Skill India
कौशल भारत-कुशल भारत

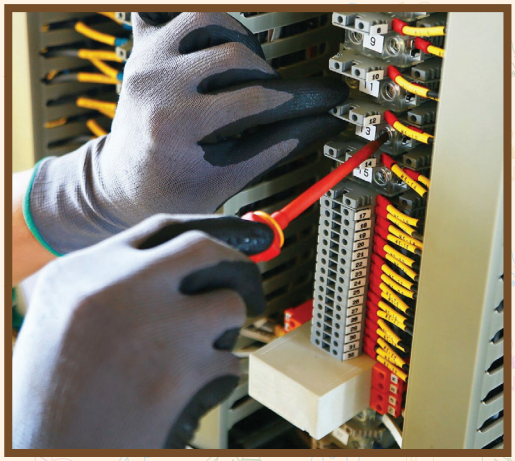
सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
RE IMAGINE FUTURE

Telecom Sector Skill Council

Facilitator Guide





Sector
Telecom

Sub-Sector
Passive Infrastructure

Occupation
Customer Service/ Passive Infrastructure

Reference ID: TEL/Q4304, Version 1.0
NSQF level 3

Telecom Electrician (Basic)

This book is sponsored by

Telecom Sector Skill Council of India

Estel House, 3rd Floor, Plot No:- 126, Sector 44

Gurugram, Haryana 122003

Phone: 0124-2222222

Email: tssc@tsscindia.com

Web: www.tsscindia.com

Printed in India

This book is sponsored by Telecom Sector Skill Council of India (TSSC)

"Skill development of the new generation is a national need and is the foundation of Aatmnirbhar Bharat"

Shri Narendra Modi
Prime Minister of India

Acknowledgements

The Telecom Sector Skill Council (TSSC) would like to thank all the individuals and institutions who contributed in various ways towards the preparation of this facilitator guide. The guide could not have been completed without their active contribution. Special gratitude is extended to those who collaborated during the development of the different modules in the facilitator guide. Wholehearted appreciation is also extended to all who provided peer review for these modules.

The preparation of this guide would not have been possible without the telecom industry's support. Industry feedback has been extremely beneficial since inception to conclusion, and it is with the industry's guidance that we have tried to bridge the existing skill gaps in the industry. This facilitator guide is dedicated to the aspiring youth, who desire to achieve special skills that will be a lifelong asset for their future endeavours.

About this Guide

The facilitator guide (FG) for Telecom Electrician (Basic) is primarily designed to facilitate skill development and training of people, who want to become professional Telecom Electrician (Basic) in various stores. The facilitator guide is aligned to the Qualification Pack (QP) and the National Occupational Standards (NOS) as drafted by the Sector Skill Council (TSSC) and ratified by National Skill Development Corporation (NSDC).

It includes the following National Occupational Standards (NOSs)-

1. TEL/N4306: Optimize DC and AC Circuits with RLC Components
2. TEL/N4307: Operate series and parallel circuit using circuit simulation software
3. TEL/N4308: Work with DC power supply system
4. TEL/N4309: Test the power backup system to ensure proper working of DC-DC converter, battery, and controller
5. TEL/N4310: Install the surge protection system
6. TEL/N9101: Organise Work and Resources as per Health and Safety Standards
7. DGT/VSQ/N0101: Employability Skills (30 Hours)

Post this training, the participants will be able to perform tasks as professional Telecom Electrician (Basic). We hope that this Facilitator Guide provides a sound learning support to our young friends to build a lucrative career in the Telecom Skill Sector of our country.

Symbols Used

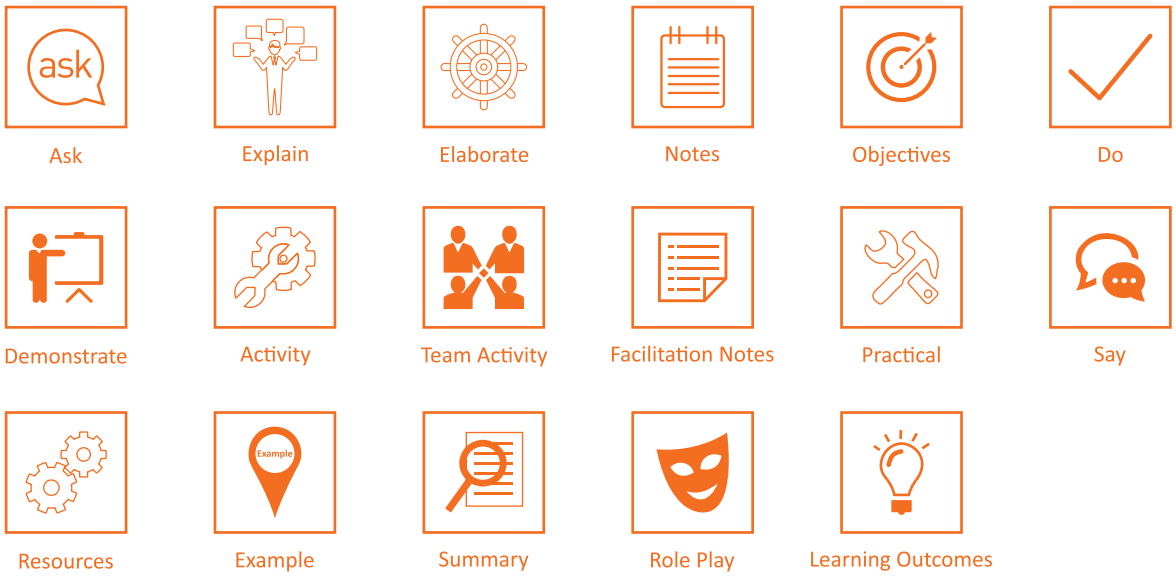


Table of Contents

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

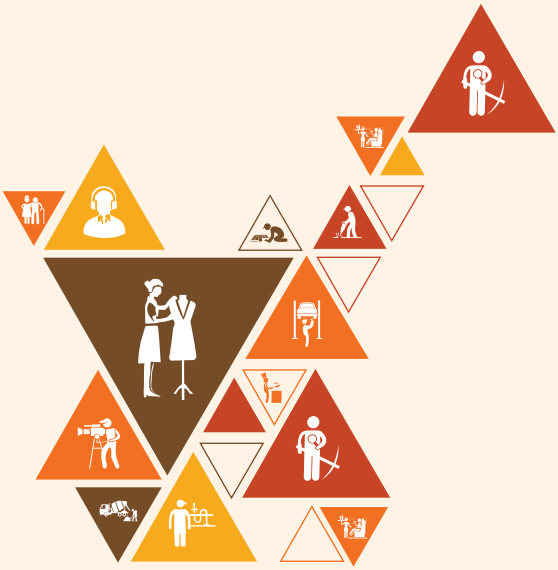
N·S·D·C
RE IMAGINE FUTURE

Telecom Sector Skill Council

1. Introduction to the role of a Telecom Electrician (Basic)

Unit 1.1 - Understanding the Telecom Industry in India and Role of a Telecom Electrician

Unit 1.2 - Workplace Practices and Operations Management



Bridge Module

Key Learning Outcomes

By the end of this module, the participants will be able to:

1. Discuss the job role of a Telecom Electrician (Basic).
2. Explain the scope of work for a Telecom Electrician (Basic).

Unit 1.1: Understanding the Telecom Industry in India and Role of a Telecom Electrician

Unit Objectives

By the end of this unit, the participants will be able to:

1. Discuss about the Telecom Industry and its Sub-Sectors in India
2. State the roles and responsibilities of a Telecom Electrician
3. Discuss the role and responsibilities of a Telecom Electrician (Basic)

Resources to be Used

Whiteboard, projector, telecom industry videos, presentation slides, printed handouts, and telecom equipment (e.g., cables, connectors, tools).

Say

- "Good morning, everyone! I'm excited to be here with you today."
- "In this session, we're going to dive into the Telecom Industry in India and understand the vital role a Telecom Electrician plays within it."
- "By understanding these roles and the industry's structure, you'll be equipped with the knowledge to support telecom services effectively, which is essential in today's tech-driven world."

Ask

- "Have you ever wondered how you get your phone signal or internet connection in different places?"
- "Can you think of a situation where a telecom electrician might be called to fix something?"
- "What do you think happens behind the scenes when you make a phone call or access the internet?"

Do

- Begin by introducing the session's objectives and emphasizing the importance of the telecom sector.
- Use the projector to show a visual presentation that outlines the different sub-sectors of the telecom industry in India.
- Break down the role and responsibilities of a Telecom Electrician, using the handouts for reference.
- Provide real-life examples where telecom electricians solve issues in the field.
- Share a short video about the daily life and work environment of a Telecom Electrician.
- Use a flip chart to note key terms and concepts discussed during the session.

Elaborate

- Discuss the Telecom Industry and its Sub-Sectors in India: Explain the telecom ecosystem in India, including mobile networks, broadband services, satellite communications, and equipment providers.
- State the Roles and Responsibilities of a Telecom Electrician: Define the key duties such as installing and maintaining telecom equipment, troubleshooting systems, ensuring safety standards, and responding to faults.
- Discuss the Role and Responsibilities of a Telecom Electrician (Basic): Go deeper into specific tasks like wiring, connecting circuits, testing equipment, and supporting telecom engineers and technicians.

Demonstrate

Demonstrate how to properly install and secure telecom cables and connectors. Use a telecom cable, tools, and connectors to show the step-by-step process of connecting and testing telecom equipment.

Activity

1. **Activity Name:** Role Identification and Responsibilities
2. **Objective:** Help participants understand the day-to-day responsibilities of a Telecom Electrician and the sub-sectors of the telecom industry.
3. **Type of Activity:** Group
4. **Resources:** Presentation slides, flip chart, markers, handouts.
5. **Time Duration:** 25 minutes
6. **Instructions:**
    - Divide participants into small groups.
    - Assign each group a different sub-sector of the telecom industry (e.g., mobile networks, broadband, satellite communications).
    - Ask each group to list key responsibilities of a Telecom Electrician within their assigned sub-sector.
    - After 10 minutes, ask each group to share their findings with the class.
    - Facilitate a discussion about the overlaps and unique tasks for each sub-sector.
    - Write the key points on the flip chart for the class to refer back to.
7. **Outcome:** Participants will be able to identify and understand the key responsibilities and roles of Telecom Electricians within different telecom sub-sectors.

Notes for Facilitation

- Keep the session interactive by encouraging questions and input from the participants.
- Regularly check for understanding by asking participants to summarize key points.
- Ensure participants are familiar with basic telecom terminology and equipment.
- Be sure to emphasize the importance of safety and precision when working as a Telecom Electrician.
- Stress the need for continuous learning due to technological advancements in the telecom industry.
- Use simple, clear language to describe technical aspects of the telecom industry to ensure everyone understands, especially for beginners.

Unit 1.2: Workplace Practices and Operations Management

Unit Objectives

By the end of this unit, the participants will be able to:

1. Discuss about organizational policies and best practices.
2. Illustrate the process workflow and responsibilities of a Telecom Electrician (Basic)
3. Discuss the organizational policies and best practices for workplace.
4. State the daily, weekly, and monthly operations of a Telecom Electrician (Basic) at the site.

Resources to be Used

Whiteboard or Projector Flip Charts Markers Handouts (Organizational Policies and Templates for Process Workflows) Industry-Specific Documents (Telecom Electricians - Basic) Sample Checklists (Daily, Weekly, Monthly Tasks) Operations Manual Relevant Case Studies or Examples Video Demonstrating a Typical Day of a Telecom Electrician (Basic)

Say

- Good morning, everyone! I hope you're ready to learn some important concepts today that will help you in your career as Telecom Electricians. We're going to dive into the core aspects of workplace practices and operations management."
- By the end of this session, you will understand the key organizational policies and best practices, the responsibilities in your role, and how to structure your daily operations effectively.
- Understanding these workplace practices is essential for you to function effectively as a Telecom Electrician, ensuring that you contribute to the smooth operations of your team and meet industry standards.

Ask

- "How do you usually keep track of your tasks on a daily basis?"
- "Can you think of a situation when knowing your responsibilities helped you avoid mistakes?"
- "Have you ever faced any challenges because of unclear organizational policies or guidelines at work?"

Do

- Begin the session by introducing the topics covered in the class.
- Discuss the importance of workplace practices and how they ensure smooth operations.
- Present the key organizational policies and best practices relevant to the Telecom Electrician (Basic) role.

- Guide the participants through the process workflow for a Telecom Electrician, breaking down each responsibility.
- Go over the different operations (daily, weekly, and monthly) expected of a Telecom Electrician (Basic) at the site.
- Encourage the participants to share any experiences or thoughts they have related to workplace practices.

Elaborate

- Outline key organizational rules and standard operating procedures (SOPs) that ensure a safe and efficient work environment.
- Explain the step-by-step workflow for a Telecom Electrician, ensuring clarity on roles and responsibilities.
- Cover the importance of following established policies to maintain productivity, safety, and compliance.
- Break down the tasks expected of a Telecom Electrician on different timelines, focusing on routine, maintenance, and troubleshooting tasks.

Demonstrate

Walk through the daily, weekly, and monthly checklist for a Telecom Electrician on a site, demonstrating how to plan and prioritize tasks efficiently.

Activity

1. **Activity Name:** “Creating a Process Workflow”
2. **Objective:** To help participants understand the process workflow and key responsibilities of a Telecom Electrician.
3. **Type of Activity:** Group
4. **Resources:** Flip charts, markers, handouts with process examples
5. **Time Duration:** 25 minutes
6. **Instructions:**
    - Divide participants into small groups (3-4 people).
    - Provide each group with a flip chart and markers.
    - Ask each group to create a process workflow for a Telecom Electrician’s typical day, including key responsibilities.
    - Once they have completed the flow, have them present it to the class.
    - Discuss each group’s workflow, providing feedback and clarifications.
7. **Outcome:** Participants will be able to identify the key tasks in a Telecom Electrician’s day, understand the process workflow, and collaborate to design an efficient daily schedule.

Notes for Facilitation

- Ensure you engage all participants by asking questions and encouraging discussion.
- Use visual aids like the whiteboard or slides to reinforce complex concepts.
- Emphasize the importance of following the workflow for safety and efficiency.
- Highlight the role of organizational policies in minimizing errors and maintaining consistency.
- Stress the importance of regularly reviewing and adhering to the daily, weekly, and monthly operations to maintain productivity.

