SCHEME OF VALUATION

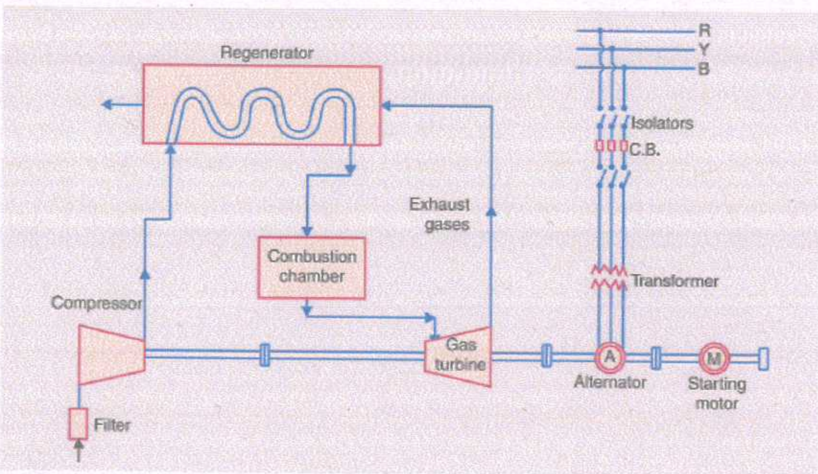
(Scoring Indicators)

Revision (2015) Course Code: 4034

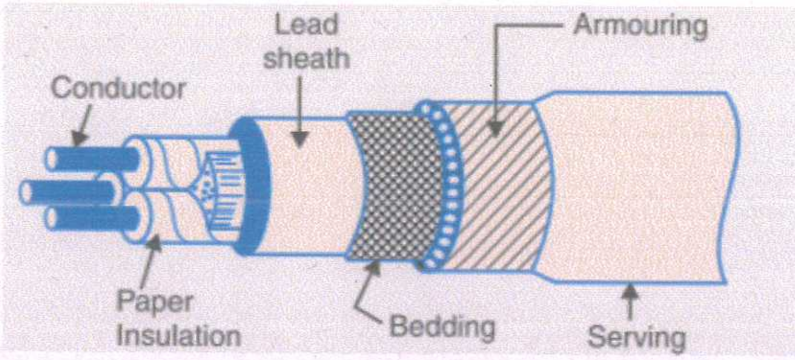
Course Title : **ELECTRICAL POWER GENERATION, TRANSMISSION AND DISTRIBUTION**

Qst. No	Scoring Indicator	Split up Score	Sub Total	Total
I	Part A			
1.	The moderator consists of graphite rods which enclose the fuel rods. The moderator slows down the neutrons before they bombard the fuel rods.	2	2	
2.	a) The ratio of average load to the maximum demand during a given period is known as load factor	1		
.	b) The ratio of the sum of individual maximum demands to the maximum demand on power station is known as diversity factor.	1	2	
3	Copper,Aluminium, Steel cored aluminium, galvanised steel, Cadmium copper	2	2	
4	The difference in voltage at the receiving end of a transmission line between conditions of no load and full load is called voltage regulation and is expressed as a percentage of the receiving end voltage.	2	2	10
5	The tendency of alternating current to concentrate near the surface of a conductor is known as skin effect.	2	2	

