Department of Electrical Engineering
Assignment
Date: 20/04/2020

Course Details

Course Title: Electric Power Distribution and Utilization **Module:** 4th (B Tech)
Instructor: Engr. Waleed jan **Total Marks:** 30

Student Details

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Q1.	**(a)**	It is often difficult to draw a line between the power transmission and power distribution systems. However, what are the different factors on the basis of which a power distribution system can be differentiated from a power transmission system? Explain briefly.	**Marks 05**
	(b)	Underground electrical system cannot be used for very large voltages. Justify this statement.	**Marks 05**
Q2.	**(a)**	Now-a-days, electrical energy is generated, transmitted and distributed in the form of alternating current. Justify this statement.	**Marks 05**
	(b)	It is evident from comparison that both overhead and underground system has its own advantages and disadvantages. However, what are the few factors on the basis of which overhead system may be preferred over underground system?	**Marks 05**
Q3.	**(a)**	Ring main scheme of connection is more reliable as compared to radial system but is less reliable as compared to interconnected system. Justify this statement.	**Marks 05**
	(b)	Why is it important requirement of a good distribution system that voltage variations at consumer's terminals should be as low as possible?	**Marks 05**

Answer Sheet

Q1 (a):

It is often difficult to draw a line between the power transmission and power distribution systems. However, what are the different factors on the basis of which a power distribution system can be differentiated from a power transmission system? Explain briefly.

Ans:

Different factors on the basis of which a power distribution system can be differentiated from a power transmission system:

BASIS	TRANSMISSION LINE	DISTRIBUTION LINE
Usage	Transmission Line helps in the movement of electricity from power plant to the substations.	The Distribution line carries electricity from the substation to the consumer's end.
Phase	It is carried out electricity in three phase supply system.	It requires a single phase supply system for carrying electricity.
Voltage level	Carries electricity at a very high voltage. About 11000 volts.	Carries electricity at a very low and safe level of about 220 volts.
Current conduction level	They conduct current at 69 kV or more.	They conduct less than 69 kV

BASIS	TRANSMISSION LINE	DISTRIBUTION LINE
Thickness	Transmission lines are thick lines.	Distribution line are thin as compared to the transmission line.

OR

- Transmission Line helps in the movement of electricity from a power plant or power station to the various substations whereas the distribution line carries electricity from the substation to the consumer's end. i.e, to the residential and commercial customers.
- Transmission line carries power or electricity in three phase supply system. Distribution system requires a single phase supply system for carrying electricity.
- Transmission line carries electricity at a very high voltage that is of about 11000 volts whereas Distribution lines carries electricity at a very low and safe value level that is about 220 volts.
- Transmission line, conducts current at 69 kilo volts or more, but distribution line conduct current at less than 69 kilo Volt.
- Distribution line are thin as compared to the transmission line.

Q1 (b):

Underground electrical system cannot be used for very large voltages. Justify this statement.

Ans:

An overhead system can be operated at 400 kV or above but an underground system offers problems at such voltages.

One of the technical problems in the case of high voltage cables especially if the length is more (running into several kilometers) is because of the capacitance. In the case of cables the conductors are much nearer and the dielectric constant of the insulation is around 4.Where as in case of overhead wire the conductors are farther from each other and the insulation which is air has a dielectric constant of

1.Because of this the capacitance of a cable per kilometer is much more than the overhead system and this leads to greater charging currents. This will necessitate the use of inductors for compensation. As brought in the other answers, cost of underground system is more anywhere from 5 or more times the cost of an overhead system. **OR**

In overhead lines, the individual line wires are separated in air by large distance hence no problem of insulation as air is good insulator. In underground, we have to use insulated cables as earth is a conductor. Insulating the underground laid cables to voltages like 400 kV (by any means) is very expensive proposition hence not followed in India (cannot afford).

Q2 (a)

Now-a-days, electrical energy is generated, transmitted and distributed in the form of alternating current. Justify this statement.

Ans:

Electricity Generated OR Electrical Energy Generated:

Electricity is generated or produced by turning or rotation of turbines. These turbines can be rotated by any means – coal, steam, nuclear energy, renewable energy such as solar energy etc. In most power plants, turbines are rotated by the pressure of steam. This steam is created by boiling water using burning coal in large boilers. The pressure of steam is such that is turns the turbines, which in turn generates electricity. Hydroelectricity uses the force of running water downstream a man-made water reservoir dam. The great force of the running water turns the turbines. The motive is to turn the turbines by any means.

