Complex Engineering Problem

DC Distributor

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Submitted To

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Subject

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1. Objective:

The objectives of this CEP are as follow:

(i) To get familiar with DC distribution system, its functionality and importance.

(ii) To solve the DC distribution problem and analyze it.

2. Introduction:

A DC distributor is a device or system that facilitates the distribution of direct current (DC) power from a central source to multiple devices or circuits. The main objective of a DC distributor is to streamline power distribution, eliminating the need for individual power connections and enhancing overall system efficiency. With the development of transformers, AC has taken over the load formerly supplied by DC. Nowadays electrical energy is transmitted and distributed in the form of AC as an economic proposition. However, for certain applications DC supply is absolutely necessary.

Electric power can be distributed by both AC and DC, and both has its own pros and cons. For both AC and DC distribution system the input source is AC. In case of AC distribution system power is generated at one place and is stepped down or up by transformers at the sub-station level. In case of DC distribution system input source (AC) is converted into DC and is transmitted across the sub stations, and to step up or step down a DC we need special converters.

3. Types of the DC Distributors:

DC distributors are usually classified on the basis of the way they are fed by the feeders. Following are the four types of DC distributors.

1. Distributor fed at one end.
2. Distributor fed at both ends.
3. Distributor fed at center.
4. Ring distributor.

Here, we will briefly describe about Distributor Fed at One End and Fed at Both Ends;

3.1. Distributor fed at one end:

In this type, the distributor is connected to the supply at one end and loads are tapped at different points along its length. The following figure shows the single line diagram of a distributor fed at one end. It worth to note that -

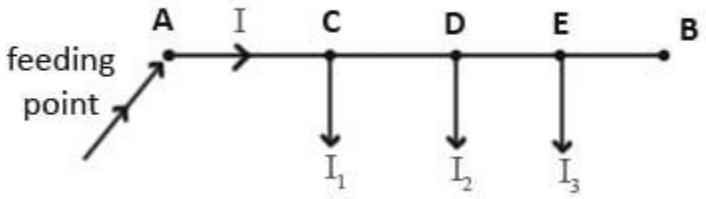


Figure 1: DC Distributor FED at One End

The following points are worth noting in a Singly Fed Distributor;

- The current in various sections of the distributor away from the feeding point goes on decreasing. From the above figure, the current in section DE is less than the current in section CD and likewise.
- The voltage also goes on decreasing away from the feeding point. In the above figure, voltage at point E will be minimum.
- In case of a fault in any section of the distributor, the whole distributor will have to be disconnected from the supply. Thus, the continuity of supply is interrupted.

3.2.Distributor fed at both ends:

In this type, the distributor is connected to supply at both ends and voltages at feeding points may or may not be equal. The minimum voltage occurs at some load point which is shifted with the variation of load on different sections of the distributor.

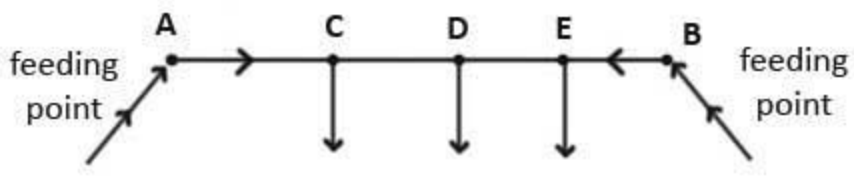


Figure 2: DC Distributor FED at Both Ends

The following points are worth noting in a Double Fed Distributor;

- If a fault occurs at any feeding point, continuity of the supply is ensured from the other feeding point.
- If a fault occurs on any section of the distributor, continuity of the supply is ensured on both sides of the fault with respective feeding points.
- The conductor cross-section area required for a doubly fed distributor is much less than that required for a distributor fed at one end.

4. Equipment:

1. Power supply (220 volts)
2. Step-down Transformer
3. Resistors
4. Millimeter
5. Dc voltmeter
6. Connecting leads
7. Switch
8. Hardboard
9. Voltage regulator

5. Theoretical background:

5.1. Power supply:

Power supply unit is used for providing stable electricity. The device converts and supply electricity of required voltage and frequency. Power supplies are classified by applications for available DC, AC and output voltage ranges.

5.2. Step-down Transformer:

Step-down transformers are a critical part of the power distribution system and are used for reducing the voltage from one level to another. Step-down transformers decrease the voltage incoming to the site by increasing the electrical current. It does this by converting the high incoming voltage in the primary winding to the necessary lower voltage in the secondary windings.