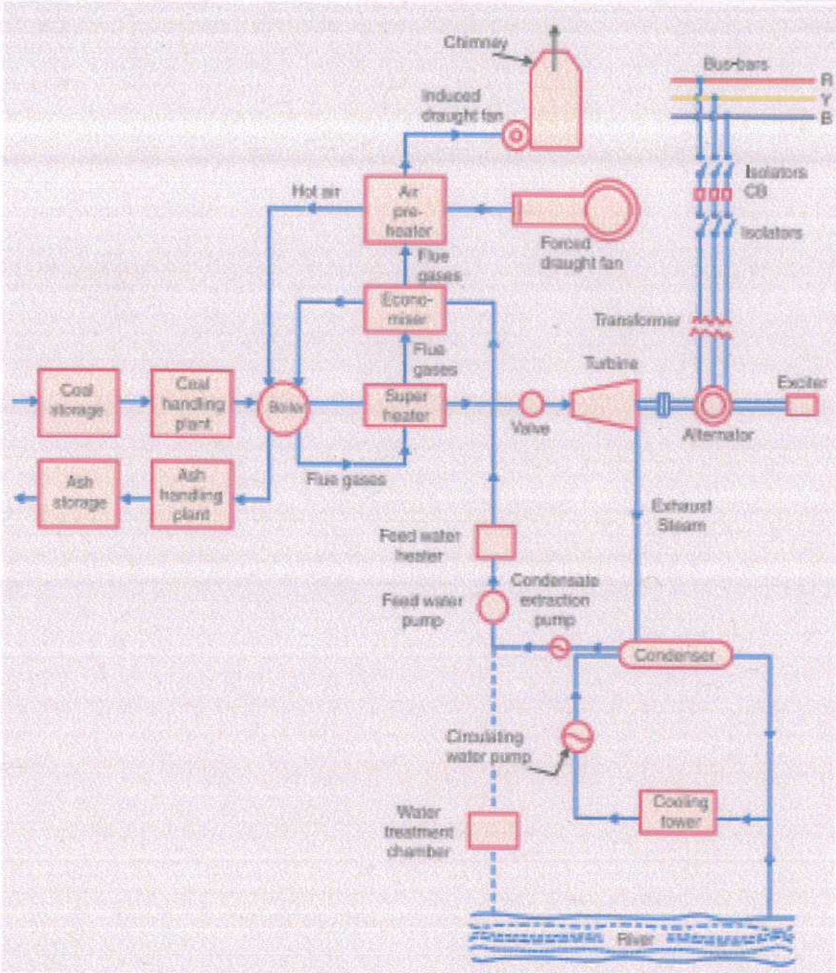
II	**Part B**			
1	Availability of water.			
	Disposal of waste.			
	Distance from populated areas			
	Transportation facilities.	4		
	Explanation	2	6	
2				



	Layout	6	6	
3	$$\text{Diversity factor} = \frac{1500+750+100+450}{2500} = \mathbf{1{\cdot}12}$$ $$\text{Average demand} = \frac{\text{kWh generated / annum}}{\text{Hours in a year}} = 45\times10^5/8760 = 513{\cdot}7\text{ kW}$$ $$\text{Load factor} = \frac{\text{Average load}}{\text{Max. demand}} = \frac{513{\cdot}7}{2500} = 0{\cdot}205 = \mathbf{20{\cdot}5\%}$$	2*3	6	
4	**Advantages of interconnected grid systems**			
	Exchange of peak loads			
	Use of older plants			
	Ensures economical operation			
	Increases diversity factor			
	Reduces plant reserve capacity			
	Increases reliability of supply	1*6	6	

5	The phenomenon of violet glow, hissing noise and production of ozone gas in an overhead transmission line is known as corona.			
	Factors Affecting Corona	2		
	1. Atmosphere 2. Conductor size 3. Spacing between conductors 4. Line voltage	1*4	6	
6	Static capacitor Synchronous condenser Phase advancers Explanation	3*2	6	
7	Cores or Conductors Insulatian Metallic sheath. Bedding Armouring Serving	3		
				
	Figure	3	6	30

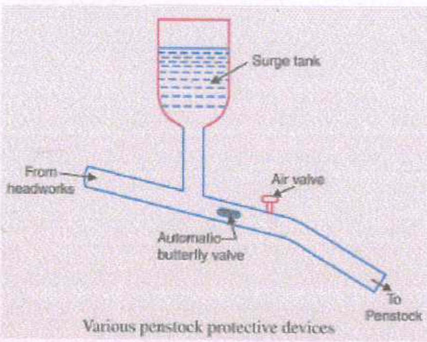
<table>
<tr><td>III</td><td>PART C</td><td></td><td></td><td></td></tr>
<tr><td>i)</td><td>