Answers to Exercises for PHB

Multiple Choice Questions:

1. a. Installing telecom infrastructure
2. b. Data analytics
3. a. Legal compliance
4. a. Inspecting telecom equipment
5. b. Basic electrical knowledge

Descriptive Questions:

1. Refer to: Unit 1.1: Introduction to Skill India Mission
   Topic: 1.1.1 Overview of the Telecom Industry and its Sub-Sectors in India
2. Refer to: Unit 1.1: Introduction to Skill India Mission
   Topic 1.1.2 Role and responsibilities of a Telecom Electrician (Basic)
3. Refer to: Unit 1.1: Introduction to Skill India Mission
   Topic 1.1.3 Employment Opportunities for Telecom Electricians (Basic)
4. Refer to: UNIT 1.2: Workplace Practices and Operations Management
   Topic: 1.2.3 Daily, Weekly, and Monthly Operations of a Telecom Electrician (Basic) at the Site
5. Refer to: UNIT 1.2: Workplace Practices and Operations Management
   Topic 1.2.2 Process Workflow and Responsibilities of a Telecom Electrician (Basic)

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
RE IMAGINE FUTURE

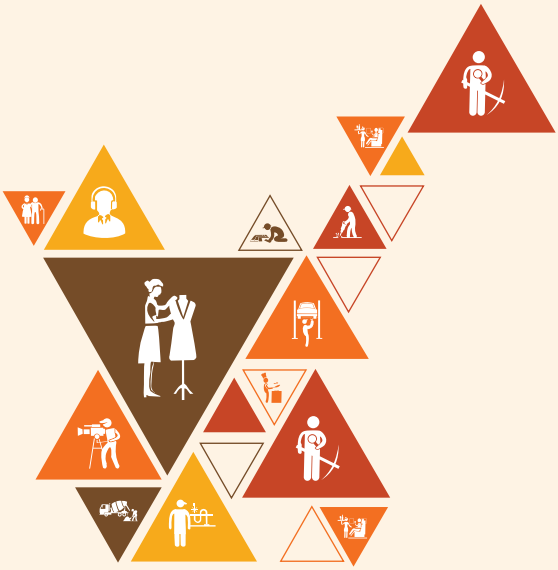
Telecom Sector Skill Council

2. DC and AC Circuits Optimization with RLC Components

Unit 2.1 - Fundamentals of Circuit Components and Laws

Unit 2.2 - Application of Circuit Design and Analysis

Unit 2.3 - Advanced Circuit Design and Maintenance



TEL/N4306

Key Learning Outcomes

By the end of this module, the participants will be able to:

1. Define the fundamental components in electronic circuits (resistors, voltage sources, and
2. current sources).
3. Describe the equations for calculating power dissipation in circuits ($P = IV$ and $P = I^2R$).
4. Calculate power dissipation and understand how it relates to the efficiency of components.
5. Design circuits with capacitors to offset inductive loads and improve power factor.

Unit 2.1: Fundamentals of Circuit Components and Laws

Unit Objectives

By the end of this unit, the participants will be able to:

1. Identify various components in electronic circuits (Resistors, Voltage Sources, and Current Sources).
2. Explain the application of Ohm's Law in relating voltage, current, and resistance.
3. Show how to calculate power dissipation in circuits.
4. State the principles of Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL).
5. Demonstrate series and parallel connections of components in circuits.
6. State the significance of selecting components with appropriate specifications for design requirements.

Resources to be Used

Multimeter, resistors of different values, breadboard, connecting wires, DC power supply, ammeter, voltmeter, circuit diagrams, worksheets, calculators, whiteboard, markers.

Say

- Hey everyone! Welcome to today's session on the fundamentals of circuit components and laws. I'm excited to dive into this because circuits are the foundation of all electronic devices!
- By the end of this session, you'll be able to identify key circuit components, understand Ohm's Law, apply Kirchhoff's Laws, and even calculate power dissipation in circuits.
- Understanding this topic is essential because circuits are everywhere – from your phone to your home appliances. Knowing how they work helps in troubleshooting, designing, and even optimizing electrical systems!

Ask

- Have you ever noticed that when you add more electrical appliances in a room, the lights sometimes dim for a second? Why do you think that happens?
- When you turn up the volume on a speaker, how do you think electricity plays a role in that?
- Why do you think some electrical wires are thicker than others?

Do

- Introduce the various circuit components with real-life examples (e.g., resistors as light dimmers, voltage sources as batteries).
- Explain Ohm's Law with a simple analogy, such as water flowing through a pipe where voltage is the water pressure, current is the flow, and resistance is the pipe's size.

- Solve a basic power dissipation problem step by step on the board.
- Illustrate Kirchhoff's Current Law and Voltage Law using a simple circuit diagram and break it down logically.
- Show how series and parallel circuits behave differently using a breadboard setup.
- Discuss how selecting appropriate components ensures efficiency and safety in circuit design.

Elaborate

- Identify circuit components – Explain resistors, voltage sources, and current sources with their functions and symbols.
- Apply Ohm's Law – Demonstrate the relationship between voltage, current, and resistance using $V = IR$.
- Calculate power dissipation – Show how to compute power in a circuit using $P = VI$ or $P = I^2R$.
- State Kirchhoff's Laws – Explain KCL (sum of currents at a junction is zero) and KVL (sum of voltages in a closed loop is zero).
- Demonstrate series and parallel circuits – Compare how current and voltage behave in different configurations.
- Select appropriate components – Discuss how to choose the right resistor, voltage source, and current source based on circuit requirements.

Demonstrate

Set up a basic series and parallel circuit using a breadboard, resistors, and a power source. Measure the voltage and current at different points using a multimeter to show the differences between series and parallel connections.

Activity

1. **Activity:** Build a Simple LED Circuit
2. **Objective:** Understand circuit components, Ohm's Law, and series-parallel connections.
3. **Type:** Group Activity
4. **Resources:** LED, resistors, breadboard, DC power supply, wires, multimeter
5. **Time Duration:** 30 minutes
6. **Instructions:**
   - Distribute the components and ask participants to design a simple LED circuit using a resistor in series.
   - Have them calculate the resistor value needed using Ohm's Law.
   - Once the circuit is complete, measure voltage and current using a multimeter.
   - Modify the circuit by adding another resistor in parallel and observe the changes.
7. **Outcome:** Participants will grasp circuit connections, Ohm's Law applications, and the importance of resistance selection.

Notes for Facilitation

- Keep the session interactive by encouraging participants to predict circuit behavior before testing.
- Use real-life analogies to simplify concepts for beginners.
- Highlight the importance of correct resistor selection in preventing overheating and failures.
- Emphasize the safety aspects of working with electrical components, especially handling power sources.
- Reinforce Kirchhoff's Laws by linking them to real-world power distribution systems.
- Allow time for troubleshooting in activities, fostering problem-solving skills.

Unit 2.2: Application of Circuit Design and Analysis

Unit Objectives

By the end of this unit, the participants will be able to:

1. Demonstrate the process of balancing series and parallel connections to distribute loads evenly
2. State the benefits of using circuit simulation software for modelling and analysis
3. Display the application of KCL and KVL in solving complex circuits
4. Discuss about Power dissipation and its relation to component efficiency
5. Use voltage and current dividers to achieve desired levels
6. Explain how to balance series and parallel connections in circuits
7. Analyse simple circuits with resistors, voltage sources, and current sources
8. Show how to resolve and repair issues in series and parallel connections of voltage, current, and resistance.
9. Identify components with appropriate specifications for real-world applications
10. Discuss circuit optimization for minimizing power losses through efficient component selection
11. Implement components for uniform load distribution and stress reduction in circuits

Resources to be Used

Multimeter, breadboard, resistors, voltage sources, current sources, circuit simulation software, connecting wires, variable power supply, oscilloscope, ammeter, voltmeter, whiteboard, markers, projector, circuit diagrams, textbooks on circuit analysis, handouts with circuit problems, soldering iron, digital multimeter, power resistors, and electronic component datasheets.

Say

- Hey everyone! I'm excited to dive into today's session on circuit design and analysis. We'll be unlocking the secrets of how circuits behave and how we can optimize them for real-world applications!
- Today, we'll explore key techniques such as balancing series and parallel connections, applying Kirchhoff's Laws, and optimizing circuit efficiency to minimize power losses.
- Understanding circuits is fundamental to electronics and electrical engineering. Whether you're troubleshooting a faulty device or designing new electronic systems, mastering these concepts will set you up for success!

Ask

- Have you ever wondered how electrical devices in your home manage to share power without overloading?
- Why do some batteries last longer in certain devices compared to others, even if they have the same voltage?
- What do you think happens when multiple devices are plugged into the same extension cord?

Do

- Start by explaining the difference between series and parallel circuits using a simple real-world analogy, such as water pipes.
- Introduce Kirchhoff's Laws and demonstrate their applications using basic circuit diagrams.
- Use a circuit simulation software to show how power dissipation changes when different resistors and components are used.
- Conduct a hands-on activity where learners measure voltage and current in series and parallel circuits using a multimeter.
- Guide learners through a discussion on selecting the right components to optimize power efficiency and load distribution.

Elaborate

- Demonstrate load distribution in series and parallel circuits – Show how balancing loads prevents component failure and improves efficiency.
- Explain the benefits of circuit simulation software – Highlight how these tools help analyze circuits before physical implementation.
- Apply Kirchhoff's Current and Voltage Laws (KCL & KVL) – Use them to solve complex circuit problems methodically.
- Discuss power dissipation and efficiency – Explain how excessive power loss impacts circuit performance.
- Use voltage and current dividers – Demonstrate how they control voltage levels and current flow.
- Analyze simple circuits with resistors and sources – Work through examples of basic circuit configurations.
- Troubleshoot series and parallel connections – Identify and resolve faults in circuits.
- Select appropriate components for real-world applications – Understand how to choose resistors, capacitors, and power sources.
- Optimize circuits for efficiency – Discuss ways to reduce energy loss through better component selection.
- Implement uniform load distribution – Show how to reduce stress on components and increase circuit lifespan.

Demonstrate

Show how to measure voltage, current, and resistance in a series and parallel circuit using a multimeter.

Activity

1. **Activity Name:** Circuit Load Balancing Challenge
2. **Objective:** To practically understand how to distribute loads evenly in a circuit and analyse power dissipation.
3. **Type of Activity:** Group activity
4. **Resources:** Breadboard, resistors of different values, multimeter, voltage source, connecting wires, circuit diagrams
5. **Time Duration:** 25 minutes

6. **Instructions:**
   - Divide the trainees into small groups and provide each group with a breadboard, resistors, and a voltage source.
   - Ask them to construct two circuits: one in series and one in parallel, using the given resistors.
   - Instruct them to measure the voltage across and current through each resistor using a multimeter.
   - Compare the power dissipation in both circuits and discuss which configuration is more efficient and why.
   - Challenge the groups to modify their circuits to achieve a balanced load distribution and measure the changes.
   - Conclude by having each group share their observations and learning.
7. **Outcome:** Participants will gain hands-on experience in analyzing and balancing circuit loads while understanding power dissipation and efficiency.

Notes for Facilitation

- Encourage active participation by asking trainees to predict circuit behavior before testing it.
- Ensure all safety precautions are followed while handling electrical components.
- Highlight the importance of circuit optimization in energy-efficient designs.
- Emphasize that series circuits share current, while parallel circuits share voltage.
- Explain that choosing the right resistor values impacts power dissipation and efficiency.
- Reinforce that circuit simulation software is a valuable tool for testing before building physical circuits.

Unit 2.3: Advanced Circuit Design and Maintenance

Unit Objectives

By the end of this unit, the participants will be able to:

1. Analyse AC waveforms with desired amplitude, frequency, and phase characteristics.
2. Design circuits with capacitors to offset inductive loads and improve power factor
3. Using thicker conductors to minimize energy loss as heat.
4. Install voltage regulators and filters for stable output voltage and harmonics reduction.
5. Discuss how to select and implement of efficient transformers for voltage transformation.
6. Design circuits for resonance frequency to achieve peak responses.
7. Implement power factor correction for system efficiency and cost reduction.
8. Demonstrate simulation and analysis of circuits using SPICE software.
9. State the significance of monitoring and maintaining circuit performance in power factor correction setups.
10. Analyse circuit behaviour across frequencies and resonance conditions.

Resources to be Used

Oscilloscope, function generator, multimeter, AC and DC power supplies, capacitors, inductors, resistors, transformers, voltage regulators, filters, SPICE simulation software, power factor correction kits, thick-gauge conductors, circuit boards, soldering tools, insulation materials, frequency analyser, data sheets, whiteboard, markers, projector, instructional videos, printed circuit diagrams, safety gloves, protective eyewear.

Say

- Hey everyone! Welcome to today's session on Advanced Circuit Design and Maintenance. I'm really excited because we're going to dive into some of the most important concepts that power modern electrical systems.
- By the end of this session, you'll be able to analyse AC waveforms, design circuits for better efficiency, implement power factor correction, and even simulate circuits using SPICE software.
- Understanding this topic is crucial because well-designed circuits improve efficiency, reduce energy losses, and ensure stable power supply—factors that impact real-world applications in industries, homes, and even in renewable energy systems.

Ask

- Have you ever noticed why the power bill increases when appliances like ACs or refrigerators are used more?
- Why do some electrical devices heat up more than others when plugged in for a long time?
- Have you ever seen the flickering of lights in a building and wondered what might be causing it?

Do

- Start by explaining how AC waveforms work and discuss their amplitude, frequency, and phase characteristics.
- Use an oscilloscope to show different waveforms and analyze how they change with different loads.
- Demonstrate how capacitors offset inductive loads and improve power factor using a simple RLC circuit setup.
- Explain how using thicker conductors helps in minimizing energy loss due to resistance.
- Introduce voltage regulators and filters and show how they stabilize output voltage and reduce harmonics.
- Walk through the selection criteria for efficient transformers and their role in voltage transformation.
- Use a function generator and circuit components to demonstrate resonance frequency and peak responses.
- Show a power factor correction setup and discuss its benefits in terms of efficiency and cost savings.
- Guide participants in a SPICE simulation session to analyze circuit behaviors under different conditions.

Elaborate

- Explain how amplitude, frequency, and phase characteristics impact circuit performance.
- Show how capacitors counteract inductive loads.
- Discuss how reducing resistance minimizes heat-related energy losses.
- Demonstrate their role in stabilizing voltage and minimizing harmonics.
- Explain key factors in choosing transformers for voltage transformation.
- Show how resonance circuits maximize energy efficiency.
- Discuss methods to improve system efficiency and reduce costs.
- Guide learners through circuit analysis using simulations.
- Monitor and maintain circuit performance: efficient operation.
- Show how different frequencies affect circuit behaviour.

Demonstrate

Use an oscilloscope and function generator to display AC waveforms and analyze how different components (capacitors, inductors, resistors) affect phase and amplitude in real time.

Activity

1. **Activity Name:** Power Factor Correction Setup (Topics: Power Factor Correction, Using Capacitors to Offset Inductive Loads, Monitoring Circuit Performance)
2. **Objective:** To understand and implement power factor correction in an AC circuit.
3. **Type of Activity:** Group
4. **Resources:** Power factor correction kit, AC power supply, inductive load (motor or transformer), capacitor bank, multimeter, oscilloscope, whiteboard.
5. **Time Duration:** 30 minutes

6. **Instructions:**
   - Divide participants into small groups and assign each group an AC circuit with an inductive load.
   - Measure and record the initial power factor using a multimeter.
   - Connect capacitors to the circuit and observe the change in power factor.
   - Adjust the capacitor values and re-measure the power factor to optimize efficiency.
   - Discuss findings with the class and relate them to industrial applications.
7. **Outcome:** Participants will understand how capacitors improve power factor and reduce energy waste.