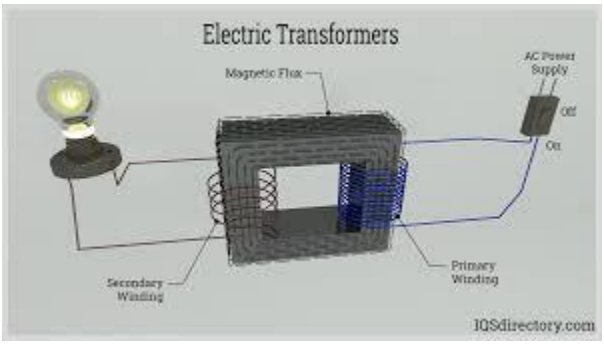


Figure 3: Step Down Transformer

5.3. Resistors:

A resistor is used to limit the current flow so that it does not become too high. A resistor must be placed in series. Resistors can also be used to provide a specific voltage for an active device such as a transistor.

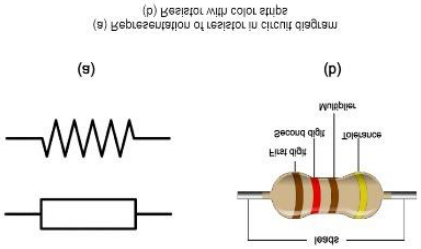


Figure 4: Resistor

5.4. Millimeter:

A digital multimeter is a test tool used to measure two or more electrical values—principally voltage (volts), current (amps) and resistance (ohms). It is a standard diagnostic tool for technicians in the electrical/electronic industries.

Figure 5: Digital Multimeter

5.5. Connecting leads:

A connecting wire allows travels the electric current from one point to another point without resistivity. Resistance of connecting wire should always be near zero.


Figure 6: Connecting Wires

5.6. Switch:

Switch-Disconnectors can be used to break direct currents (DC) so circuits can be safely isolated for maintenance work. The switch in a DC distributor is used to control the flow of electrical power to individual devices or circuits. It allows you to turn on or off the power supply to specific loads as needed, providing control and convenience in the distribution system.

Figure 7: Switch

6. Circuit diagram:

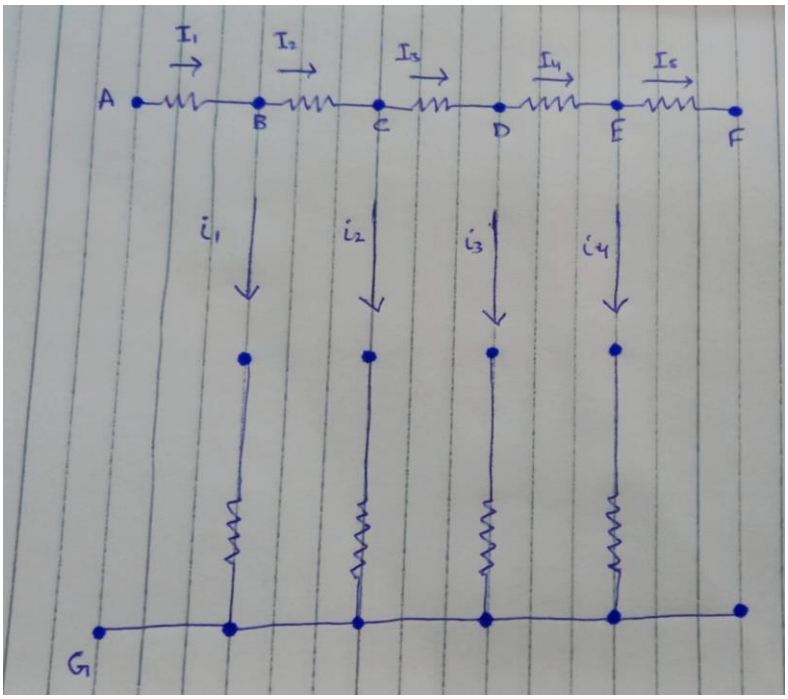
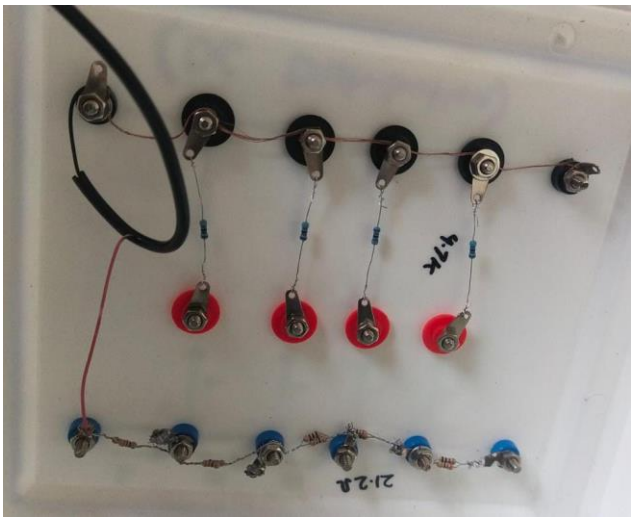