Layout
Labelling
Surge tank.</td><td>

4
5</td><td>

9</td><td></td></tr>
<tr><td>ii)</td><td>



Various penstock protective devices

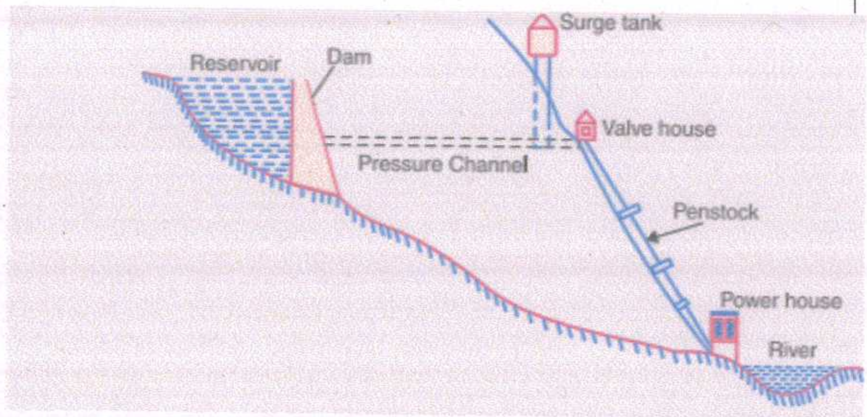
Open conduits leading water to the turbine require no protection.
However, when closed conduits are used, protection</td><td></td><td></td><td></td></tr>
</table>

becomes necessary to limit the abnormal pressure in the conduit.

	Explanation	4		
	Figure	2	6	15
	OR			

IV

i)



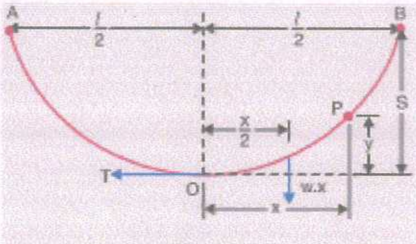
Explanation	5		
Figure	4	9	

ii)

S.No.	Item	Steam Power Station	Diesel Power Plant
1.	*Site*	Such plants are located at a place where ample supply of water and coal is available, transportation facilities are adequate	Such plants can be located at any place because they require less space and small quantity of water.
2.	*Initial cost*	Initial cost is lower than those of hydroelectric and nuclear power plants.	Initial cost is less as compared to other plants.
3.	*Running cost*	Higher than hydroelectric and nuclear plant because of the requirement of huge amount of coal.	Highest among all plants because of high price of diesel.
4.	*Limit of source of power*	Coal is the source of power which has limited reserves all over the world.	Diesel is the source of power which is not available in huge quantities due to limited reserves.
5.	*Cost of fuel transportation*	Maximum because huge amount of coal is transported to the plant site.	Higher than hydro and nuclear power plants
6.	*Cleanliness and simplicity*	Least clean as atmosphere is polluted due to smoke.	More clean than steam power and nuclear power plants.

