Department of Electrical Engineering
Assignment
Date: 26/06/2020

Course Details

Course Title:	Electric Power Distribution and Utilization	**Module:**	4^{th} (B Tech)
Instructor:	Engr. Waleed Jan	**Total Marks:**	50

Student Details

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Note: Draw neat diagram where necessary. Assume missing details if required.

Q1.	A DC distributor XY, which is 2 wired, 500m long, is fed from both ends at 230V. Various loads of 10 A, 40 A, 30 A and 40 A are tapped at distances of 100m, 250m, 350m and 450 m from the end X respectively. If the area of cross-section of distributor conductor is $2cm^2$, find the minimum consumer voltage. Take the value of resistivity $1{\cdot}5 \times 10^{-5}$ Ω cm		**Marks 10**
Q2.	A DC distributor AB, which is 2 wired, 3km long, supplies loads of 150A, 200A, 250A and 100A situated 500 m, 1300 m, 2300 m and 3000 m from the supply point A. The resistance of each conductor is 0·02Ω per 1000 m. Calculate the potential difference at each load point if a p.d. of 400 V is maintained at point A.		**Marks 10**
Q3.	A D.C. distribution system, which is 3-wired, is supplying a load of 7 Ω resistance across the positive outer and neutral and a load of 9 Ω resistance across negative outer and neutral at the far end of the distributor. The resistance of each conductor is 0·2 Ω. If the voltage between any outer and neutral at the load end is to be kept at 260 V, find the voltages at the feeding end.		**Marks 10**
Q4.	**(a)**	What will happen if the insulating material used for underground cable is hygroscopic and has low dielectric strength?	**Marks 05**
	(b)	Pure rubber cannot be used as an insulating material for underground cable. Justify this statement.	**Marks 05**
Q5.	**(a)**	In Direct laying method of underground cable, the maintenance cost is high. Justify this statement.	**Marks 05**
	(b)	The Solid system used for laying of underground cable is expensive as compared to direct laid system. Justify this statement.	**Marks 05**

Answer Sheet

Q1:

A DC distributor XY, which is 2 wired, 500m long, is fed from both ends at 230V. Various loads of 10 A, 40 A, 30 A and 40 A are tapped at distances of 100m, 250m, 350m and 450 m from the end X respectively. If the area of cross-section of distributor conductor is 2cm2, find the minimum consumer voltage. Take the value of resistivity 1•5 × 10−5 Ω cm

Ans:

Solution

Resistance of 1m length of distributer

$$= 2\times\frac{1.5\times10^{-5}\times100}{1} = 3\times10^{-3}$$

Resistance of section = AC, Rac = $(3\times 10^{-3})100 = 0.3\Omega$

Resistance of section = CD, Rcd = $(3\times 10^{-3})150 = 0.4\Omega$

Resistance of section = DE, Rde = $(3\times 10^{-3})100 = 0.3\Omega$

Resistance of section = EF, Ref = $(3\times 10^{-3})100 = 0.3\Omega$

Resistance of section = FB , Rfb = $(3\times 10^{-3})100 = 0.3\Omega$

Voltage at Y = voltage at X – drop over length XY

$$V_Y = [V_X - I_A R_{AC} + (I_A - 20)R_{CD} + (I_A - 60)R_{DE} + (I_A - 110)R_{EF} + (I_A - 140)R_{FB}]$$

$$230 = 230-[0.3I_A + 0.4(I_A - 20) + 0.3(I_A - 60) + 0.3(I_A - 110) + 0.3(I_A - 140)]$$

$$= 230-(1.6I_A - 12.58)$$

Or $1.6I_A = 12.58$

$$I_A = 12.58/-1.6 = 7.862\text{A}$$

Knowing the value of

I_A current in any section can be determined .thus current in section Cd, $I_{CD} = I_A - 20 = 7.862-20 = -12.138$A from C to D

$I_{DE} = I_A - 60 = 7.682 - 60 = -52.138$A from D to E

Current in section EF, $I_{EF} = I_A - 110 = 7.862 - 110$ = -102.138A from E to F
Current in section FB, $I_{FB} = I_A - 140 =$ 7.862-140 = -132.138A From F to B