Figure 8: Circuit Diagram

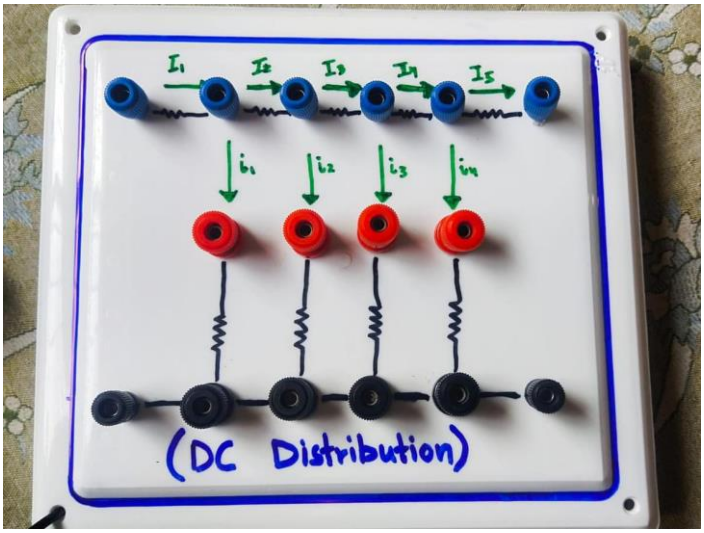
7. Construction and Working:

First, we design the distribution panel that will house the components of the DC distributor. Then we choose an appropriate Power supply source according to our voltage and current requirement. We design the wiring layout, ensuring proper wire gauges and connections to handle the expected current without voltage drop or excessive heating. We use appropriate connectors and consider the

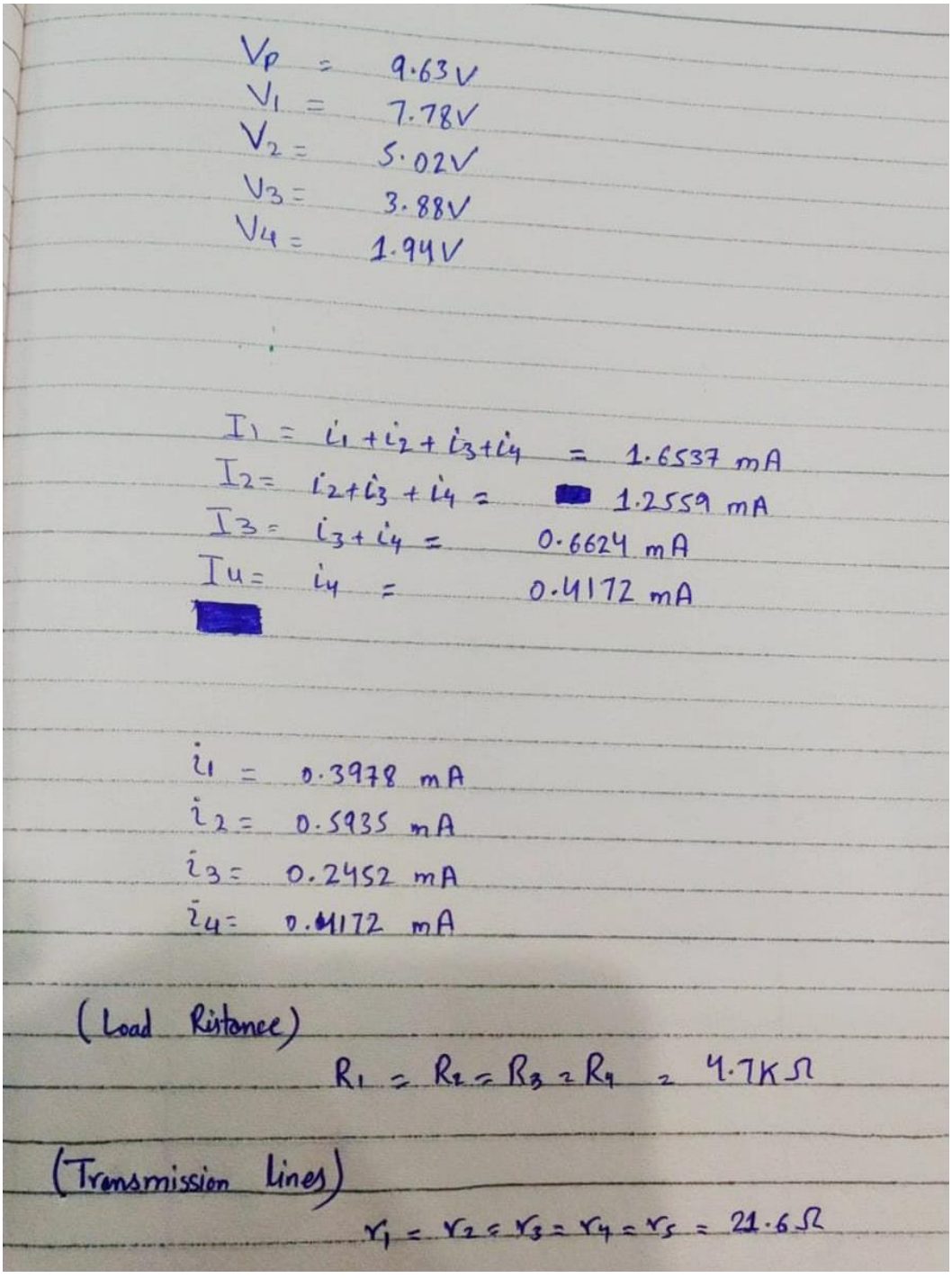
routing of wires to ensure neatness and ease of maintenance. We install terminal blocks within the distribution panel to facilitate the connection and distribution of power to individual devices or circuits.