1*6 | 6 | 15

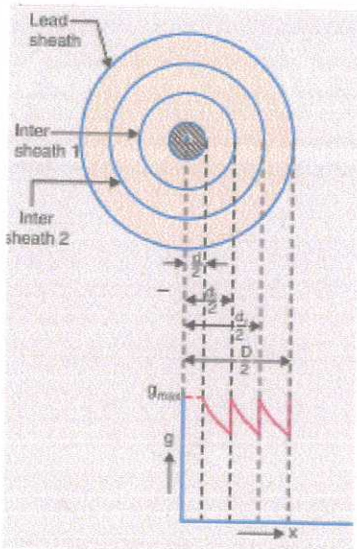
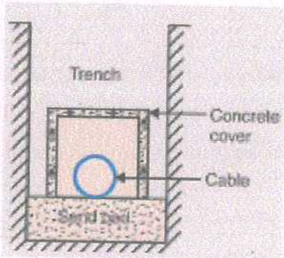
V (i)	**Types of Tariff** 1)Simple tariff 2)Flat rate tariff 3)Block rate tariff 4)Two-part tariff 5)Maximum demand tariff 6)Power factor tariff 7)Three-part tariff. Explanation	7	7	
(ii)	Units consumed/year $=$ Max. demand $\times$ L.F. $\times$ Hours in a year $= (100)\times(0{\cdot}6)\times(8760)$ kWh $= 5{\cdot}256\times10^5$ kWh Max. demand in kVA $= 100/\text{p.f.} = 100/0{\cdot}8 = 125$ Annual bill $=$ Max. demand charges + Energy charges $=$ Rs $75\times125 +$ Rs $0{\cdot}15\times5{\cdot}256\times10^5$ $=$ Rs 9375 + Rs 78,840 = **Rs 88,215**	8	8	15
	OR			
VI i)	Maximum demand in kVA at a p.f. of 0·8 $= 240/0{\cdot}8 = 300$ $\therefore$ Annual bill $=$ Demand charges + Energy charges $=$ Rs $50\times300 +$ Rs $0{\cdot}1\times50{,}000$ $=$ Rs 15,000 + Rs 5000 = Rs 20,000 $\therefore$ Flat rate/unit $=$ Rs $\dfrac{20{,}000}{50{,}000} =$ Rs $0\cdot40 =$ **·40 paise** When p.f. is raised to unity, the maximum demand in kVA $= 240/1 = 240$ Annual bill $=$ Rs $50\times240 +$ Rs $0{\cdot}1\times50{,}000$ $=$ Rs 12,000 + Rs 5,000 = Rs 17,000 Annual saving $=$ Rs $(20{,}000 - 17{,}000) =$ **Rs 3000**	9		
(ii)	**Base load**. The unvarying load which occurs almost the whole day on the station is known as base load.			

	Peak load. The various peak demands of load over and above the base load of the station is known as peak load. The curve showing the variation of load on the power station with respect to (w.r.t) time is known as a **load curve.**	3*2	6	15
VII (i)	The difference in level between points of supports and the lowest point on the conductor is called sag. ***(i) When supports are at equal levels.*** Consider a conductor between two equilevel supports A and B with O as the lowest point as shown in Fig. 8.24. It can be proved that lowest point will be at the mid-span.  Fig. 8.24 Let l = Length of span w = Weight per unit length of conductor T = Tension in the conductor. Consider a point P on the conductor. Taking the lowest point O as the origin, let the co-ordinates of point P be x and y. Assuming that the curvature is so small that curved length is equal to its horizontal projection (*i.e.*, $OP = x$), the two forces acting on the portion OP of the conductor are : ***(a)*** The weight wx of conductor acting at a distance $x/2$ from O. ***(b)*** The tension T acting at O. Equating the moments of above two forces about point O, we get, $Ty = wx \times \frac{x}{2}$ or $y = \frac{wx^2}{2T}$ The maximum dip (sag) is represented by the value of y at either of the supports A and B. At support A, $x = l/2$ and $y = S$ $\therefore$ Sag, $S = \frac{w(l/2)^2}{2T} = \frac{wl^2}{8T}$	8	8	
(ii)	**Short transmission line** When the length of an overhead transmission line is upto about 50 km and the line voltage is comparatively low (< 20 kV) **Medium transmission lines.** When the length of an overhead transmission line is about 50- 150 km and the line voltage is moderatly high (>20 kV < 100 kV), **Long transmission lines.** When the length of an overhead transmission line is more than 150 km and line voltage is very high (> 100 kV) OR	7	7	15