Electricity Transmitted:

After electricity is generated in power plant, it is time for transmission. This is done by using step-up transformers that increases the voltage. This high voltage electricity is transmitted through a network of electrically conductive wires of aluminum or copper. These lines are called high-voltage transmission lines that can transmit electricity over long distances.

Electricity Distributed:

Electricity is distributed via electric distribution substation. At the substation, the high voltage electricity from the high-voltage transmission lines is passed through

step-down transformers that lower the voltage. The electricity is then transmitted to network of local electric distribution lines. Before electricity enters a home, the voltage is again lowered using step-down transformers. In most countries the voltage is 220 V AC or 110 V DC. In a home, electricity is distributed to different outlets by network of wires through electrical wiring.

Q2 (b)

It is evident from comparison that both overhead and underground system has its own advantages and disadvantages. However, what are the few factors on the basis of which overhead system may be preferred over underground system?

Ans:

Advantages and disadvantages of overhead line system:

Advantages

- High Power transmission.
- Low installation and material cost.
- Long distance transmissions.
- The fault or damage in overhead lines can easily locate.
- Maintenance of the line is easier.
- Extension or joining on overhead lines can be performed easily and also it facilitates easy replacing.

Disadvantages

- As it is exposed to the surrounding, safety risk is high.
- A continuous pathway for the line creates obstructions.
- Vulnerable to lightning strikes
-

Underground transmission system

Advantages

- The underground transmission systems are safer than the overhead transmission system.
- Safer from lightning.
- It creates no obstructions.

Disadvantages

- Installation process through various geographic areas has high difficulties, because of ground excavation.

- The installation cost of Underground transmission is high, as it requires a continuous trench or concrete ducts for cable installation. Also, it has a high material cost due to the requirement of thick and insulated conductors.
- Underground transmission systems have a high cost of maintenance. Because the line needs to dig up before any repair activities and required to reinstall again.
- High complications in fault detection and maintenance.
- High voltage transmission is difficult in underground transmission.
- Limited by thermal capacity.

Comparison and Few Factors on the basis of which overhead system may be preferred over underground system:

Construction

Underground cables are more expensive to construct since they have to be electrically insulated and have protection against moisture, corrosion, mechanical damage and other environmental impacts from the soil. Construction of the cables is more complicated compared to the overhead cables which are simple to construct, and do not require insulation and sheathing. The overhead cables have lesser requirements and cheaper to construct.

Installation: The installation of overhead lines on poles is easier and straightforward. However, the underground cables require digging trenches and this may be complicated by other utility service lines such as water pipes, oil and gas pipelines, sewer lines. Other complications may arise due to rocks, loose soil and water along the routes, making them more expensive to install.

Heat dissipation

Heat dissipation in underground cables is limited by the layers of insulation and protection such as armoring and sheaths. Most of the heat is therefore retained near the cable unlike the overhead cables where most of the heat is released to the surrounding and automatic natural cooling is provided by the air.

Size of Conductors

Underground cables have larger conductor sizes compared to overhead lines for the same amount of power. This is due to the fact that the overhead lines have a natural cooling and hence the ability to carry more power without heating up.

Voltage carrying capacity

The overhead lines are better suited to carry higher voltages compared to the underground cables, which are limited by the expensive construction and limited heat dissipation. For these reasons, the underground cables are mostly used for transmitting up to 33KV.

Fault detection and repair

It is easier to detect and repair faults in overhead cables. It is more complicated and takes more time to locate and repair the underground systems.

Public safety

Underground cables are safer to the public, animals and environment compared to the overhead lines i.e. there are no issues such as people getting in contact with fallen lines. The overhead cables can be brought down and human, animal intervention, weather as well vegetation such as trees.

The underground cables are less impacted by these conditions and not affected by trees, animals, accidents, wind, storms and other physical interference that may lead to broken poles and short circuits or cable breakages.

Effect of lightning discharges

Overhead cables are more prone to lightning strikes whereas the underground cables are not affected by the discharges.