The actual distribution of currents in the various sections of the distributors

It is clear that current are coming to the load point E from both sides i.e From D

:. Minimum consumer voltage

$$V_E\ V_A\text{-}(\ I_{AC}R_{AC}+I_{CD}R_{Cd}+I_{DE}R_{DE}$$

= 230-(7.682×0.3+7.862×0.4+7.862×0.3)
= 230-7.682
= -222.318V **Ans.**

Q2:

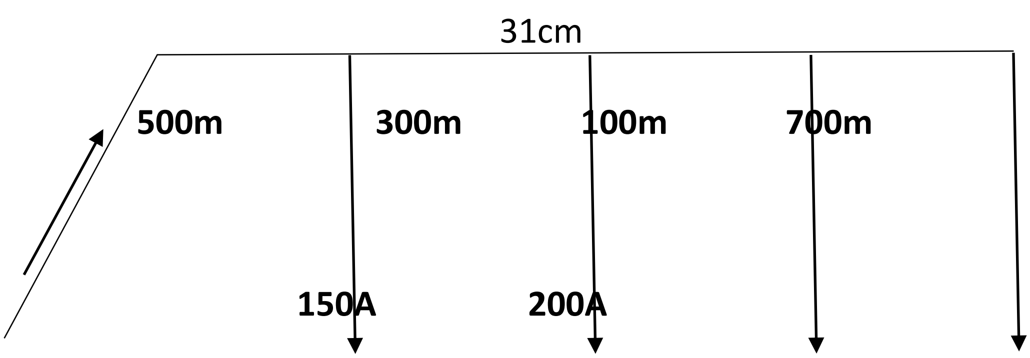
A DC distributor AB, which is 2 wired, 3km long, supplies loads of 150A, 200A, 250A and 100A Situated 500 m, 1300 m, 2300 m and 3000 m from the supply point A. The resistance of each conductor is 0•02Ω per 1000 m. Calculate the potential difference at each load point if a p.d. of 400 V is maintained at point A.

Ans:

Required data:

Potential difference of each load =?

Solution



The single line diagram of distributer with its topped current.

Resistance per 1000m distributer is =2×0.02 =0.04 Ω

Resistance of section A_C ,R_{AC}

A_C ,R_{AC} = 0.04 × 500/1000

=0.04 × 0.5

A_C , R_{AC} =0.02 Ω

Resistance of section A_{CP} ,R_{ACD}

C_D ,R_{CD} = 0.04 ×200/1000

C_D ,R_{CD} =0.032 Ω

Resistance of section D_E ,R_{DE}

D_E ,R_{DE} =0.04 × 1000/1000

= 0.04 × 1

D_E ,R_{DE} = 0.04 Ω

Resistance of section

E_B ,R_{EB} = 0.04 × 700/1000

= 0.04 ×0.7

E_B ,R_E =0.28 Ω

The current and the various setion of distributer are

L_{EB} = 100A

I_{DE} =100 +250 =350A

I_{CD} = 350 +200

= 550A

I_{AC} =550 +150

=700A

- Potential difference at point C= ?

  V_C = Voltage at A – Voltage drop in A.C

  =VA –I_{AC} . R_{AC}

  = 400 -700×0.02

  = 400 -14

  V_C = 386V

Potential difference at point D =?

V_D = VC –I_{CD} . R_{CD}

= 386 -550×0.032

= 386 -17.6

= 368.4V

V_D =368.4V

Potential difference at point E=?

V_E = V_D - I_{DE} . R_{DE}

=368.4 – 350 × 0.04

=368.4 – 14

=354.4V

V_E = 354.4V

Potential difference at load point B = ?

$V_B = VE - I_{EB} . R_{EB}$

$= 354.4 - 100 \times 0.028$

$= 354.4 - 2.8$

$= 351.6V$

$V_B = 351.6V$ **Ans.**

Q3:

A D.C. distribution system, which is 3-wired, is supplying a load of 7 Ω resistance across the positive outer and neutral and a load of 9 Ω resistance across negative outer and neutral at the far end of the distributor. The resistance of each conductor is 0•2 Ω. If the voltage between any outer and neutral at the load end is to be kept at 260 V, find the voltages at the feeding end.