220**V** ac supply is given, then a step-down transformer is connected. Resistors were used in transmission lines to protect the line from high voltage as well as loads. Connect the resistors in series. Then connect the power supply to the transformer. Measure the voltage and current at various points in the circuit which will explain the concept of dc distributor fed at one end where load is distributed among various resistors connected in series. Then the distribution of voltage and current is shown at various points using millimeter and voltmeter. Current at the points away from supply will be less as compared to the points near the supply. This means current goes on decreasing as we move away from source or supply in the distributor which is fed at one end.



8. Calculations:



$V_p = 9.63V$
$V_1 = 7.78V$
$V_2 = 5.02V$
$V_3 = 3.88V$
$V_4 = 1.94V$

$I_1 = i_1 + i_2 + i_3 + i_4 = 1.6537\ mA$
$I_2 = i_2 + i_3 + i_4 = 1.2559\ mA$
$I_3 = i_3 + i_4 = 0.6624\ mA$
$I_4 = i_4 = 0.4172\ mA$

$i_1 = 0.3978\ mA$
$i_2 = 0.5935\ mA$
$i_3 = 0.2452\ mA$
$i_4 = 0.4172\ mA$

(Load Ristance)
$R_1 = R_2 = R_3 = R_4 = 4.7K\Omega$

(Transmission Lines)
$r_1 = r_2 = r_3 = r_4 = r_5 = 21.6\Omega$

9.

Applications of DC Distributors:

a) DC power distribution in residential, commercial, and industrial settings.
b) Automotive and marine electrical systems.

c) Renewable energy systems such as solar power and wind power installations.

d) Telecommunications and data centers.

9. Importance and Benefits of DC Distributors:

9.1.Efficient Power Distribution:

- Centralized distribution allows for easier management and organization of power supply.
- Simplifies wiring and reduces overall complexity of the electrical system.
- Enables power sharing from a single power source to multiple devices, improving system scalability.

9.2.Enhanced Safety and Protection:

- Incorporation of protective measures like fuses or circuit breakers prevents damage to devices and circuits.
- Minimizes the risk of electrical hazards by maintaining current within safe limits.

9.3.Voltage Stability and Regulation:

Some DC distributors offer voltage regulation or monitoring, ensuring a steady power supply to connected devices.

Conclusion:

In this CEP, we learnt about the construction of a DC distribution system and its basic structure. We performed tests on the distribution system and calculated load values (Voltage, current, resistance).

References:

1. DC Power Distribution Systems | electricaleasy.com
2. https://slideplayer.com/slide/16919238/
3. Principles of power system by VK MEHTA