fixed charges and running charges. • The fixed charges depend upon the maximum demand of the consumer while the running charges depend upon the number of units consumed by the consumer. Thus, the consumer is charged at a certain amount per kW of maximum demand plus a certain amount per kWh of energy consumed i.e., **Total charges = Rs (b x kW+ c x kWh)** Where, b = charge per kW of maximum demand c = charge per kWh of energy consumed This type of tariff is mostly applicable to industrial consumers **Three-part tariff.** When the total charge to be made from the consumer is split into three parts viz., fixed charge, semi-fixed charge and running charge, it is known as a three-part tariff. i. **Total charge = Rs (a + b x kW+ c x kWh)** Where, a = fixed charge made during each billing period. It includes\ interest and depreciation on the cost of secondary distribution and labour cost of collecting revenues, b = charge per kW of maximum demand, c = charge per kWh of energy consumed.	3.5+3.5	7	7

VII	Units consumed/year = Max.demand×L.F.× Hours in an year = (200)x(0·4)x8760 = 7,00,800 kWh Annual charges =Annual M.D.charges +Annualenergy charge = Rs (100x200 + 0·1x7,00,800) = Rs 90,080 Overall cost/kWh = Rs$\frac{90,080}{7,00,800}$ = 0.125 = 12.5*paise*	3 2 2	7	7
VIII	 L.F. of consumer 1 = $\frac{\text{Energy consumed / day}}{\text{Max. demand} \times \text{Hours in a day}} \times 100$ $= \frac{600 \times 6 + 200 \times 2 + 800 \times 6}{800 \times 24} \times 100 = 45{\cdot}8\%$ L.F. of consumer 2 = $\frac{200 \times 8 + 1000 \times 2 + 200 \times 2}{1000 \times 24} \times 100 = 16{\cdot}7\%$ L.F. of consumer 3 = $\frac{200 \times 6 + 1200 \times 2 + 200 \times 2}{1200 \times 24} \times 100 = 13{\cdot}8\%$	4 1+1+1	7	7
IX	**1.Copper.** Copper is an ideal material for overhead lines owing to its high electrical conductivity and greater tensile strength. It is always used in the hard drawn form as stranded conductor.Although hard drawing decreases the electrical conductivity slightly yet it increases the tensile strength considerably. Copper has high current density , the current carrying capacity of copper per unit of X-sectional area is quite large. This leads to two advantages. Firstly, smaller X-sectional area of conductor is required and secondly, the area offered by the conductor to wind loads is reduced. Moreover, this metal is quite homogeneous, durable and has high scrap value. **2.Aluminium**. Aluminium is cheap and fight as compared to copper but it has much smaller conductivity and tensile strength (1) The conductivity of aluminium is 60% that of copper.. (ii) The specific gravity of aluminium (2-71 gm/cc) is lower than that of copper (8-9 gm/cc), Therefore, an aluminium conductor has almost one-half the weight of equivalent copper conductor. Aluminium conductor being light, is liable to	1.5 1.5	1.5 + 1.5 + 2 + 1+ 1	7

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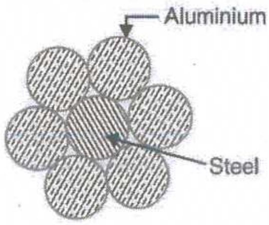
<td>greater swings and hence larger cross-arms are required.
(iv) Due to lower tensile strength and higher co-efficient of linear expansion of aluminium, the sag is greater in aluminium conductors.
Considering the combined properties of cost, conductivity, tensile strength, weight etc., aluminium has an edge over copper.Therefore, it is being widely used as a conductor material.
It is particularly profitable to use aluminium for heavy-current transmission where the conductor size is large and its cost forms a major proportion of the total cost of complete installation.
3. Steel cored aluminium. In order to increase the tensile strength, the aluminium conductor is reinforced with a core of galvanised steel wires. The "composite conductor Aluminium thus obtained is known as steel cored aluminium and is abbreviated as A.C.S.R. (aluminium conductor steel reinforced).
Steel-cored aluminium conductor consists of central core of


galvanised steel wires surrounded by a number of aluminium strands. Usually, diameter of both steel and aluminium wires is the same. The X-section of the two metals are generally in the ratio of 1:6 but can be modified to 1:4 in order to get more tensile strength for the conductor. Fig. shows steel cored aluminium conductor having one steel wire surrounded by six wires of aluminium.
The steel cored aluminium conductors have the following advantages: (i) The reinforcement with steel increases the tensile strength but at the same time keeps the composite conductor light. Therefore, steel cored aluminium conductors will produce smaller sag and hence longer spans can be used. (ii) Due to smaller sag with steel cored aluminium conductors, towers of smaller heights can be used.