Interference

Overhead lines interfere with communication lines that are in close proximity, have corona discharge, radio and TV interference which does not happen with the underground lines.

Voltage drop

There is more voltage drop in the overheads due to the fact that their cables are of much smaller diameter than underground cables for the same power delivery.

Environmental impact

The underground cables have more environmental and health benefits due reduced noise and better vegetation management. In addition, they have less transmission losses, reduced damage and accidents such as wildlife electrocutions.

On the other hand the overhead cables can be brought down by human, animal intervention, weather such as strong winds and storms, as well vegetation such as tall trees. The underground cables are less impacted by these conditions and have less visual impact.

Land use

The underground cables allow better use of land coupled with better views without the sight of poles and cables. This leads to improved property values.

Life expectancy

Overhead lines have a longer life span compared to undergrounds cables.

Conclusion

The underground cables are more expensive to construct and install, however, they are convenient, less likely to break and mostly used to provide the missing link where overhead cables cannot be used. The choice of the cable to use is determined by the particular situation. The overhead cables are widely used due to their cost and ability to carry more power compared to the underground.

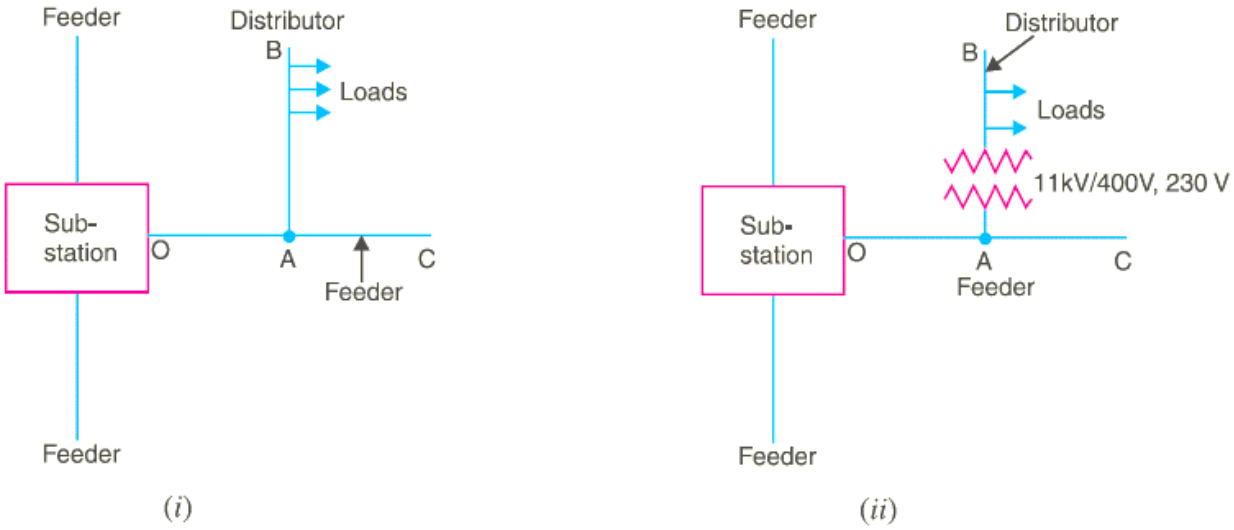
Q3 (a)

Ring main scheme of connection is more reliable as compared to radial system but is less reliable as compared to interconnected system. Justify this statement.

Ans:

Radial System:

- In this system, separate feeders radiate from a single substation and feed the distributors at one end only.



- Figure (i), in the previous slide, shows a single line diagram of a radial system for dc. Distribution where a feeder OC supplies a distributor AB at point A.
- Obviously, the distributor is fed at one end only i.e., point A is this case.
- Figure (ii), in the previous slide, shows a single line diagram of radial system for ac distribution.
- The radial system is employed only when power is generated at low voltage and the substation is located near the load.

Advantages of Radial System:

1) Its initial cost is minimum.
2) It is the simplest distribution system.