Notes for Facilitation

- Ensure safety precautions while working with live circuits, especially when dealing with AC power sources.
- Encourage participants to engage in discussions and ask questions throughout the session.
- Emphasize the importance of power factor correction in reducing electricity costs and improving system efficiency.
- Demonstrate how improper circuit design can lead to losses and inefficiencies in real-world applications.
- Highlight the significance of resonance in communication and power electronics.
- Explain how simulation tools like SPICE can be used to predict circuit behavior before actual implementation.
- This guide provides a structured approach to teaching Advanced Circuit Design and Maintenance with clear objectives, interactive discussions, hands-on demonstrations, and engaging activities.

Answers to Exercises for PHB

Multiple Choice Questions:

1. b. V=IR
2. c. Kirchhoff's Current Law (KCL)
3. a. SPICE
4. a. $P=I^2R$
5. a. Capacitor

Descriptive Questions:

1. Refer to: UNIT 2.1: Fundamentals of Circuit Components and Laws
   Topic: 2.1.4 Principles of Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL)
2. Refer to: UNIT 2.2: Application of Circuit Design and Analysis
   Topic 2.2.2 Benefits of Using Circuit Simulation Software for Modelling and Analysis
3. Refer to: UNIT 2.1: Fundamentals of Circuit Components and Laws
   Topic 2.1.5 Series and Parallel Connections of Components in Circuits
4. Refer to: UNIT 2.1: Fundamentals of Circuit Components and Laws
   Topic: 2.1.3 Calculations for Power Dissipation in Circuits
5. Refer to: UNIT 2.2: Application of Circuit Design and Analysis
   Topic 2.2.7 Analysis of Simple Circuits with Resistors, Voltage Sources, and Current Sources

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

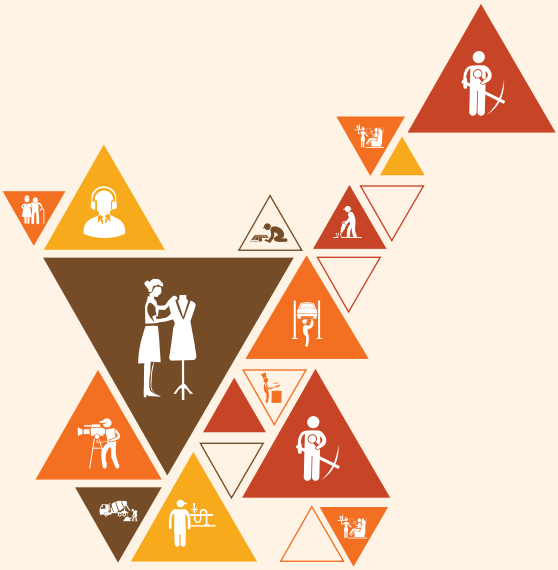
N·S·D·C
RE IMAGINE FUTURE

Telecom Sector Skill Council

3. Simulation Based Operation of Series and Parallel Circuits

Unit 3.1 - Fundamentals of Circuit Simulation and Measurement

Unit 3.2 - Analysis, Evaluation, and Experimentation in Circuit Simulations



TEL/N4307

Key Learning Outcomes

By the end of this module, the participants will be able to:

1. Explain the significance of setting resistance and voltage values in circuit simulation.
2. Differentiate between the measured current and voltage values to identify trends and variations.
3. Evaluate the impact of value changes on circuit performance and behavior.

Unit 3.1: Fundamentals of Circuit Simulation and Measurement

Unit Objectives

By the end of this unit, the participants will be able to:

1. Identify circuit simulation software tools
2. Discuss the purpose of ammeters and voltmeters in circuit analysis
3. Demonstrate setting resistance and voltage values in circuit simulation
4. State the function of ammeters and voltmeters
5. Demonstrate opening and creating a new project in circuit simulation software
6. Demonstrate connecting components in circuit design

Resources to be Used

Circuit simulation software, ammeter, voltmeter, resistors, power supply, digital multimeter, computer with circuit simulation software installed, projector, whiteboard, markers, handouts with circuit diagrams, and a worksheet for practice exercises.

Say

- Hey everyone! I hope you're all doing great today. I'm really excited to dive into today's session on circuit simulation and measurement—it's going to be fun and hands-on!
- By the end of this session, you'll be able to identify circuit simulation tools, understand the function of ammeters and voltmeters, and build a simple circuit in simulation software.
- Knowing how to simulate circuits helps you test designs before building them physically, saving time, money, and effort. It's a crucial skill for anyone interested in electronics!

Ask

- Have you ever used a mobile charger? How do you think it controls the flow of electricity?
- When you see a battery percentage on your phone, how do you think the device measures it?
- Why do electricians use measuring instruments like voltmeters and ammeters when working on electrical systems?

Do

- Introduce circuit simulation and measurement, explaining how software tools help in testing circuit performance without physical components.
- Show a list of common circuit simulation software tools and briefly explain their uses.
- Explain the purpose and function of ammeters and voltmeters using real-life analogies.

- Demonstrate how to set resistance and voltage values in a circuit simulation tool.
- Walk through the steps to create a new project in circuit simulation software.
- Guide participants in connecting basic components in the simulation tool to form a simple circuit.

Elaborate

- Identify circuit simulation software tools – Introduce software like Multisim, Proteus, and LTspice used for simulating electrical circuits.
- Discuss the purpose of ammeters and voltmeters in circuit analysis – Explain how these instruments help measure current and voltage to analyze circuit behavior.
- Demonstrate setting resistance and voltage values in circuit simulation – Show how to modify component properties in simulation software to achieve desired circuit performance.
- State the function of ammeters and voltmeters – Describe how an ammeter measures current flow and a voltmeter measures voltage difference across components.
- Demonstrate opening and creating a new project in circuit simulation software – Guide the steps to start a project, add components, and configure settings.
- Demonstrate connecting components in circuit design – Show how to link resistors, power sources, and measuring devices to form a working circuit.

Demonstrate

- Creating a Simple Circuit in Simulation Software
- Open the circuit simulation software and create a new project.
- Add a power source, a resistor, an ammeter, and a voltmeter to the workspace.
- Connect the components correctly, ensuring the ammeter is in series and the voltmeter is in parallel.
- Set resistance and voltage values and run the simulation to observe readings.

Activity

1. **Activity Name:** Simulating and Measuring a Basic Circuit
2. **Objective:** Understand how to set up a circuit in simulation software and measure voltage and current.
3. **Type of Activity:** Individual
4. **Resources:** Computer with circuit simulation software, worksheet with circuit diagram, and reference guide for ammeters and voltmeters.
5. **Time Duration:** 30 minutes
6. **Instructions:**
   - Open the circuit simulation software and create a new project.
   - Insert a voltage source (5V), a resistor (1kΩ), and an ammeter in series.
   - Connect a voltmeter across the resistor.
   - Run the simulation and observe the readings of voltage and current.

- Record the values and compare them with theoretical calculations using Ohm's Law.
- Discuss findings with the facilitator.

7. **Outcome:** Participants will understand how to set up, simulate, and measure a basic circuit using a software tool.

Notes for Facilitation

- Encourage active participation by asking questions and engaging students with real-life examples.
- Allow hands-on practice and troubleshoot issues as students explore the software.
- Explain how different circuit simulation software tools may have slightly different interfaces but follow similar principles.
- Emphasize the importance of correctly placing ammeters in series and voltmeters in parallel to avoid incorrect readings.
- Provide a step-by-step walkthrough for students who may be struggling with the simulation software.
- Ensure students document their readings and discuss any discrepancies between simulation results and theoretical calculations.

Unit 3.2: Analysis, Evaluation, and Experimentation in Circuit Simulations

Unit Objectives

By the end of this unit, the participants will be able to:

1. Assess the Component Impact by Analyzing Simulation Results
2. Explain the Distinctions Between Measured Current and Voltage
3. Design Resistance Values for Resistors
4. Determine Voltage Values for Voltage Sources
5. Evaluate the Effects of Running Simulations on Value Changes
6. Interpret and Discuss Simulation Results for Circuit Modifications
7. Evaluate the Accuracy of Ammeter and Voltmeter Measurements
8. Analyze the Impact of Value Changes on Circuit Behavior
9. Develop and Refine Complex Circuit Designs
10. Formulate Hypotheses and Experiment with Component Values

Resources to be Used

Multimeter, oscilloscope, resistor kits, breadboards, voltage sources, circuit simulation software (such as LTspice, Multisim, or Proteus), power supply, ammeters, voltmeters, circuit diagrams, whiteboard, markers, projector, computer, and printed worksheets.

Say

- Hey everyone! I'm really excited about today's session because we're diving into something that engineers and circuit designers work with all the time—circuit simulations!
- By the end of this session, you'll be able to analyze circuit behavior, experiment with component values, and evaluate how changes impact real-world performance using simulations.
- Understanding circuit simulations is crucial because it helps you test circuits virtually before building them physically, saving time, money, and avoiding potential design failures.

Ask

- Have you ever noticed how adjusting the brightness of a bulb with a dimmer switch changes its intensity? What do you think is happening with the circuit?
- Why do some phone chargers work faster than others?
- Have you ever wondered why electronic devices sometimes require specific power ratings?

Do

- Introduce circuit simulation software and provide a brief demonstration of its interface and functionalities.
- Show a simple pre-built circuit in the simulator and analyze the current and voltage readings.
- Guide learners through modifying resistor and voltage source values while observing the effect on the circuit.
- Encourage participants to interpret results and discuss the impact of component changes on circuit behavior.
- Conduct a hands-on demonstration comparing simulated measurements with real-life circuit measurements using multimeters and oscilloscopes.
- Facilitate a guided activity where participants modify and analyze circuit parameters in the simulation software.

Elaborate

- Assess the Component Impact by Analyzing Simulation Results – Examine how changes in resistor, capacitor, and inductor values affect circuit performance.
- Explain the Distinctions Between Measured Current and Voltage – Clarify the difference between these electrical quantities and how they behave in circuits.
- Design Resistance Values for Resistors – Adjust and select appropriate resistor values to achieve desired circuit functionality.
- Determine Voltage Values for Voltage Sources – Set voltage sources to required values based on circuit requirements.
- Evaluate the Effects of Running Simulations on Value Changes – Observe how modifying circuit parameters impacts the overall circuit behavior.
- Interpret and Discuss Simulation Results for Circuit Modifications – Analyze the outcomes of different component configurations.
- Evaluate the Accuracy of Ammeter and Voltmeter Measurements – Compare actual measurements with simulation data to understand precision and limitations.
- Analyze the Impact of Value Changes on Circuit Behavior – Investigate how variations in component values influence current flow, voltage drops, and power dissipation.
- Develop and Refine Complex Circuit Designs – Build upon basic circuit knowledge to create and test more intricate designs.
- Formulate Hypotheses and Experiment with Component Values – Predict circuit behavior, modify values, and analyze the impact to validate hypotheses.

Demonstrate

Demonstration of Circuit Simulation vs. Physical Circuit Measurements – Build a simple resistor-voltage source circuit in simulation software and measure current/voltage.

Activity

1. **Activity Name:** Exploring Circuit Changes in Simulation
2. **Objective:** Understand how changing resistor and voltage values in a circuit simulation affects current and voltage distribution.
3. **Type of Activity:** Group
4. **Resources:** Circuit simulation software, computers, predefined circuit diagrams, worksheets, resistor and voltage source data sheets.
5. **Time Duration:** 30 minutes
6. **Instructions:**
   - Divide participants into small groups and assign each group a predefined circuit in the simulator.
   - Instruct them to measure and record initial voltage and current values.
   - Ask each group to modify resistor values one at a time and observe the impact on current and voltage.
   - Have them repeat the process for voltage sources.
   - Each group presents their findings, explaining trends and any unexpected behaviours.
7. **Outcome:** Participants gain hands-on experience in analysing circuit behaviour through controlled component variations.

Notes for Facilitation

- Ensure all participants have access to the circuit simulation software and understand the basic interface before beginning the activity.
- Encourage participants to discuss and justify their observations with peers before providing explanations.
- If technical issues arise with software, use a whiteboard to simulate circuit modifications and discuss expected results.
- Emphasize the importance of systematic parameter changes when analyzing circuits.
- Highlight real-world applications where simulations save time and resources in circuit design.
- Reinforce the differences between theoretical calculations, simulated values, and real-world measurements to manage expectations in practical applications.

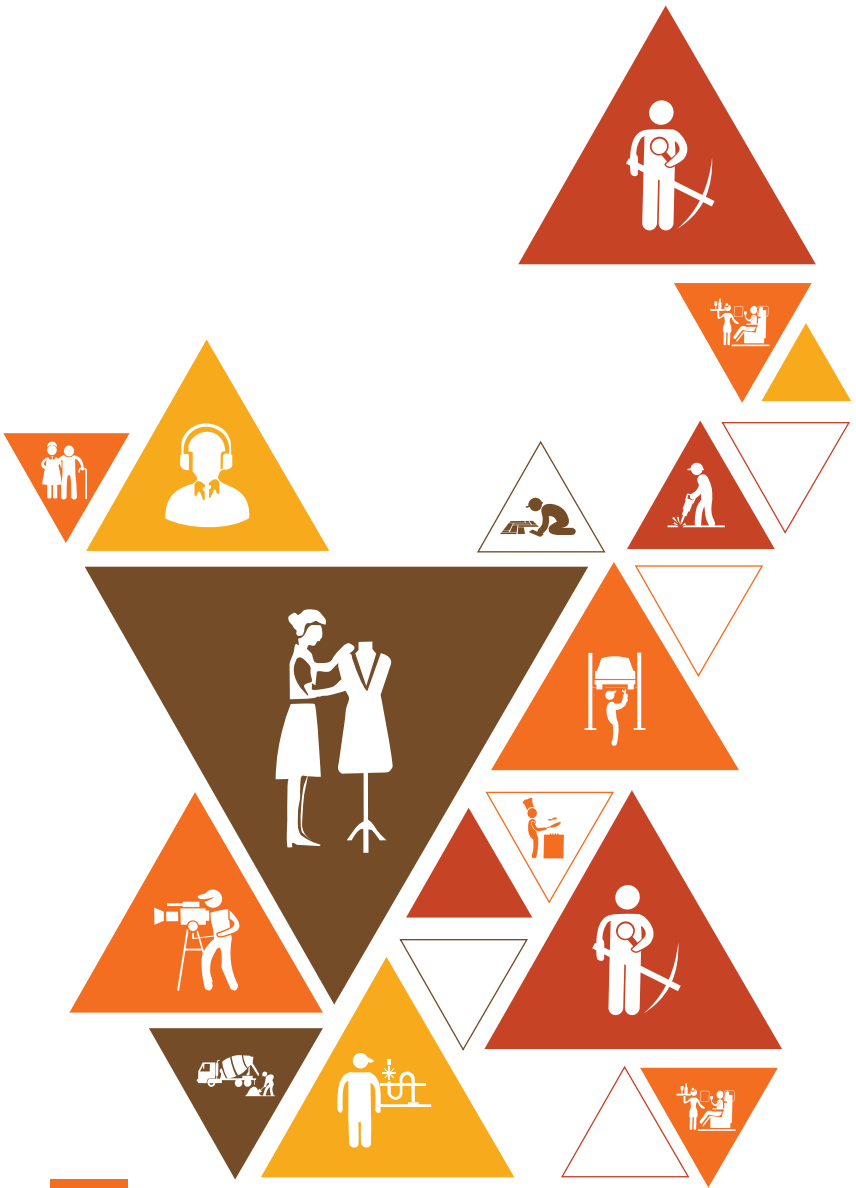
Answers to Exercises for PHB

Multiple Choice Questions:

1. d. All of the above
2. b. Measure current
3. a. Ensure realistic current flow
4. a. Current distribution
5. a. Configuring voltage sources

Descriptive Questions:

1. Refer to: UNIT 3.1: Fundamentals of Circuit Simulation and Measurement
   Topic: 3.1.1 Circuit Simulation Software Tools)
2. Refer to: UNIT 3.1: Fundamentals of Circuit Simulation and Measurement
   Topic 3.1.2 Purpose of Ammeters and Voltmeters in Circuit Analysis
3. Refer to: UNIT 3.1: Fundamentals of Circuit Simulation and Measurement
   Topic 3.1.3 Setting Resistance and Voltage Values in Circuit Simulation
4. Refer to: UNIT 3.1: Fundamentals of Circuit Simulation and Measurement
   Topic: 3.1.4 Function of Ammeters and Voltmeters
5. Refer to: UNIT 3.1: Fundamentals of Circuit Simulation and Measurement
   Topic 3.1.6 Connecting Components in Circuit Design



Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
RE IMAGINE FUTURE

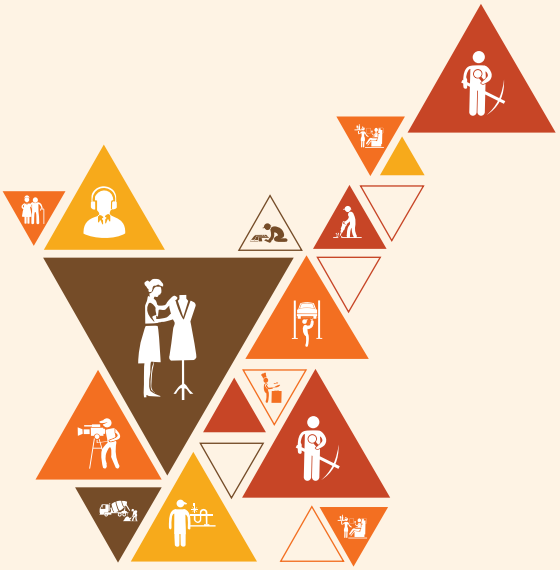
Telecom Sector Skill Council

4. DC Power Supply Systems Operations and Management

Unit 4.1 - Fundamentals of Power Supply Design and Components

Unit 4.2 - Power Supply Circuit Design and Practical Implementation

Unit 4.3 - Testing, Adjustment, and Circuit Optimization



TEL/N4308

Key Learning Outcomes

By the end of this module, the participants will be able to:

1. Explain the concept of steady output voltage and its importance in electronic circuits.
2. Power up a practical circuit and use a multimeter to measure and adjust the output voltage and current.
3. Design power supplies with voltage regulation and galvanic isolation features for specific applications during hands-on training.

Unit 4.1: Fundamentals of Power Supply Design and Components

Unit Objectives

By the end of this unit, the participants will be able to:

1. Describe the Voltage and Current Requirements of Electronic Devices
2. Explain the Types of DC Power Supplies and Their Applications
3. Discuss the Importance of Maintaining a Constant Output Voltage
4. Elaborate on the Role of Transformers in Converting AC Voltage
5. Assess the Purpose of Capacitors in Smoothing DC Voltage
6. Analyze the Concept of Steady Output Voltage
7. Evaluate the Use of Current Limiting in Power Supplies

Resources to be Used

Multimeter, DC power supply Units, resistors, capacitors, transformers, breadboard, connecting wires, oscilloscope, diode, voltage regulator ICs, power resistors, ammeter, AC-DC adapter, printed diagrams of different power supply types, whiteboard, markers, projector, presentation slides, handouts with circuit diagrams, worksheet for calculations, and safety gloves.

Say

- Hey everyone! I'm excited to be here with you today as we explore an essential part of electronics—power supply design and its components! You might not realize it, but power supplies are the backbone of almost every device we use daily.
- By the end of today's session, you'll understand how electronic devices receive power, why steady voltage is crucial, and the role of key components like transformers and capacitors in ensuring smooth power delivery.
- Imagine plugging your phone in, and it charges unpredictably, or worse—damages your device. A well-designed power supply prevents such issues, ensuring that electronic devices operate safely and efficiently.

Ask

- Have you ever noticed your phone charging slower or overheating when using a different charger?
- Why do we need adapters for some electronic devices while others can be plugged directly into a wall socket?
- What happens if there's a sudden power surge in your house? How do your devices handle it?

Do

- Start with a quick discussion based on the “Ask” section to engage learners and encourage real-world connections.
- Use printed diagrams or a projector to show different power supply types and their applications.
- Demonstrate the role of transformers, capacitors, and voltage regulators in a power supply circuit using a breadboard setup.
- Guide participants through simple voltage measurements using a multimeter to observe fluctuations in power supply circuits.
- Allow learners to analyze circuit behavior with and without a smoothing capacitor and discuss their observations.

Elaborate

- Explain how different devices require specific voltage and current levels to function safely and efficiently.
- Introduce linear, switching, and battery-based power supplies, discussing their use in various applications.
- Emphasize how voltage fluctuations can damage components and why voltage regulation is critical.
- Show how transformers adjust voltage levels in AC circuits before conversion to DC.
- Describe how capacitors store and release charge to reduce voltage fluctuations and ensure steady DC output.
- Discuss voltage regulation techniques and how devices like Zener diodes and voltage regulators maintain consistency.
- Explain how current limiting protects circuits from excessive current flow and prevents overheating or damage.

Demonstrate

The effect of a capacitor on smoothing DC voltage by observing fluctuating voltage on an oscilloscope.

Activity

1. **Activity Name:** Designing a Basic DC Power Supply
2. **Objective:** To help learners understand the role of key components in a power supply circuit.
3. **Type of Activity:** Group
4. **Resources:** Breadboard, transformer, rectifier diodes, capacitor, voltage regulator IC, multimeter, oscilloscope, connecting wires.
5. **Time Duration:** 30 minutes
6. **Instructions:**
    - Divide participants into small groups and provide them with circuit components.
    - Each group will assemble a basic power supply circuit, starting with a transformer, then a rectifier, capacitor, and finally a voltage regulator.

- Use a multimeter to measure voltage at each stage of the circuit.
- Observe the output before and after adding a capacitor and discuss the results.

7. **Outcome:** Participants will gain hands-on experience in assembling a DC power supply and understand how each component contributes to a stable output voltage.

Notes for Facilitation

- Encourage interactive participation by relating the concepts to everyday electronic devices.
- Ensure all safety precautions are followed when working with live circuits, especially AC voltage.
- Emphasize the difference between regulated and unregulated power supplies.
- Highlight the significance of current limiting and how it prevents damage in real-world applications.
- Show real-world examples of power supply failures and how they impact electronic devices.

Unit 4.2: Power Supply Circuit Design and Practical Implementation

Unit Objectives

By the end of this unit, the participants will be able to:

1. Determine the Transformer Turns Ratio for Specific Voltage Conversion Requirements
2. Explain the Sequential Connection of Components in a Power Supply Circuit
3. Evaluate the Appropriate Type of DC Power Supply for a Given Application
4. Design Voltage Regulation to Maintain a Stable Output Voltage in a Practical Power Supply Circuit
5. Assess the Suitability of a Transformer for Voltage Conversion in a Hands-On Electronics Project
6. Calculate and Justify the Value of a Smoothing Capacitor to Reduce Pulsations in the Output Voltage
7. Develop a Power Supply Circuit that Ensures a Steady Output Voltage in Real-World Scenarios
8. Implement and Test a Current-Limiting Feature in a Power Supply for Protection and Practical Use
9. Analyze and Calculate the Turns Ratio of a Transformer for Voltage Transformation as Part of a Class Project
10. Assemble, Connect, and Troubleshoot Electronic Components Based on a Provided Power Supply Design

Resources to be Used

Multimeter, Oscilloscope, Breadboard, Assorted Resistors, Capacitors, Diodes, Voltage Regulators (e.g., 7805, 7812), Bridge Rectifier, Step-Down Transformer, Soldering Iron, Solder Wire, Connecting Wires, DC Power Supply, LED Indicators, Load Resistors, Circuit Diagrams, Whiteboard, Marker, Projector, Handouts with Formulas, Calculators.

Say

- Good [morning/afternoon], everyone! I'm excited to dive into today's session because we're going to explore something that powers nearly every electronic device we use daily—power supply circuits!
- By the end of this session, you'll understand how to design a stable power supply circuit, calculate transformer turns ratio, choose the right components, and ensure safe operation.
- Understanding power supply circuits is crucial because every electronic gadget, from mobile chargers to industrial machines, depends on them.

Ask

- "Have you ever wondered how your phone charger converts AC from the wall socket into the DC power your phone needs?"
- "Why do some electronic devices need a specific adapter, while others can work with different chargers?"
- "Have you noticed how some appliances heat up over time?

Do

- Start with a simple example by showing a phone charger and explaining its internal components in layman's terms.
- Display a basic block diagram of a power supply circuit on the board and walk through each stage—transformer, rectifier, filter, regulator, and load.
- Distribute handouts with transformer equations and ask participants to calculate turns ratios for given input and output voltage values.
- Set up a working power supply circuit on a breadboard and demonstrate how voltage is converted and regulated.
- Engage participants by having them measure voltage at different points in the circuit using a multimeter.

Elaborate

- Determine Transformer Turns Ratio – Calculate how many turns are needed in the primary and secondary windings to achieve the required voltage conversion.
- Explain Sequential Connection of Components – Understand how transformers, rectifiers, filters, and regulators work together to provide stable DC output.
- Evaluate the Type of DC Power Supply – Compare linear vs. switching power supplies and determine the best option for a given application.
- Design Voltage Regulation – Implement regulators to maintain a steady output voltage despite fluctuations in input voltage or load conditions.
- Assess Transformer Suitability – Select the right transformer for a project based on power rating, efficiency, and voltage conversion needs.
- Calculate and Justify Smoothing Capacitor Value – Compute the capacitance required to minimize output ripple in a rectified DC supply.
- Develop a Steady Power Supply Circuit – Design and assemble a circuit that maintains a consistent voltage under different loads.
- Implement a Current-Limiting Feature – Add resistors or active components to prevent excess current flow and protect the circuit.
- Analyze and Calculate Transformer Turns Ratio – Perform hands-on calculations and testing to validate theoretical predictions.
- Assemble and Troubleshoot Components – Build a complete power supply circuit, identify potential issues, and rectify them.

Demonstrate

Show how a transformer steps down voltage – Use a step-down transformer and measure input and output voltages with a multimeter. Explain why the turns ratio determines voltage conversion.

Activity

1. **Activity Name:** Design and Build a Simple Regulated Power Supply
2. **Objective:** To construct a working power supply circuit that converts AC to a stable DC voltage.
3. **Type of Activity:** Group
4. **Resources:** Breadboard, Transformer, Diodes, Capacitors, Voltage Regulator (e.g., 7805), Resistors, Multimeter, DC Load (LED or motor).
5. **Time Duration:** 30 minutes
6. **Instructions:**
   - Provide participants with a circuit diagram of a regulated power supply (220V AC to 5V DC).
   - Have them connect the step-down transformer to the AC mains (under supervision).
   - Guide them to wire a bridge rectifier and filter capacitor to convert AC to DC.
   - Instruct them to connect a voltage regulator (7805) and measure the output voltage.
   - Test the circuit with an LED as a load and observe stability.
   - Ask them to troubleshoot any voltage fluctuations and correct errors.
7. **Outcome:** Participants will gain hands-on experience in assembling a basic power supply, understanding component functions, and troubleshooting circuit issues.

Notes for Facilitation

- Keep the session interactive by encouraging participants to share their observations.
- Ensure safety while working with transformers and AC power connections.
- Emphasize why transformer turns ratio is crucial for proper voltage conversion.
- Highlight the importance of smoothing capacitors in reducing voltage ripple.
- Explain how a voltage regulator stabilizes output, ensuring safe operation for electronic devices.

Unit 4.3: Testing, Adjustment, and Circuit Optimization

Unit Objectives

By the end of this unit, the participants will be able to:

1. Analyze Multimeter Readings to Measure and Evaluate the Output Voltage and Current of a Power Supply
2. Discuss the Procedure for Adjusting Voltage Regulators to Achieve the Desired Output Voltage
3. Explain the Significance of AC Waveform Blocking and Utilization in Power Supply Circuits
4. Evaluate the Advantages and Disadvantages of Utilizing Both Halves of the AC Input Waveform
5. Describe the Role of Filter Capacitors in Reducing Ripple and Stabilizing the Pulsating DC Waveform
6. Assess the Importance of Voltage Regulation and Galvanic Isolation in Power Supply Design
7. Calibrate a Practical Circuit by Measuring and Adjusting the Output Voltage and Current Using a Multimeter
8. Modify Voltage Regulators in Real-Time to Achieve the Desired Output Voltage
9. Demonstrate the Utilization of Practical AC Waveforms by Allowing One Half to Pass Through and Blocking the Other Half
10. Develop and Test Circuits That Utilize Both Halves of the AC Input Waveform
11. Integrate Filter Capacitors into a Practical Power Supply Circuit to Enhance Stability and Reduce Ripple
12. Design and Implement Power Supplies with Voltage Regulation and Galvanic Isolation Features for Specific Applications

Resources to be Used

Multimeters, DC power supplies, voltage regulators (LM317, 7805, etc.), filter capacitors, resistors, diodes, oscilloscopes, AC-DC converters, breadboards, connecting wires, soldering iron, heat sinks, transformers, circuit diagrams, marker board, projector, printed handouts.

Say

- Hey everyone! Excited to have you all here today! We're diving into an essential part of working with power supply circuits—how to test, adjust, and optimize them to ensure they perform reliably and efficiently.
- By the end of this session, you'll be able to measure voltages and currents accurately, adjust voltage regulators, and implement components like capacitors and transformers to improve circuit stability and efficiency.
- Understanding these concepts is crucial because a properly optimized power circuit can mean the difference between a reliable device and a failing one. Whether you work on consumer electronics, industrial machinery, or embedded systems, these skills will help you troubleshoot and enhance power supplies effectively!

Ask

- Have you ever used a multimeter to check if a battery is charged? How did you determine if it was working properly?
- Why do we need voltage regulation in our mobile phone chargers and power adapters? What happens if the voltage is too high or too low?
- Have you ever noticed a flickering light when using certain electrical appliances? What do you think causes that effect?