4.Galvanised steel. Steel has very high tensile strength. Therefore, galvanised steel conductors can be used for extremely long spans or for short line sections exposed to abnormally high stresses due to climatic conditions. They have been found very suitable in rural areas where cheapness is the main consideration. Due to poor conductivity and high resistance of steel, such conductor are not suitable for transmitting large power over a long distance. However, they can be used to advantage for transmitting a small power over</td>
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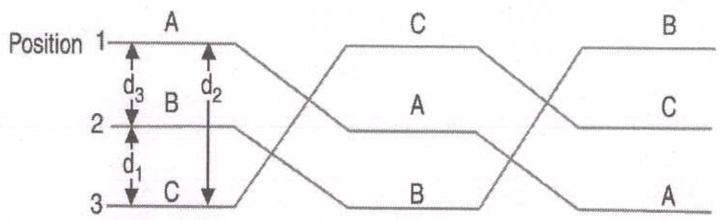
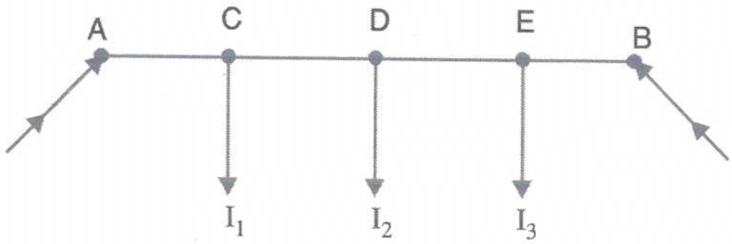
	a small distance where the size of the copper conductor desirable from economic considerations would be too small and thus unsuitable for use because of poor mechanical strength. **5. Cadmium copper.** The conductor material now being employed in certain cases is copper alloyed with cadmium. An addition of 1% or 2% cadmium to copper increases the tensile strength by about 50% and the conductivity is only reduced by 15% below that of pure copper. Therefore cadmium copper conductor can be useful for exceptionally long spans. However, due to high cost of cadmium, such conductors will be economical only for lines of small X-section i.e., where the cost of conductor material is comparatively small compared with the cost of supports.	1		
X	When 3-phase line conductors are not equidistant from each other, the conductor spacing is said to be unsymmetrical. Under such conditions, the flux linkages and inductance of each phase are not the same. A different inductance in each phase results in unequal voltage drops in the three phases even if the currents in the conductors are balanced. Therefore, the voltage at the receiving end will not be the same for all phases. In order that voltage drops are equal in all conductors, we generally interchange the positions of the conductors at regular intervals along the line so that each conductor occupies the original position of every other conductor over an equal distance. Such an exchange of positions is known as transposition.. Figure shows the transposed line. The phase conductors are designated as *A, B* and *C* and the positions occupied are numbered 1, 2 and 3. The effect of transposition is that each conductor has the same average inductance. 	3(fig) + 4 explanation	3+ 4	7
XI	**Distributor fed at both ends.** In this type of feeding, the distributor is connected to the supply mains at both ends and loads are tapped off at different points along the length of the distributor. The voltage at the feeding points may or may not be equal.	3(fig)	3 + 2 + 2	7

	 Fig. shows a distributor *AB* fed at the ends *A* and *B* and loads of *I*1, *I*2 and *I*3 tapped off at points *C*, *D* and *E* respectively. Here, the load voltage goes on decreasing as we move away from one feeding point *say A*, reaches minimum value and then again starts rising and reaches maximum value when we reach the other feeding point *B*. The minimum voltage occurs at some load point and is never fixed. It is shifted with the variation of load on different sections of the distributor. **Advantages** (a) If a fault occurs on any feeding point of the distributor, the continuity of supply is maintained from the other feeding point. b) In case of fault on any section of the distributor, the continuity of supply is maintained from the other feeding point. c) The area of X-section required for a doubly fed distributor is much less than that of a sing fed distributor.	2(explanation) 2x1		
XII	Direct laying. This method of laying underground cables is simple and cheap and is much favoured in modern practice. In this method, a trench of about 1·5 metres deep and 45 cm wide is dug. The trench is covered with a layer of fine sand (of about 10 cm thickness) and the cable is laid over this sand bed. The sand prevents the entry of moisture from the ground and thus protects the cable from decay. After the cable has been laid in the trench, it is covered with another layer of sand of about 10 cm thickness.The trench is then covered with bricks and other materials in order to protect the cable from mechanical injury. When more than one cable is to be laid in the same trench, a horizontal or vertical interaxial spacing of atleast 30 cm is provided in order to reduce the effect of mutual heating and also to ensure that a fault occurring on one cable does not damage the adjacent cable.	3(explanation) 4(fig)	7	7