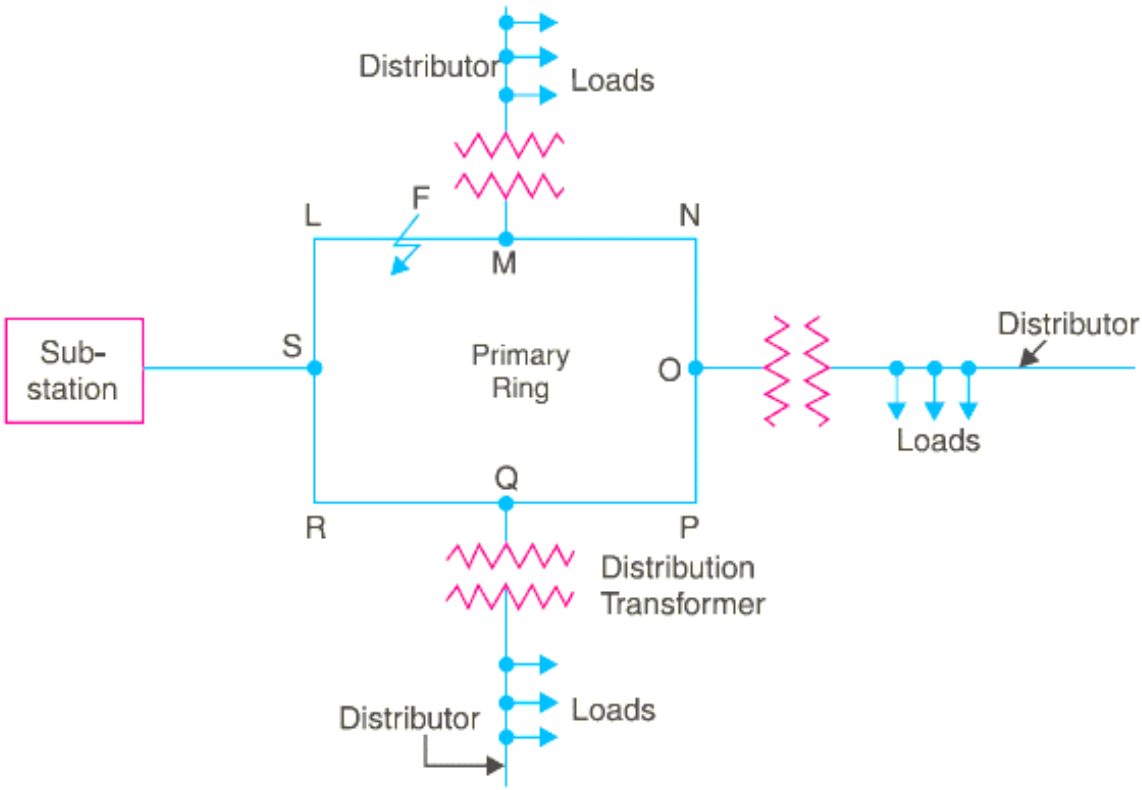
Disadvantages of Radial System

1) 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.
2) The consumers at the distant end (B) of the distributor would be subjected to serious voltage fluctuations when the load on the distributor changes.

Due to these limitations, this system is used for short distances only.

Ring Main System:

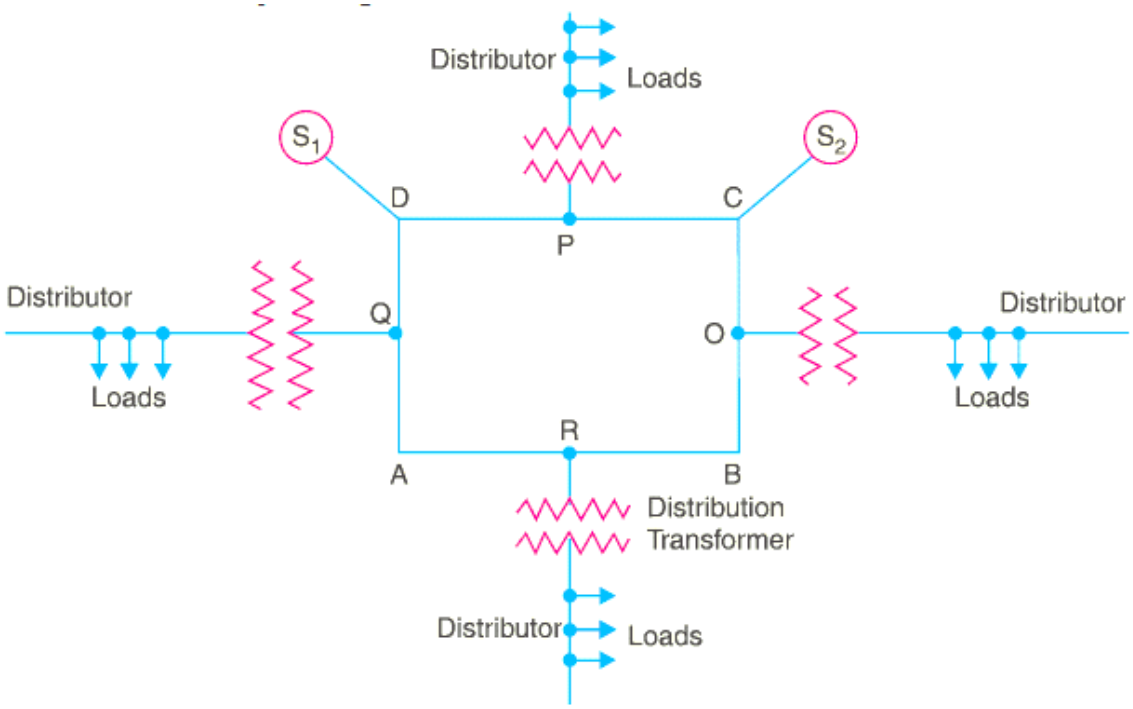
- In this system, the primaries of distribution transformers form a loop.
- The loop circuit starts from the substation bus-bars, makes a loop through the area to be served, and returns to the substation.



- The above figure, shows the single line diagram of ring main system for ac. 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 system is very reliable as each distributor is fed via two feeders i.e. the distributor from point M is supplied by the feeders SLM and SRQPONM.
- Thus, 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 time continuity of supply is maintained to all the consumers via the feeder SRQPONM.

Interconnected system:

- When the feeder ring is energized by two or more than two generating stations or substations, it is called interconnected system.



- The figure above shows the single line diagram of interconnected system where the closed feeder ring ABCD is supplied by two substations S1 and S2 at points D and C respectively.
- Distributors are connected to points O, P, Q and R of the feeder ring through distribution transformers.
- The interconnected system has the following advantages:

1) It increases the service reliability.
2) Any area fed from one generating station during peak load hours can be fed from the other generating station.

Q3 (b):

Why is it important requirement of a good distribution system that voltage variations at consumer's terminals should be as low as possible?

Ans:

Requirements of a Distribution System:

- A considerable amount of effort is necessary to maintain an electric power supply within the requirements of various types of consumers.
- Some of the requirements of a good distribution system are:

1) Proper Voltage
2) Availability of power on demand
3) Reliability.

1). Proper Voltage:

- One important requirement of a distribution system is that voltage variations at consumer's terminals should be as low as possible.
- The changes in voltage are generally caused due to the variation of load on the system.
- Low voltage causes inefficient lighting and possible burning out of motors and other electrical appliances.
- High voltage causes lamps to burn out permanently and may cause failure of other appliances.
- Therefore, a good distribution system should ensure that the voltage variations at consumer's terminals are within permissible limits.
- The Permissible limit of voltage variations is ± 6% of the rated value at the consumer's terminals.

- Thus, if the declared voltage is 230 V, then the highest voltage of the consumer should not exceed 244 V while the lowest voltage of the consumer should not be less than 216 V.

2). Availability of power on demand:

- Power must be available to the consumers in any amount that they may require from time to time.
- For example, motors may be started or shut down, lights may be turned on or off, without advance warning to the electric supply company.
- As electrical energy cannot be stored, therefore, the distribution system must be capable of supplying load demands of the consumers.
- This necessitates that operating staff must continuously study load patterns to predict in advance those major load changes that follow the known schedules.

3). Reliability:

- Modern industry is almost dependent on electric power for its operation. Homes and office buildings are lighted, heated, cooled and ventilated by electric power.
- This calls for reliable service. Unfortunately, electric power, like everything else that is man-made, can never be absolutely reliable.
- However, the reliability can be improved to a considerable extent by interconnected system, reliable protection system and providing additional reserve facilities.