Do

- Start by introducing the concept of testing circuits and why accurate measurements are critical in power supply design.
- Demonstrate how to use a multimeter to measure voltage and current in a power supply circuit.
- Explain and show the process of adjusting a voltage regulator to achieve a stable output voltage.
- Illustrate how AC waveforms behave in rectification and how we can use different components to improve circuit efficiency.
- Guide participants in modifying a simple power supply circuit by adding or adjusting filter capacitors and observing changes in ripple voltage.
- Conclude with a Q&A session to reinforce key concepts and clarify doubts.

Elaborate

- Analyze multimeter readings: Explain how to measure and interpret voltage and current values in a circuit using a multimeter.
- Discuss voltage regulator adjustment: Outline the process of tweaking a voltage regulator to achieve the required output voltage.
- Explain AC waveform blocking: Describe how rectifiers block and utilize AC waveforms in power circuits.
- Evaluate AC waveform utilization: Compare the effects of using half-wave vs. full-wave rectification in circuits.
- Describe filter capacitor functions: Explain how capacitors reduce ripple and stabilize DC output in power supplies.
- Assess voltage regulation and galvanic isolation: Discuss their importance in preventing circuit damage and ensuring electrical safety.
- Calibrate circuits: Demonstrate step-by-step how to measure and adjust circuit parameters for optimal performance.
- Modify voltage regulators: Show practical ways to alter voltage regulator settings for different applications.
- Utilize AC waveforms: Demonstrate allowing one half of an AC waveform to pass while blocking the other.
- Develop AC-utilizing circuits: Design and test circuits that incorporate both halves of the AC waveform.
- Integrate filter capacitors: Implement capacitors in circuits to enhance voltage stability and reduce noise.
- Design power supplies with voltage regulation and isolation: Create circuits that ensure stable power delivery and prevent electrical interference.

Demonstrate

- Demonstration: Measuring and Adjusting Voltage Using a Multimeter
- Show how to measure the input and output voltage of a power supply using a multimeter and make adjustments to a voltage regulator to achieve a desired voltage level.

Activity

1. **Activity Name:** Voltage Regulation and Ripple Reduction
2. **Topics Covered:** Modify Voltage Regulators, Integrate Filter Capacitors
3. **Objective:** To observe how voltage regulation and capacitor filtering impact circuit stability.
4. **Type of Activity:** Group
5. **Resources:** Multimeters, power supply circuits, voltage regulators, filter capacitors, resistors, breadboards, connecting wires, oscilloscopes.
6. **Time Duration:** 30 minutes
7. **Instructions:**
   - Divide participants into small groups and provide each group with a basic power supply circuit.
   - Instruct them to first measure the voltage output without any modifications and record their findings.
   - Have them adjust the voltage regulator and measure the new output.
   - Ask them to integrate a filter capacitor and observe changes in ripple voltage using an oscilloscope.
   - Compare the circuit performance before and after modifications and discuss observations.
8. **Outcome:** Participants will understand the role of voltage regulation and filtering in stabilizing power supplies and reducing unwanted fluctuations.

Notes for Facilitation

- Encourage hands-on engagement by letting participants take turns using the multimeter and making adjustments to circuits.
- Relate the topics to real-life applications like mobile chargers, UPS systems, and home inverters to maintain interest and engagement.
- Ensure all safety precautions are followed, especially when dealing with AC power sources.
- Emphasize the importance of precise measurements and proper circuit adjustments to avoid damaging components.
- Clarify the role of each circuit component in power supply optimization to enhance understanding.
- Summarize key takeaways at the end and encourage participants to ask questions about practical implementation.

Answers to Exercises for PHB

Multiple Choice Questions:

1. b. Output voltage
2. c. Capacitor
3. b. Circuit protection
4. a. Voltage regulator
5. d. Galvanic isolation

Descriptive Questions:

1. Refer to: UNIT 4.1: Fundamentals of Power Supply Design and Components
   Topic: 4.1.1 Voltage and Current Requirements of Electronic Devices
2. Refer to: UNIT 4.1: Fundamentals of Power Supply Design and Components
   Topic 4.1.4 Role of Transformers in Converting AC Voltage
3. Refer to: UNIT 4.1: Fundamentals of Power Supply Design and Components
   Topic 4.1.5 Purpose of Capacitors in Smoothing DC Voltage
4. Refer to: UNIT 4.2: Power Supply Circuit Design and Practical Implementation
   Topic: 4.2.1 Calculate the Transformer Turns Ratio for Specific Voltage Conversion Requirements
5. Refer to: UNIT 4.3: Testing, Adjustment, and Circuit Optimization
   Topic 4.3.6 Define Voltage Regulation and Galvanic Isolation in the Context of Power Supply Design

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
RE IMAGINE FUTURE

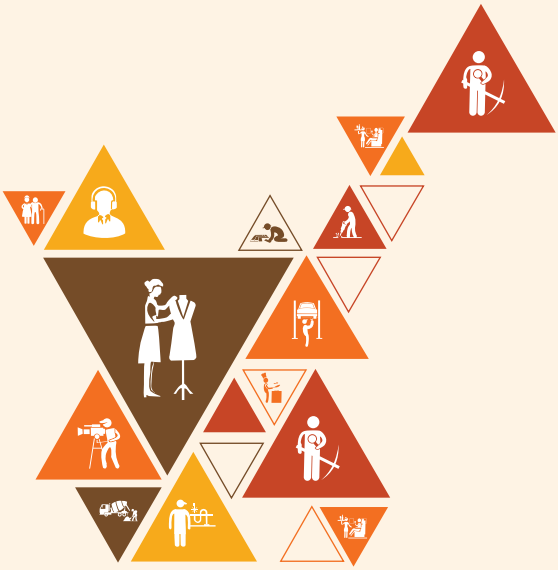
Telecom Sector Skill Council

5. Power Backup System Testing

Unit 5.1 - Power Backup System Components and Design

Unit 5.2 - Testing and Simulation of Power Backup Systems

Unit 5.3 - Efficiency, Safety, and System Performance



TEL/N4309

Key Learning Outcomes 

By the end of this module, the participants will be able to:

1. Interpret the role of a controller in a battery charging system.
2. Create and execute test scenarios for simulating fault conditions in a power backup system.
3. Develop a procedure for integrating components into a full power backup system.

Unit 5.1: Power Backup System Components and Design

Unit Objectives

By the end of this unit, the participants will be able to:

1. Describe the Components and Their Connections in a Power Backup System
2. Elaborate on the Purpose of a DC-DC Converter and Its Typical Operating Range
3. Analyze the Role of a Controller in a Battery Charging System
4. Evaluate the Suitability of Different Types of UPS Systems (Online, Offline, Line-Interactive) Based on Specific Needs
5. Compare the Suitability of Different Types of UPS Systems (Online, Offline, Line-Interactive) Based on Specific Needs

Resources to be Used

Presentation slides, whiteboard and markers, UPS system models (Online, Offline, and Line-Interactive), battery charging system with a controller, DC-DC converter circuit, multimeter, connection diagrams, handouts on power backup system components, and a video demonstration of a UPS system in action.

Say

- (Greeting) Hey everyone! Welcome to today's session. I hope you're all doing great. We're going to dive into an essential topic—Power Backup Systems—that plays a huge role in keeping our electronics running during power failures.
- (Objective) By the end of this session, you'll understand how power backup systems are structured, how different components function together, and how to evaluate different types of UPS systems for specific needs.
- (Why It Matters) Imagine working on something critical, and suddenly, the power goes out—without a backup system, all your progress could be lost! Understanding power backup systems will help you select, maintain, and troubleshoot them effectively.

Ask

- Have you ever experienced a sudden power outage? What happened to your electronic devices?
- When you charge your phone, have you noticed how the charging speed changes depending on the charger? Why do you think that happens?
- Can you think of a place where an uninterrupted power supply is absolutely necessary? (e.g., hospitals, data centers)

Do

- Introduce the concept of power backup systems and explain why they are essential in different settings.
- Show the physical components of a power backup system using diagrams or real hardware models.
- Explain the function of the DC-DC converter and demonstrate how it adjusts voltage levels.
- Describe the controller's role in battery charging and why it's important for efficiency and longevity.
- Compare different UPS types and discuss real-world applications to help learners relate the concepts to daily life.

Elaborate

- Describe the Components and Their Connections in a Power Backup System – Explain the function and interconnection of batteries, inverters, controllers, and converters in a backup system.
- Elaborate on the Purpose of a DC-DC Converter and Its Typical Operating Range – Discuss why voltage conversion is needed, how it maintains efficiency, and its typical input/output values.
- Analyze the Role of a Controller in a Battery Charging System – Explain how controllers regulate charging and prevent overcharging or deep discharge of batteries.
- Evaluate the Suitability of Different Types of UPS Systems (Online, Offline, Line-Interactive) Based on Specific Needs – Discuss the pros and cons of each UPS type and how to choose the right one based on reliability, cost, and usage scenario.
- Compare the Suitability of Different Types of UPS Systems (Online, Offline, Line-Interactive) Based on Specific Needs – Provide side-by-side comparisons and use case studies to help learners differentiate the UPS types.

Demonstrate

Show a working UPS system and explain its key components by pointing them out. Turn the system on and off to simulate a power failure and explain how the backup mechanism activates.

Activity

1. **Activity Name:** UPS System Identification and Selection
2. **Topics:** Evaluate the Suitability of Different Types of UPS Systems, Compare the Suitability of Different Types of UPS Systems
3. **Objective:** To help learners identify and select the right UPS type for different needs
4. **Type of Activity:** Group Activity
5. **Resources:** Handouts with descriptions of different UPS system types, real-life scenarios requiring backup power, chart paper, markers
6. **Time Duration:** 30 minutes

7. **Instructions:**
   - Divide learners into small groups and provide each group with a set of real-life scenarios (e.g., home office, data center, hospital).
   - Give them descriptions of different UPS systems and their specifications.
   - Each group must discuss and decide which UPS system would be most suitable for their assigned scenario.
   - Groups will write down their reasoning on chart paper and present it to the class.
   - Facilitate a discussion on the choices made by different groups and provide feedback.
8. **Outcome:** Learners will be able to evaluate different UPS systems based on specific requirements and justify their selection.

Notes for Facilitation

- Encourage interaction by asking learners to share their own experiences with power outages.
- Use visuals, models, and hands-on demonstrations to keep the session engaging.
- Emphasize the importance of proper UPS selection for different environments.
- Clarify the role of DC-DC converters in ensuring smooth voltage regulation.
- Highlight the impact of controllers in optimizing battery life and efficiency.

Unit 5.2: Testing and Simulation of Power Backup Systems

Unit Objectives

By the end of this unit, the participants will be able to:

1. Explain the Procedure for Measuring and Monitoring the Output Voltage of a DC-DC Converter
2. Calculate and Justify Battery Capacity Based on Discharge Time and Current
3. Develop and Execute Test Scenarios for Simulating Fault Conditions in a Power Backup System
4. Design and Implement a Test Plan to Ensure the Seamless Transition from AC to Battery Power
5. Assemble, Connect, and Troubleshoot a DC-DC Converter, Battery, and Controller in a Power Backup System
6. Assess and Rectify Loose Connections or Damaged Components Before Testing
7. Evaluate the Behavior of a Power Backup System During Transitions and Verify Voltage Regulation and Protection Mechanisms
8. Describe Practical Setups to Measure Input and Output Power Using Appropriate Instruments
9. Formulate a Testing Procedure for Simulating Fault Conditions and Ensuring Proper Responses

Resources to be Used

Multimeters, oscilloscopes, DC power supplies, resistive loads, DC-DC converters, batteries, controllers, power backup systems, wiring tools, simulation software, data sheets of DC-DC converters and batteries, protective gear such as gloves and goggles, safety guidelines documentation, and worksheets for calculations and test plans.

Say

- "Good day, everyone! I'm excited to guide you through today's session on testing and simulating power backup systems. This is a crucial part of understanding how backup systems function and ensure power reliability."
- "Today, we will learn how to measure and monitor the output voltage of a DC-DC converter, calculate battery capacity, develop fault simulation tests, and ensure a seamless transition from AC to battery power. These skills are fundamental in troubleshooting and maintaining power backup systems."
- "Understanding this topic is important because power failures can lead to major disruptions in industries, healthcare, and daily life. By learning these testing and simulation techniques, you will be able to ensure uninterrupted power supply and system reliability."

Ask

- "Have you ever experienced a power outage at home? How did you manage during that time?"
- "Can you think of any devices around you that switch to battery power when electricity is lost?"
- "Why do you think it is important to test a backup power system before using it in a real-world situation?"

Do

- Introduce the concept of power backup systems and explain why testing and simulation are critical.
- Demonstrate how to measure and monitor the output voltage of a DC-DC converter using a multimeter and oscilloscope.
- Explain the calculation of battery capacity and guide participants through an example.
- Walk through the process of assembling and connecting a DC-DC converter, battery, and controller.
- Conduct a practical demonstration on identifying and rectifying loose connections or damaged components.
- Guide participants in formulating and executing test plans to simulate fault conditions and verify voltage regulation.

Elaborate

- Measure and Monitor Output Voltage – Use a multimeter or oscilloscope to check and interpret voltage readings.
- Calculate Battery Capacity – Use discharge time and current values to determine suitable battery specifications.
- Develop Fault Simulation Tests – Design test cases to replicate potential failures and assess system responses.
- Ensure Seamless Power Transition – Implement and verify automatic switching from AC to battery power.
- Assemble and Connect System Components – Set up a DC-DC converter, battery, and controller for testing.
- Identify and Rectify Faults – Inspect wiring and components for defects before testing.
- Evaluate System Behavior – Assess voltage regulation, transitions, and protection mechanisms.
- Measure Input and Output Power – Use instruments like oscilloscopes and power meters to analyze power flow.
- Formulate Testing Procedures – Create a structured approach to testing system performance under fault conditions.

Demonstrate

Show how to measure and interpret the output voltage of a DC-DC converter using a multimeter and oscilloscope.

Activity

1. **Activity Name:** Battery Capacity and Discharge Time Calculation
2. **Objective:** Understand and calculate battery capacity based on discharge time and current.
3. **Type of Activity:** Individual
4. **Resources:** Battery data sheets, calculators, formula sheets, worksheet with example scenarios
5. **Time Duration:** 25 minutes

6. **Instructions:**
   - Distribute battery data sheets and worksheets to participants.
   - Explain the formula for calculating battery capacity: Capacity (Ah) = Discharge Current (A) × Discharge Time (h).
   - Provide an example scenario where a system draws a certain current for a specific duration.
   - Ask participants to calculate the required battery capacity based on the given parameters.
   - Discuss answers and clarify any misconceptions.
7. **Outcome:** Participants will be able to calculate and justify battery capacity requirements for different applications.

Notes for Facilitation

- Ensure safety protocols are followed while handling electrical components.
- Encourage hands-on participation to enhance understanding.
- Reinforce the importance of accurate measurements for system reliability.
- Highlight real-world implications of power backup failures and how testing prevents them.
- Discuss different fault conditions and how to simulate them effectively.
- Emphasize the role of proper connection and troubleshooting before testing to avoid inaccurate results or system damage.