Ans:

Solution

Current on +ve outer I_1 = 260/7 = 37.14A

Current on –ive outer I_2 = 260/9 = 28.88A

Current in neutral $= I_1 - I_2$ = 37.14- 28.88 = 8.26A

Voltage between +ve outer and neutral at feeding end is

$$V_1 = V_{EL} + I_1 R_{AE} + (I_1 - I_2) R_{NL}$$

= 260+37.14×0.2+8.26×0.2 = 269.08V

Voltage between –ve oyter and neutral at feeding end is

$$V_2 = V_{LC} - (I_1 - I_{2)} R_{NL} + I_2 R_{BC}$$

= 260-8.26×0.2+28.88×0.2 = 267.42V **Ans.**

Q4 (a)

What will happen if the insulating material used for underground cable is hygroscopic and has low dielectric strength?

Ans:

(i) High insulation resistance to avoid leakage current.
(ii) High dielectric strength to avoid electrical breakdown of the cable.
(iii) High mechanical strength to withstand the mechanical handling of underground cables.
(iv) Non-hygroscopic i.e., it should not absorb moisture from air or soil. The moisture tends to decrease the insulation resistance and hastens the breakdown of the cable. In case the insulating material is hygroscopic, it must be enclosed in a waterproof covering like lead sheath.
(v)Non-inflammable
Types of underground cables
(vi) Low cost so as to make the underground system a viable proposition.
(vii) Unaffected by acids and alkalies to avoid any chemical action.
The principal insulating materials used in cables are rubber, vulcanized India rubber, impregnated paper, varnished cambric and polyvinyl chloride.

Q4 (b)

Pure rubber cannot be used as an insulating material for underground cable. Justify this Statement.

Ans:

Rubber may be obtained from milky sap of tropical trees or it may be produced from oil products.

It has relative permittivity varying between 2 and 3, dielectric strength is about 30 kV/mm and resistivity of insulation is 1017Ω cm.

Although pure rubber has reasonably high insulating properties, it suffers from some major drawbacks viz., readily absorbs moisture, maximum safe temperature is low (about 38ºC), soft and liable to damage due to rough handling and ages when exposed to light.

Therefore, pure rubber cannot be used as an **insulating material in underground cables**.

Q5 (a)

In Direct laying method of underground cable, the maintenance cost is high. Justify this Statement.

Ans:

Direct laying of underground cables

This method is the most popular as it is simple and cheap. The cables to be laid using this method must have the serving of bituminized paper and hessian tape so as to provide protection against corrosion and electrolysis. The direct laying procedure is as follows.

Laying procedure

- A trench of about 1.5 meters deep and 45 cm wide is dug.
- Then the trench is covered with a 10 cm thick layer of fine sand.
- The cable is laid over the sand bed. The sand bed protects the cable from the moisture from the ground.
- Then the laid cable is again covered with a layer of sand of about 10 cm thick.
- When multiple cables are to be laid in the same trench, a horizontal or vertical spacing of about 30 cm is provided to reduce the effect of mutual heating. Spacing between the cables also ensures a fault occurring on one cable does not damage the adjacent cable.
- The trench is then covered with bricks and soil to protect the cable from mechanical injury.

Advantages

- Simpler and cheaper than the other two methods
- Heat generated in cables is easily dissipated in the ground.

Disadvantages

- To install new cables for fulfilling an increased load demand, completely new excavation has to be done which costs as much as the new installation.
- Alterations in the cable network are not easy.
- Maintenance cost is higher.
- Identifying the location of a fault is difficult.
- This method cannot be used in congested areas such as metro cities where excavation is too expensive.

Q5 (b)

Ans:

Solid system

The solid system of cable laying is mainly performed where the cable is laid in the wood, cast iron, or another nonoil surface. Normally cable is laid in the manner which provides good mechanical strength to cables. This system is much appropriate for solid based systems. Normally the cables are filled with bituminous materials for providing protection and avoid heat dissipation. Then another Asphalt cover layer around the cable and bituminous material area for further protection. The system is expensive compare to the direct laid system and heat dissipation capacity is not much good compete with other systems. But for toughing material woods are much cheap so it is widely used by considering the economic impacts.