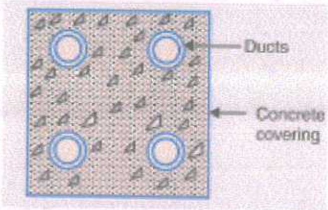
VIII	**Comparison between ac and dc transmission**			
(i)	**Advantages of d.c. transmission over high voltage a.c. transmission :** (i) It requires only two conductors as compared to three for a.c. transmission. (ii) There is no inductance, capacitance, phase displacement and surge problems in d.c. transmission. (iii) Due to the absence of inductance, the voltage drop in a d.c. transmission line is less than the a.c. line for the same load and sending end voltage. For this reason, a d.c. transmission line has better voltage regulation. (iv) There is no skin effect in a d.c. system. Therefore, entire cross-section of the line conductor is utilised. (v) For the same working voltage, the potential stress on the insulation is less in case of d.c. system than that in a.c. system. Therefore, a d.c. line requires less insulation. (vi) A d.c. line has less corona loss and reduced interference with communication circuits. (vii) The high voltage d.c. transmission is free from the dielectric losses, particularly in the case of cables. (viii) In d.c. transmission, there are no stability problems and synchronising difficulties. **Disadvantages** (i) Electric power cannot be generated at high d.c. voltage due to commutation problems. (ii) The d.c. voltage cannot be stepped up for transmission of power at high voltages. (iii) The d.c. switches and circuit breakers have their own limitations.			

	Advantages of ac transmission (i) The power can be generated at high voltages. (ii) The maintenance of a.c. sub-stations is easy and cheaper. (iii) The a.c. voltage can be stepped up or stepped down by transformers with ease and efficiency. This permits to transmit power at high voltages and distribute it at safe potentials. **Disadvantages** (i) An a.c. line requires more copper than a d.c. line. (ii) The construction of a.c. transmission line is more complicated than a d.c. transmission line. (iii) Due to skin effect in the a.c. system, the effective resistance of the line is increased. (iv) An a.c. line has capacitance. Therefore, there is a continuous loss of power due to charging current even when the line is open. Any 9 points	9		
(ii)	**Constants of a Transmission Line** Resistance. Inductance Capacitance Explanation	2*3	15	
IX i)	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 is known as string efficiency i.e., String efficiency =Voltage across the string /n × Voltage across disc nearest to conductor where n = number of discs in the string. **Methods of Improving String Efficiency** By using longer cross-arms. By grading the insulators. By using a guard ring			

	Explanation	6		
	Diagram	3	9	
ii)	**Intersheath Grading** In this method of cable grading, a homogeneous dielectric is used, but it is divided into various layers by placing metallic intersheaths between the core and lead sheath. The intersheaths are held at suitable potentials which are inbetween the core potential and earth potential. This arrangement improves voltage distribution in the dielectric of the cable and consequently more uniform potential gradient is obtained. Consider a cable of core diameter d and outer lead sheath of diameter D. Suppose that two intersheaths of diameters d 1 and d2 are inserted into the homogeneous dielectric and maintained at some fixed potentials. Let V1, V 2 and V3 respectively be the voltage between core and intersheath 1, between intersheath 1 and 2 and between intersheath 2 and outer lead sheath. As there is a definite potential difference between the inner and outer layers of each intersheath, therefore, each sheath can be treated like a homogeneous single core cable. Maximum stress between core and intersheath 1 is $g_{1max} = \dfrac{V_1}{\frac{d}{2}\log_e \frac{d_1}{d}}$ Similarly, $g_{2max} = \dfrac{V_2}{\frac{d_1}{2}\log_e \frac{d_2}{d_1}}$ $g_{3max} = \dfrac{V_3}{\frac{d_2}{2}\log_e \frac{D}{d_2}}$ Since the dielectric is homogeneous, the maximum stress in each layer is the same *i.e.,* $g_{1max} = g_{2max} = g_{3max} = g_{max}$ (say) $\therefore \quad \dfrac{V_1}{\frac{d}{2}\log_e \frac{d_1}{d}} = \dfrac{V_2}{\frac{d_1}{2}\log_e \frac{d_2}{d_1}} = \dfrac{V_3}{\frac{d_2}{2}\log_e \frac{D}{d_2}}$ **As the cable behaves like three capacitors in series, therefore, all** the potentials are in phase i.e.			

	Voltage between conductor and earthed lead sheath is $V = V1 + V2 + V3$ Intersheath grading has three principal disadvantages. Firstly, there are complications in fixing the sheath potentials. Secondly, the intersheaths are likely to be damaged during transportation and installation which might result in local concentrations of potential gradient. Thirdly, there are considerable losses in the intersheaths due to charging currents. For these reasons, intersheath grading is rarely used. 			
	Explanation Equations Figure OR	2 2 2	6	15
X (i)	**Laying of Underground Cables** Direct laying. 			