Unit 5.3: Efficiency, Safety, and System Performance

Unit Objectives

By the end of this unit, the participants will be able to:

1. Explain the Importance of Safety Precautions When Working with Power Systems
2. Calculate and Analyze the Efficiency of a DC-DC Converter Using the Efficiency Formula
3. Discuss the Comparative Efficiency of Different DC-DC Converters
4. Assess the Responsiveness and Data Accuracy of a Controller in a Power Backup System
5. Design and Integrate Real Components into a Functioning Power Backup System and Evaluate Its Performance During Power Outage Simulations
6. Determine the Efficiency of a DC-DC Converter Based on Practical Measurements
7. Evaluate and Interpret the Behavior of the Power Backup System During Discharging and Charging Processes
8. Develop and Conduct Practical Tests to Verify the UPS System's Ability to Protect Connected Devices.

Resources to be Used

Multimeters, oscilloscopes, DC-DC converters, power backup system components, UPS system, load resistors, simulation software, safety gloves, protective eyewear, instructional videos, whiteboard and markers, worksheets, and real-world case studies.

Say

- Hey everyone! Welcome to today's session on Efficiency, Safety, and System Performance. We'll explore how power systems work efficiently while maintaining safety and performance standards.
- Today, we will learn how to calculate efficiency, assess system responsiveness, and evaluate power backup performance. By the end of the session, you'll be able to test and verify system efficiency with hands-on practicals.
- Understanding these concepts is crucial because they directly impact energy consumption, device protection, and overall system reliability. Whether you work in engineering or maintenance, this knowledge will help you optimize performance and safety.

Ask

- Have you ever experienced a sudden power outage at home? What happened to your electronic devices?
- Why do you think some phone chargers heat up more than others even if they charge the same device?
- What do you think would happen if a power backup system doesn't respond accurately during a blackout?

Do

- Begin with a brief overview of power system safety, discussing potential hazards and precautions.
- Introduce the concept of efficiency in DC-DC converters and walk through a basic efficiency calculation.
- Compare different DC-DC converters, highlighting their pros and cons in terms of energy conservation.
- Demonstrate how to measure the responsiveness and data accuracy of a power backup controller.
- Guide participants through a hands-on activity where they integrate components into a power backup system.
- Conduct a power outage simulation to evaluate system performance in real time.
- Explain how to conduct practical tests to verify a UPS system's ability to protect connected devices.

Elaborate

- The risks involved in working with power systems and the importance of protective measures.
- The efficiency formula and perform a sample calculation.
- The differences between buck, boost, and buck-boost converters.
- The performance of controllers in power backup systems.
- Integrating real components into a functional system.
- Experiments to validate theoretical efficiency calculations.
- How the power backup system responds in real-world conditions.
- Controlled tests to verify how well a UPS shields devices from power fluctuations.

Demonstrate

Show how to measure the input and output power of a DC-DC converter and calculate its efficiency using real-time voltage and current readings.

Activity

1. **Activity Name:** Power Backup System Evaluation
2. **Objective:** To integrate real components into a power backup system and assess its performance during a simulated power outage.
3. **Type of Activity:** Group
4. **Resources:** Power backup system components, multimeter, oscilloscope, load resistor, simulation software, whiteboard, and markers.
5. **Time Duration:** 30 minutes
6. **Instructions:**
    - Divide participants into small groups.
    - Provide each group with components and a step-by-step guide to assembling a power backup system.

- Once assembled, instruct each group to simulate a power outage and record how their system responds.
- Measure input and output power to determine efficiency.
- Have each group present their findings, discussing performance, areas of improvement, and efficiency calculations.

7. **Outcome:** Participants will gain hands-on experience in system integration, real-time troubleshooting, and efficiency assessment.

Notes for Facilitation

- Encourage active participation and allow trainees to ask questions throughout the session.
- Ensure all safety protocols are followed when handling electrical components.
- Emphasize the importance of accurate efficiency calculations and their impact on power consumption.
- Highlight real-world applications of power backup systems in industries and households.
- Provide real-time feedback and guide participants in interpreting their results.
- Reinforce key takeaways by summarizing efficiency, safety, and performance considerations at the end of the session.

Answers to Exercises for PHB

Multiple Choice Questions:

1. b. Controller
2. c. 80-90%
3. b. Overcharge and discharge prevention
4. b. Seamless power transition
5. b. Online UPS

Descriptive Questions:

1. Refer to: UNIT 5.1: Power Backup System Components and Design
   Topic: 5.1.2 Summarize the Purpose of a DC-DC Converter and Its Typical Operating Range
2. Refer to: UNIT 5.1: Power Backup System Components and Design
   Topic 5.1.1 Explain the Components and Their Connections in a Power Backup System
3. Refer to: UNIT 5.1: Power Backup System Components and Design
   Topic 5.1.4 Assess the Suitability of Different Types of UPS Systems (Online, Offline, Line-Interactive) Based on Specific Needs
4. Refer to: UNIT 5.2: Testing and Simulation of Power Backup Systems
   Topic: 5.2.3 Create and Execute Test Scenarios for Simulating Fault Conditions in a Power Backup System
5. Refer to: UNIT 5.2: Testing and Simulation of Power Backup Systems
   Topic 5.2.4 Design a Test Plan to Ensure the Seamless Transition from AC to Battery Power

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

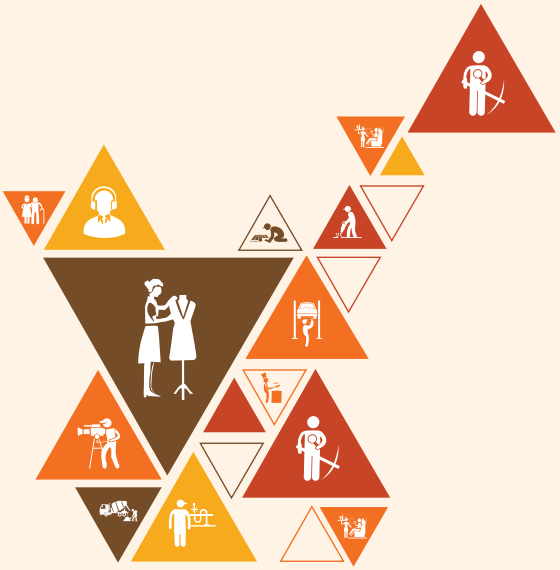
N·S·D·C
RE IMAGINE FUTURE

Telecom Sector Skill Council

6. Surge Protection System Installation Procedures

Unit 6.1 - Surge Protection Devices and Their Application

Unit 6.2 - Installation Considerations and Best Practices



TEL/N4310

Key Learning Outcomes 

By the end of this module, the participants will be able to:

1. Explain potential sources of surges, such as lightning strikes and power grid fluctuations.
2. Describe the role of grounding standards in surge protection.

Unit 6.1: Surge Protection Devices and Their Application

Unit Objectives

By the end of this unit, the participants will be able to:

1. Identify and Describe Critical Electrical and Electronic Equipment That Require Surge Protection
2. Analyze Potential Sources of Surges, Such as Lightning Strikes and Power Grid Fluctuations
3. Classify and Explain the Different Types of Surge Protection Devices (SPDs) and Their Purposes
4. Assess the Importance of Matching SPD Voltage Ratings to the System's Operating Voltage

Resources to be Used

Surge Protection Devices (SPDs), a whiteboard and markers, handouts with diagrams of SPDs, various types of electrical equipment (such as computers, home appliances, etc.) for demonstration, videos on how surges occur and affect systems, SPD demonstration units (if possible), and a surge testing device or simulation tool.

Say

- "Good day, everyone! I'm really excited to delve into a crucial aspect of electrical systems that impacts everything from our personal gadgets to large-scale industrial setups!"
- "Today, we will learn about Surge Protection Devices (SPDs), understand how surges affect equipment, and why matching SPDs to your system is vital."
- "It's essential to understand SPDs because electrical surges can damage critical devices and cause expensive downtime, and knowing how to protect them is part of being proactive in system maintenance and safety."

Ask

- "Have you ever experienced a power outage or flickering lights during a thunderstorm?"
- "What types of devices in your home or work do you think are most vulnerable to power surges?"
- "Do you know why some devices, like your computer or TV, might be affected by electrical spikes while others seem unaffected?"

Do

- Begin with a short discussion on the relevance of surge protection in daily life.
- Introduce the various types of surge sources, emphasizing lightning and power grid issues.
- Walk through the different SPD categories, making sure to explain their respective uses in real-world contexts.

- Use visual aids and demonstration units to showcase SPD models and their components.
- Explain how to match SPDs with different voltage levels in a system to prevent mishaps.
- Engage the class with the activity (detailed below) to help them understand the importance of SPDs and voltage matching.

Elaborate

- Learn to identify electrical and electronic equipment in homes and workplaces that require surge protection.
- Understand the potential sources of surges such as lightning, power grid fluctuations, and switching actions.
- Recognize different types of SPDs, including Type 1, Type 2, and Type 3, and their specific functions in preventing surge damage.
- Comprehend the importance of matching the SPD's voltage rating with the operating voltage of the system to ensure protection.

Demonstrate

Show how an SPD functions by connecting one to a device that might typically be vulnerable to power surges, like a computer. Display how the SPD absorbs and diverts the surge, preventing the device from damage

Activity

1. **Activity Name:** "SPD Installation and Matching Voltage Ratings"
2. **Objective:** To understand how to install SPDs and match their voltage ratings with a system's operating voltage.
3. **Type of activity:** Group
4. **Resources:** SPD demonstration units, multimeter, PowerPoint slides on SPD ratings, whiteboard
5. **Time Duration:** 30 minutes
6. **Instructions:**
   - Divide the participants into small groups.
   - Provide each group with an SPD unit, a multimeter, and a device that requires surge protection.
   - Ask the groups to measure the operating voltage of the device using the multimeter.
   - Have the groups choose an appropriate SPD that matches the voltage and connect it to the device.
   - After connecting the SPD, explain how they would test if it's properly working (using the multimeter and testing equipment).
   - Discuss as a group the importance of selecting the correct SPD for different voltage systems.
7. **Outcome:** Participants will be able to identify the appropriate SPD for various devices and install them correctly, matching voltage ratings.

Notes for Facilitation

- Encourage questions during the demonstration and activity to clarify understanding.
- Be sure to emphasize safety when dealing with electrical systems and SPDs, especially when handling devices that simulate surges.
- Discuss real-world applications of surge protection beyond personal electronics—such as in industrial settings and IT infrastructures.
- Remind participants that matching the SPD voltage rating is a critical step in ensuring proper surge protection and preventing damage to sensitive equipment.
- Reinforce that while SPDs are vital, they are just one part of a broader electrical safety strategy.
- Make sure to highlight how SPDs work in preventing financial and operational losses caused by power surges.

Unit 6.2: Installation Considerations and Best Practices

Unit Objectives

By the end of this unit, the participants will be able to:

1. Elaborate on the Role of Grounding Standards in Surge Protection
2. Discuss the Importance of Avoiding Sharp Bends in Wiring to Minimize Impedance

Resources to be Used

Surge protectors, grounding wire, electrical wiring diagrams, insulated wire, wire bending tools, impedance measurement instruments, whiteboard and markers, or a projector for visual aids, units for wiring, grounding setups, and tools to allow the trainees to understand each concept in action.

Say

- Hello everyone, I'm excited to be here with you today! We're going to dive into some crucial installation considerations to ensure your setups are both safe and effective!
- In today's session, we'll focus on understanding grounding standards in surge protection and why sharp bends in wiring should be avoided.
- It's essential to understand these topics, as they directly impact the performance, safety, and longevity of electrical systems, which are important in any installation project you will encounter.

Ask

- "Have you ever experienced an electrical surge that caused damage to your devices or systems?"
- "Can anyone think of a time when they noticed wires bent in a way that may have seemed unsafe or caused issues?"
- "Why do you think grounding is such an important part of electrical installations and surge protection?"

Do

- Introduce the topics by explaining the critical role grounding plays in preventing damage from electrical surges.
- Discuss how sharp bends in wires can increase impedance and affect the overall performance of electrical systems.
- Show examples of properly grounded systems and improperly bent wiring.
- Provide a clear explanation of the importance of following best practices during installations to avoid long-term problems.

- Use diagrams and visuals to help explain how surge protection and wiring are connected to impedance and grounding.
- Ensure the participants understand both theoretical concepts and practical applications through demonstrations and activities.

Elaborate

- The standards that must be followed to ensure effective surge protection.
- How surge protectors work with proper grounding to prevent damage to electrical devices.
- Clarify the concept of impedance: Define impedance and how sharp bends in wires can increase impedance, leading to inefficiency and possible damage.
- The importance of avoiding sharp bends in electrical wiring to maintain low impedance and ensure proper function.
- The role of consistent installation standards to avoid errors that could lead to costly repairs or safety hazards.

Demonstrate

- Set up a surge protector with a grounded system and show how it effectively protects devices during a surge.
- Demonstrate bending wires at sharp angles and measure impedance to show how it affects the system's performance.

Activity

1. **Activity Name:** "Grounding and Bending Best Practices"
2. **Objective:** To understand and apply the importance of proper grounding and avoiding sharp bends in electrical wiring.
3. **Type of Activity:** Group
4. **Resources:** Surge protectors, grounding wires, insulated wiring, wire bending tools, impedance measurement tools, wiring diagrams.
5. **Time Duration:** 30 minutes
6. **Instructions:**
   - Divide the trainees into small groups.
   - Provide each group with a setup that includes a surge protector, grounded wire, and a piece of wiring that can be bent.
   - Ask the groups to follow instructions to wire the surge protector with proper grounding. Demonstrate the correct method first.
   - Instruct them to deliberately bend the wire at sharp angles and measure the impedance using the tools provided.

- Have each group share their results on impedance with bent and unbent wiring.
- Discuss the observations and highlight the difference between properly installed grounding and the effect of sharp bends on impedance.

7. **Outcome:** Trainees will learn how to properly ground electrical systems and recognize the negative impact of sharp bends in wiring on impedance and system efficiency.

Notes for Facilitation

- Encourage active participation and questions to ensure everyone understands the concepts of grounding and wiring practices.
- Be mindful of the different skill levels in the class, so provide additional support to trainees who might need help with the hands-on activity.
- Reinforce the importance of grounding for safety, especially when working with sensitive electronic equipment.
- When discussing impedance, make sure to emphasize how it relates to the quality and efficiency of electrical systems.
- Ensure that participants clearly understand the connection between wiring practices and overall system performance by using hands-on examples.