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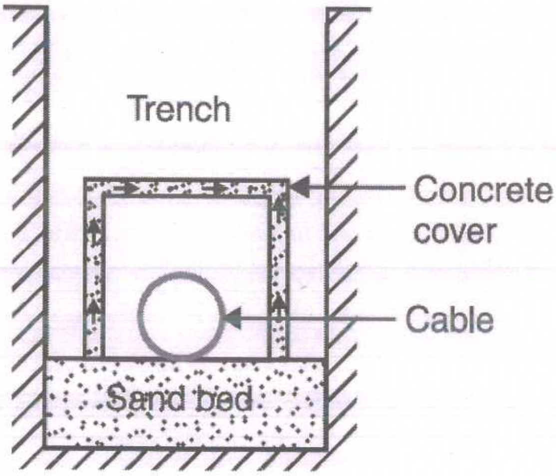
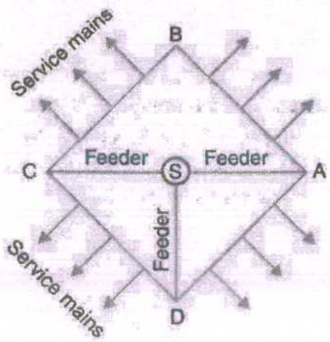
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>XIII</td><td>That part of power system which distributes electric power for local use is known as distribution system.
In general, the distribution system is the electrical system between the sub-station fed by the transmission system and the consumers meters. It generally consists of feeders, distributors and the service mains.
(i) Feeders. A feeder is a conductor which connects the sub-station (or localised generating station) to the area where power is to be distributed. Generally, no tapings are taken from the feeder so that current in it remains the same throughout. The main consideration in the design of a feeder is the current carrying capacity.
(ii) Distributor. A distributor is a conductor from which tappings are taken for supply to the consumers. In Fig. AB, BC, CD and DA are the distributors. The current through a distributor is not constant because tappings are taken at various places along its length. While designing a distributor, voltage drop along its length is the main consideration since the statutory limit of voltage variations is± 6% of rated value at the consumers' terminals.
(iii) Service mains. A service mains is generally a small cable which connects the distributor to the consumers' terminals.
</td><td>1.5

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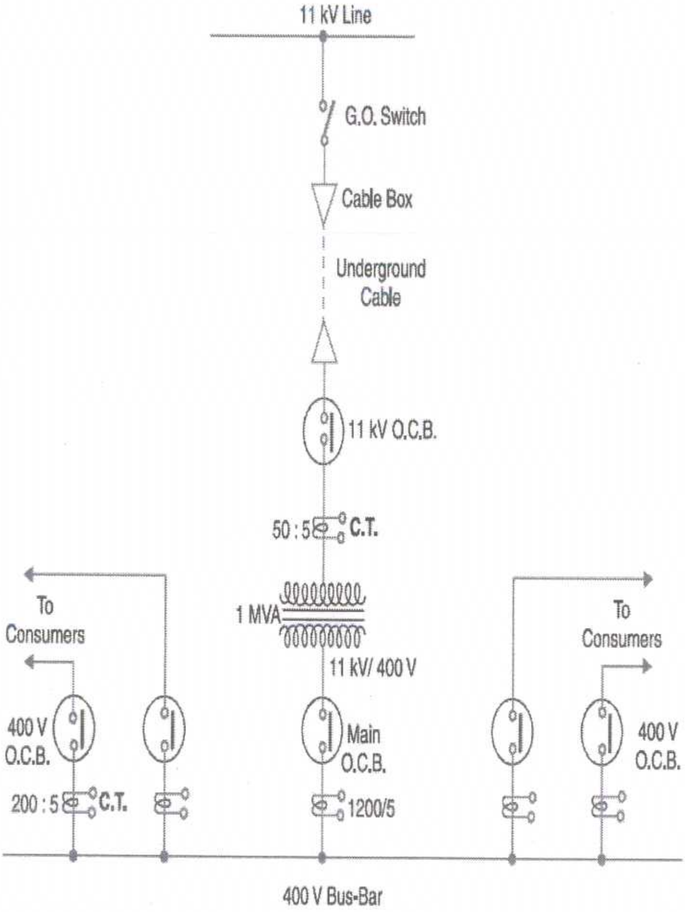
<td>
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