Draw-in system



Solid system.

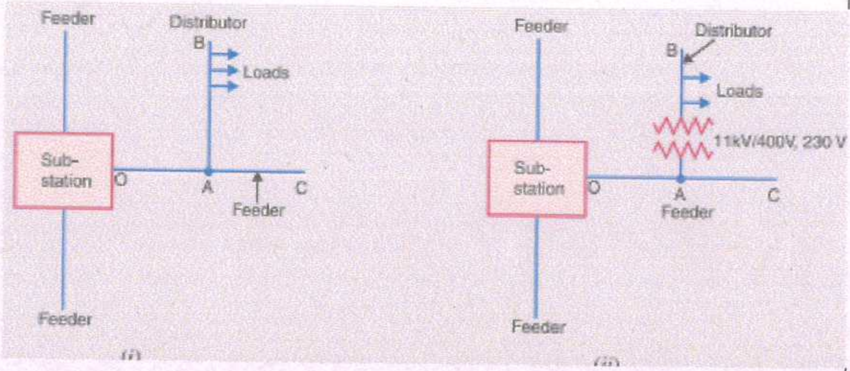
Explanation 2*3

Figure 1*3 9

(ii) Radial system and Ring system of distribution

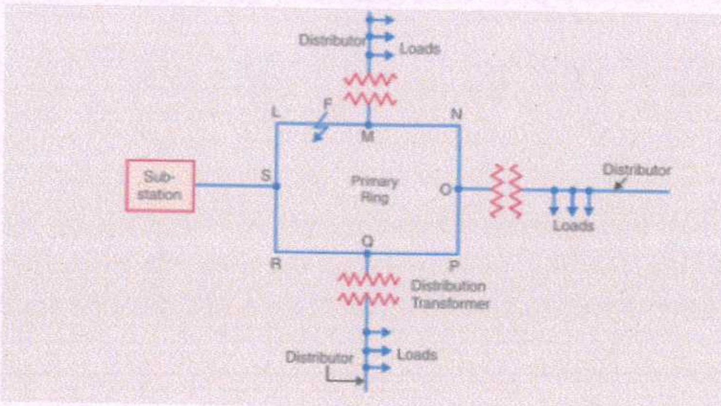
Radial System.

In this system, separate feeders radiate from a single substation and feed the distributors at one end only. Fig. shows a single line diagram of a radial system for d.c. distribution where a feeder OC supplies a distributor A B at point A. Obviously, the distributor is fed at one end only i.e., point A is this case. Fig. shows a single line diagram of radial system for a.c. distribution. The radial system is employed only when power is generated at low voltage and the substation is located at the centre of the load.



This is the simplest distribution circuit and has the lowest initial cost. However, it suffers from the following drawbacks :

(a) The end of the distributor nearest to the feeding point will be

	heavily loaded. (b) The consumers are dependent on a single feeder and single distributor. Therefore, any fault on the feeder or distributor cuts off supply to the consumers who are on the side of the fault away from the substation. (c) The consumers at the distant end of the distributor would be subjected to serious voltage fluctuations when the load on the distributor changes. **(ii) Ring main system.** In this system, the primaries of distribution transformers form a loop. The loop circuit starts from the substation bus-bars, makes a loop through the area to be served, and returns to the substation. Fig. shows the single line diagram of ring main system for a.c. distribution where substation supplies to the closed feeder LMNOPQRS. The distributors are tapped from different points M, O and Q of the feeder through distribution transformers. The ring main system has the following advantages : (a) There are less voltage fluctuations at consumer's terminals. (b) The system is very reliable as each distributor is fed via *two feeders. In the event of fault on any section of the feeder, the continuity of supply is maintained. For example, suppose that fault occurs at any point F of section SLM of the feeder. Then section SLM of the feeder can be isolated for repairs and at the same 	3*2	6	15