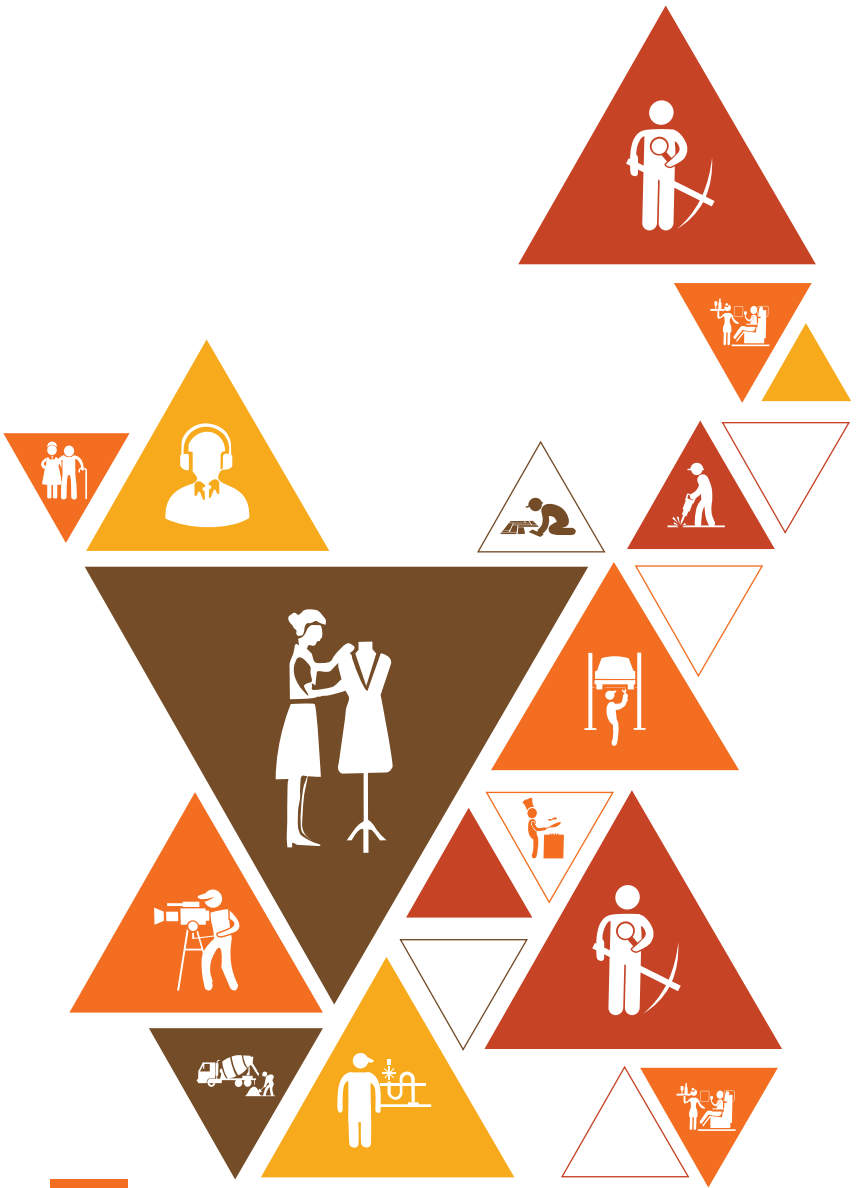
Answers to Exercises for PHB

Multiple Choice Questions:

1. b. To ensure the safety and proper design of electrical systems
2. b. To provide a safe path for fault currents
3. b. Bonding conductor
4. b. To ensure reliability and safety of the telecom electrical system
5. a. To ensure network performance and scalability

Descriptive Questions:

1. Refer to: UNIT 6.1: Surge Protection Devices and Their Application
   Topic: 6.1.1 Describe Critical Electrical and Electronic Equipment That Require Surge Protection
2. Refer to: UNIT 6.1: Surge Protection Devices and Their Application
   Topic 6.1.3 Define the Different Types of Surge Protection Devices (SPDs) and Their Purposes
3. Refer to: UNIT 6.1: Surge Protection Devices and Their Application
   Topic: 6.1.1 Describe Critical Electrical and Electronic Equipment That Require Surge Protection
4. Refer to: UNIT 6.2: Installation Considerations and Best Practices
   Topic: 6.2.2 Explain the Significance of Avoiding Sharp Bends in Wiring to Minimize Impedance
5. Refer to: UNIT 6.1: Surge Protection Devices and Their Application
   Topic 6.1.4 Explain the Importance of Matching SPD Voltage Ratings to the System's Operating Voltage



Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
RE IMAGINE FUTURE

Telecom Sector Skill Council

7. Process of Organising Work and Resources as per Health and Safety Standards

Unit 7.1 - Workplace Health & Safety

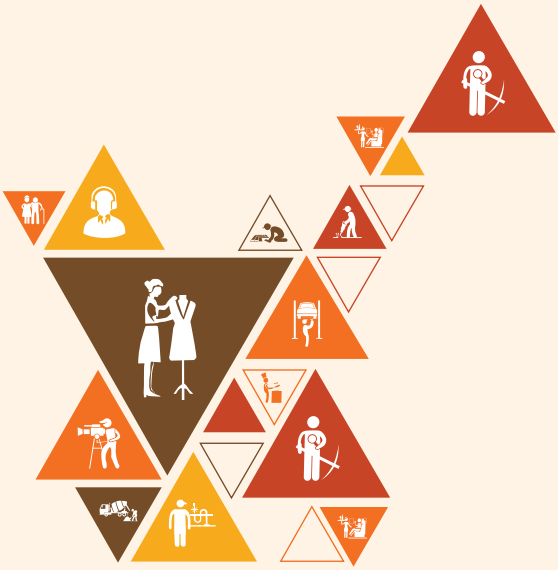
Unit 7.2 - Different types of Health Hazards

Unit 7.3 - Importance of Safe Working Practices

Unit 7.4 - Reporting Safety Hazards

Unit 7.5 - Waste Management

Unit 7.6 - Organizations' Focus on the Greening of Jobs



TEL/N9101

Key Learning Outcomes 

By the end of this module, the trainees will be able to:

1. Explain about the work place health and safety
2. Differentiate various health hazards
3. Demonstrate various first aid techniques
4. Importance of safety at workplace
5. Understand Basic hygiene Practices and hand washing techniques
6. Explain the need for social distancing
7. Understand the reporting of hazards at workplace
8. Explain e-waste and process of disposing them
9. Explain Greening of jobs

Unit 7.1: Workplace Health & Safety

Unit Objectives

By the end of this unit, the trainees will be able to:

1. Understand about workplace health and safety
2. Explain tips to design a safe workplace
3. Explain precautions to be taken at a workplace

Resources to be Used

Presentation slides or visual aids, Examples of safe workplace designs, Visuals demonstrating precautions at a workplace.

Say

- Today, we're diving into a topic that's crucial for each one of us - Workplace Health & Safety. Let's make our workspace not just productive but also safe and secure!
- Our objective today is to understand the fundamentals of workplace health and safety. We'll explore how to design a safe workplace and discuss important precautions. This knowledge is essential for creating a work environment that prioritizes our well-being.
- Workplace safety isn't just a legal requirement; it's about our well-being. Knowing the ins and outs of creating a safe workspace ensures that we can all go home healthy and sound every day.

Ask

- Can you share an experience where workplace safety measures made a significant difference?
- What are some common challenges you've observed regarding safety in your workplace?
- Why is it important for employees to actively contribute to maintaining a safe work environ-ment?

Do

- Discuss the importance of workplace health and safety.
- Outline the session objectives.

Elaborate

Understanding Workplace Health and Safety

- Provide an overview of the concept, legal aspects, and its impact on employees and produc-tivity.

Designing a Safe Workplace and Precautions

- Share tips and best practices for designing a safe workplace.
- Discuss specific precautions that should be taken at a workplace.

Demonstrate

- Demonstrate examples of safe workplace designs and explain the reasoning behind them.

Activity

1. **Activity name:** Safety Check: Design Your Workspace
2. **Objective:** Apply knowledge of safe workplace design.
3. **Type of Activity:** Group
4. **Resources:** Templates for designing workspaces, markers, and flip charts.
5. **Time Duration:** 25 minutes
6. **Instructions:**
   - Groups design a safe workspace using provided templates, considering safety aspects dis-cussed.
7. **Outcome:** Improved understanding of practical implementation of safe workspace princi-ples.

Notes for Facilitation

- Encourage open discussions and questions.
- Emphasize that safety is everyone's responsibility.
- Highlight the role of each individual in maintaining a safe workplace.
- Emphasize the psychological impact of a safe environment on employee well-being and produc-tivity.
- Encourage a proactive approach towards safety, such as reporting hazards and suggesting im-provements.

Unit 7.2: Different types of Health Hazards

Unit Objectives

By the end of this unit, the trainees will be able to:

1. Understand the health hazards
2. Demonstrate First Aid Techniques

Resources to be Used

Presentation slides or visual aids, First aid kits for demonstration purposes, Handouts on com-mon health hazards.

Say

- Today's session is crucial as we delve into 'Different Types of Health Hazards' and learn practi-cal first aid techniques. Let's ensure we are equipped with the knowledge to keep ourselves and our colleagues safe.
- Our goal today is twofold: Firstly, to understand various health hazards that can affect us in our daily lives. Secondly, we'll go beyond awareness and dive into practical first aid techniques. This knowledge can be a lifesaver in emergencies.
- In our unpredictable lives, accidents and health emergencies can happen anytime. Knowing how to identify health hazards and administer basic first aid can make a significant difference, potentially saving lives.

Ask

- Can you share an instance where knowing first aid made a difference in handling a health emergency?
- What are some common health hazards you think people might encounter in their daily lives?
- How can awareness of health hazards contribute to a safer environment at home or work?

Do

- Briefly introduce the importance of understanding health hazards.
- Outline the session objectives.

Elaborate

Understanding Health Hazards

- Discuss various health hazards such as physical, chemical, biological, ergonomic, and psy-chosocial.
- Explain how these hazards can manifest in different settings.

First Aid Techniques

- Cover basic first aid techniques, including CPR, wound care, and responding to common health emergencies.

Demonstrate

- Demonstration common health hazards using visuals or case studies, Discuss preventive measures.

Activity

1. **Activity name:** First Aid Workshop
2. **Objective:** Apply first aid techniques.
3. **Type of Activity:** Group
4. **Resources:** First aid kits, mannequins for CPR practice, bandages, and other first aid sup-plies.
5. **Time Duration:** 30 minutes
6. **Instructions:**
   - Groups practice basic first aid techniques learned during the session.
7. **Outcome:** Enhanced confidence and practical application of first aid skills.

Notes for Facilitation

- Encourage active participation and questions.
- Maintain a supportive and open learning environment.
- Emphasize the importance of remaining calm and focused during health emergencies.
- Reinforce that first aid is not a substitute for professional medical care but can significantly im-prove outcomes before help arrives.
- Encourage participants to share personal experiences related to health hazards and first aid, fostering a collaborative learning environment.

Unit 7.3: Importance of Safe Working Practices

Unit Objectives

By the end of this unit, the trainees will be able to:

1. Explain Basic Hygiene Practices
2. Understand the importance of Social Distancing
3. Demonstrate the safe working practices

Resources to be Used

Presentation slides or visual aids, Handouts on basic hygiene practices and social distancing, Personal protective equipment (PPE) for demonstration purposes.

Say

- Today, we're diving into the 'Importance of Safe Working Practices.' It's not just about rules; it's about creating a healthy and secure work environment for all of us.
- Our aim today is to understand and appreciate the importance of basic hygiene practices, the significance of social distancing, and how to practically implement safe working practices. Let's ensure our workplaces are not just productive but also safe spaces for everyone.
- Safe working practices are the cornerstone of a healthy workplace. By understanding and im-plementing them, we contribute to our own well-being and the well-being of our colleagues. It's about fostering a culture of safety and respect.

Ask

- Can you share an example of how safe working practices have made a positive impact on your work environment?
- In what ways have you seen basic hygiene practices being emphasized in your workplace?
- How do you think social distancing contributes to a safer workplace, especially in the current context?

Do

- Briefly introduce the importance of safe working practices.
- Outline the session objectives.

Elaborate

Basic Hygiene Practices

- Discuss the significance of personal hygiene, handwashing, and maintaining a clean work-space.

Importance of Social Distancing

- Explain the concept of social distancing and its relevance in preventing the spread of infec-tions.
- Relate it to the current context and public health guidelines.

Safe Working Practices Demonstration

- Demonstrate the correct way to wear and dispose of PPE.
- Illustrate proper techniques for maintaining social distance in various workplace scenarios.

Demonstrate

Conduct a practical demonstration of implementing safe working practices in a simulated workplace scenario.

Activity

1. **Activity name:** Safety Drill (30 minutes)
2. **Objective:** Apply safe working practices.
3. **Type of Activity:** Group
4. **Resources:** PPE, visual aids, workplace layout.
5. **Time Duration:** 30 minutes
6. **Instructions:**
   - Groups perform a safety drill, incorporating basic hygiene practices and social distancing.
7. **Outcome:** Improved understanding and practical application of safe working practices.

Notes for Facilitation

- Encourage open discussions on experiences and concerns related to safety.
- Foster a non-judgmental environment to promote learning.
- Emphasize that safe working practices are everyone's responsibility.
- Stress the importance of adapting these practices to the specific context of the workplace.
- Encourage participants to share personal anecdotes about the positive impact of safe working practices in their lives.

Unit 7.4: Reporting Safety Hazards

Unit Objectives

By the end of this unit, the trainees will be able to:

1. Discuss the process of reporting in case of emergency (safety hazards)
2. Understand methods of reporting hazards

Resources to be Used

Presentation slides or visual aids, Examples of emergency contact information, Handouts on reporting procedures.

Say

- Today, we're delving into the critical topic of 'Reporting Safety Hazards.' It's not just about knowing the procedures but understanding why reporting is crucial for our collective well-being.
- Our goal today is to discuss the process of reporting safety hazards, especially in emergencies. We'll understand the methods and explore why our proactive reporting is vital for maintaining a safe working environment.
- Safety is everyone's responsibility. By the end of today's session, you'll be equipped with the knowledge needed to effectively report safety hazards, ensuring a prompt and appropriate re-sponse to emergencies.

Ask

- Can you share a situation from your own experience where reporting a safety hazard led to a positive outcome?
- How often do you review emergency contact information at your workplace?
- What challenges do you think individuals might face when it comes to reporting safety hazards?

Do

- Introduce the importance of reporting safety hazards.
- Outline the session objectives.

Elaborate

Process of Reporting in Emergencies

- Discuss the step-by-step process of reporting safety hazards during emergencies.

Methods of Reporting Hazards

- Explore different methods of reporting, including direct communication, use of emergency hotlines, and digital reporting systems.

Importance of Timely Reporting

- Emphasize the impact of timely reporting on preventing accidents and minimizing damage.

Demonstrate

- Simulate an emergency scenario and guide participants through the process of reporting. Demonstrate the use of various reporting methods.

Activity

1. **Activity name:** Reporting Drills
2. **Objective:** Practice reporting safety hazards.
3. **Type of Activity:** Group
4. **Resources:** Emergency contact information, reporting forms.
5. **Time Duration:** 30 minutes
6. **Instructions:**
   - Groups participate in reporting drills based on different emergency scenarios.
7. **Outcome:** Improved understanding and confidence in reporting procedures.

Notes for Facilitation

- Encourage a proactive attitude toward reporting safety hazards.
- Foster a non-punitive reporting culture to ensure open communication.
- Emphasize the importance of reporting even minor safety concerns.
- Stress the role of confidentiality in reporting to encourage openness.
- Discuss any specific reporting protocols or systems in place in the participants' workplaces.

Unit 7.5: Waste Management

Unit Objectives

By the end of this unit, the trainees will be able to:

1. Understand what is e-waste
2. Understand the concept of waste management
3. Explain the process of recycling of e-waste

Resources to be Used

Visual aids or slides on e-waste, Samples of e-waste products, Information on local waste man-agement facilities, Recycling bins or containers.

Say

- Today, we're diving into a crucial topic – 'Waste Management.' It's not just about cleaning up; it's about understanding what we discard and how it impacts the environment.
- Our objective today is to explore the world of waste management, with a special focus on e-waste. By the end, you'll understand what e-waste is, the concept of waste management, and the recycling process, contributing to a cleaner, greener planet.
- The way we manage waste, especially electronic waste, has a direct impact on our environ-ment. Understanding this process empowers us to make informed choices and actively partici-pate in creating a sustainable future.

Ask

- Can you name some electronic devices you've discarded recently, and what did you do with them?
- Have you ever thought about what happens to your old gadgets once you throw them away?
- Do you currently practice any recycling habits at home or in your workplace?

Do

- Introduce the concept of waste management and its importance.
- Outline the session's objectives.

Elaborate

Understanding E-Waste

- Define e-waste and discuss common electronic products contributing to it.

Concept of Waste Management

- Explain the overall concept of waste management, including the 3 R's (Reduce, Reuse, Re-cycle).

Recycling Process of E-Waste

- Detail the process of recycling e-waste and the environmental benefits.

Demonstrate

Demonstrate the disassembly of a simple electronic device to highlight recyclable compo-nents. Discuss the importance of responsible disposal.

Activity

1. **Activity name:** E-Waste Sorting
2. **Objective:** Sort various e-waste items into categories (recyclable, non-recyclable).
3. **Type of Activity:** Group
4. **Resources:** Samples of e-waste, recycling bins.
5. **Time Duration:** 30 minutes
6. **Instructions:**
   - Groups sort provided e-waste items, discussing reasons for their choices.
7. **Outcome:** Improved understanding of e-waste categories and recycling possibilities.

Notes for Facilitation

- Encourage participants to share personal experiences or challenges related to waste manage-ment.
- Emphasize the importance of individual responsibility in waste reduction.
- Provide information on local e-waste recycling facilities or programs.
- Discuss the impact of improper e-waste disposal on the environment.
- Encourage participants to share any sustainable waste management practices they are aware of.

Unit 7.6: Organizations' Focus on the Greening of Jobs

Unit Objectives

By the end of this unit, the trainees will be able to:

1. Understand the concept of ESG
2. Explain the different factors of ESG

Resources to be Used

Visual aids or slides on e-waste, Samples of e-waste products, Information on local waste man-agement facilities, Recycling bins or containers.

Say

- Today, we're diving into a crucial topic – 'Waste Management.' It's not just about cleaning up; it's about understanding what we discard and how it impacts the environment.
- Our objective today is to explore the world of waste management, with a special focus on e-waste. By the end, you'll understand what e-waste is, the concept of waste management, and the recycling process, contributing to a cleaner, greener planet.
- The way we manage waste, especially electronic waste, has a direct impact on our environ-ment. Understanding this process empowers us to make informed choices and actively partici-pate in creating a sustainable future.

Ask

- Can you name some electronic devices you've discarded recently, and what did you do with them?
- Have you ever thought about what happens to your old gadgets once you throw them away?
- Do you currently practice any recycling habits at home or in your workplace?

Do

- Introduce the concept of waste management and its importance.
- Outline the session's objectives.

Elaborate

Understanding E-Waste

- Define e-waste and discuss common electronic products contributing to it.

Concept of Waste Management

- Explain the overall concept of waste management, including the 3 R's (Reduce, Reuse, Re-cycle).

Recycling Process of E-Waste

- Detail the process of recycling e-waste and the environmental benefits.

Demonstrate

Demonstrate the disassembly of a simple electronic device to highlight recyclable compo-nents. Discuss the importance of responsible disposal.

Activity

1. **Activity name:** E-Waste Sorting
2. **Objective:** Sort various e-waste items into categories (recyclable, non-recyclable).
3. **Type of Activity:** Group
4. **Resources:** Samples of e-waste, recycling bins.
5. **Time Duration:** 30 minutes
6. **Instructions:**
   - Groups sort provided e-waste items, discussing reasons for their choices.
7. **Outcome:** Improved understanding of e-waste categories and recycling possibilities.

Notes for Facilitation

- Encourage participants to share personal experiences or challenges related to waste manage-ment.
- Emphasize the importance of individual responsibility in waste reduction.
- Provide information on local e-waste recycling facilities or programs.
- Discuss the impact of improper e-waste disposal on the environment.
- Encourage participants to share any sustainable waste management practices they are aware of.

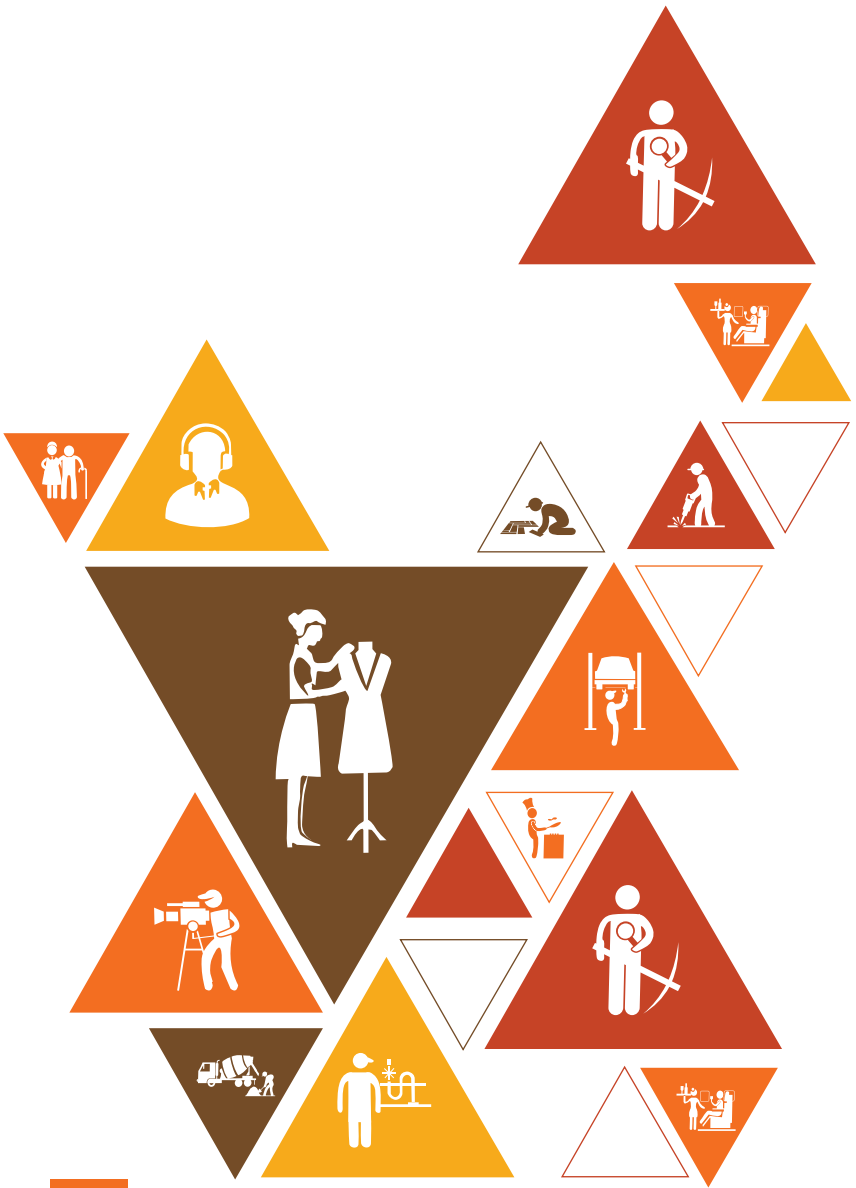
Answers to Exercises for PHB

Multiple Choice Questions

1. a. First Aid
2. a. Cold
3. a. Antiseptic
4. a. Chemical hazards
5. a. Cardio Pulmonary Resuscitation

Answer the following:

1. Refer - UNIT 7.1 Hazards and Accidents in the Store and Safe Practices
   Topic – Importance of Health and Safety
2. Refer - UNIT 7.1 Hazards and Accidents in the Store and Safe Practices
   Topic – Effects of Poor Maintenance
3. Refer - UNIT 7.1 Hazards and Accidents in the Store and Safe Practices
   Topic – Importance of Health and Safety
4. Refer - UNIT 7.2 Safety Practices
   Topic – Securing Customer Records
5. Refer - UNIT 7.2 Safety Practices
   Topic – Securing Customer Records



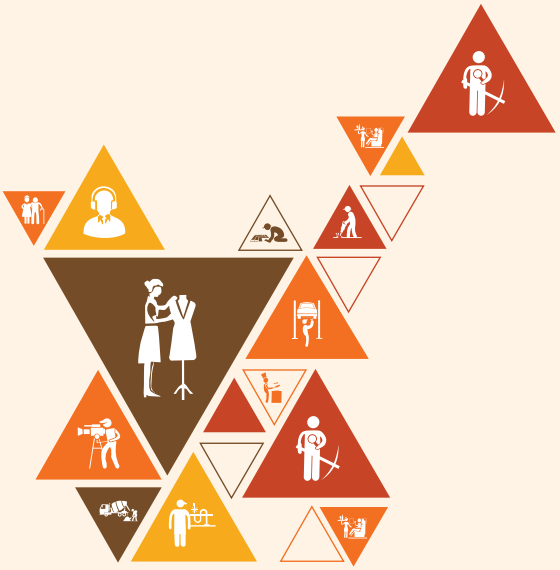
Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
RE IMAGINE FUTURE

Telecom Sector Skill Council

8. Employability Skills



DGT/VSQ/N0101

Scan the QR codes or click on the link for the e-books

https://www.skillindiadigital.gov.in/content/list

Employability Skills

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
RE IMAGINE FUTURE

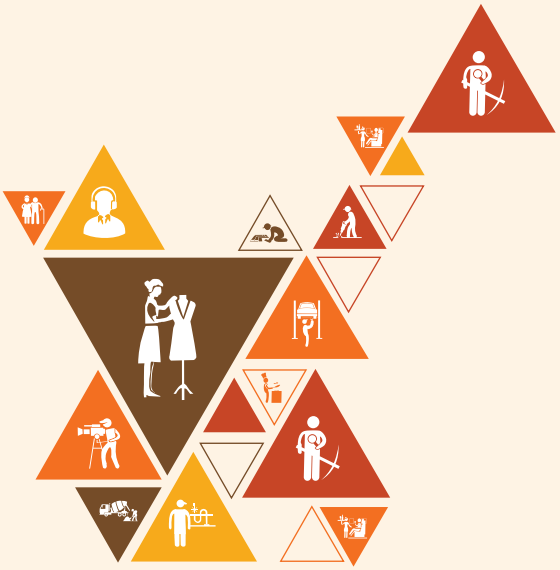
Telecom Sector Skill Council

9. Annexures

Annexure I: Training Delivery Plan

Annexure II: Assessment Criteria

Annexure III: List of QR Codes Used in PHB



Annexure I

Training Delivery Plan

Training Delivery Plan			
Program Name:	Telecom Electrician (Basic)		
Qualification Pack Name & Ref. ID	Telecom Electrician (Basic), TEL/Q4304, V1.0		
Version No.	1.0	**Version Update Date**	Not Applicable
Pre-requisites to Training (if any)	Not Applicable		
Training Outcomes	**By the end of this program, the participants will be able to:** 1. Describe the size and scope of the Telecom industry and its sub-sectors. 2. Discuss the role and responsibilities of a Telecom Electrician and identify various employment opportunities in this field. 3. Define fundamental components in electronic circuits, recall Ohm's Law, apply Kirchhoff's laws, design circuits, simulate AC waveforms, and analyze circuit behaviors using simulation software. 4. Develop and implement standardized electrical procedures for telecom infrastructure to enhance operational efficiency and safety.		

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
1	**Introduction to the role of a Telecom Electrician (Basic)**	**Overview of the Telecom Industry and the Role of a Telecom Electrician (Basic)**	• Describe the size and scope of the Telecom industry and its subsectors. • Discuss the role and responsibilities of a Telecom Electrician (Basic).	Bridge Module	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Training Kit - Trainer Guide, Presentations, Whiteboard, Marker, Projector, Laptop, Video Films	8 Theory (5:00) Practical (3:00)
		Employment Opportunities and Workplace Ethics for a Telecom Electrician	• Identify various employment opportunities for a Telecom Electrician (Basic). • Discuss the organisational policies on workplace ethics, managing sites, quality standards, personnel management and public relations (PR).				8 Theory (5:00) Practical (3:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Roles and Responsibilities of a Telecom Electrician (Basic) in Organizational Workflow	• Describe the process workflow in the organization and the role of a Telecom Electrician (Basic). • List the various daily, weekly, monthly operations/activities that take place at the site under a Telecom Electrician (Basic).				8 Theory (5:00) Practical (3:00)
		Role and Responsibilities of a Telecom Electrician (Basic)	• Role play based on case studies, outlining the scope, responsibilities, and challenges of a Telecom Electrician (Basic). • Analyse the requirements for the course and prepare for the prerequisites of the course.				6 Theory (5:00) Practical (1:00)
2	**DC and AC Circuits Optimization with RLC Components**	**Basic Circuit Components and Ohm's Law**	• Identify simple components such as resistors, voltage sources, and current sources. • Solve Ohm's Law (V = IR) to relate voltage, current, and resistance. • Calculate power dissipation using P = IV or P = I^2R. • Apply KCL and KVL to solve complex circuits with multiple elements and loops. • Resolve and repair any issues related to series and parallel connections for voltage, current, and resistance. • Choose components with appropriate specifications to match the design requirements.	TEL/N4306 PC1, PC2, PC3, PC4, PC5, PC6, PC7, PC8, PC9, PC10 KU1, KU2, KU3, KU4	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Training Kit - Trainer Guide, Presentations, Whiteboard, Marker, Projector, Laptop, Video Films	8 Theory (3:00) Practical (5:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Minimize power losses by selecting resistors with lower values and efficient components. • Use voltage dividers or current dividers to achieve desired voltage or current levels. • Balance series and parallel connections to distribute loads and minimize stress on components. • Use circuit simulation software to model and analyse circuits before implementing them physically.				
		AC Circuits and Power Factor Optimization	• Simulate AC waveforms with characteristics such as amplitude, frequency, and phase. • Analyze AC by converting sinusoidal waveforms into complex numbers, considering magnitude and phase angle. • Relate uniform load distribution system to develop electrical circuits for whole beam or slab. • Work with Phasor Diagrams. • Distribute loads uniformly to avoid overloading specific parts of the circuit. • Add capacitors to offset inductive loads and improve the power factor. • Use thicker conductors with lower resistance to decrease energy loss as heat.	TEL/N4306 PC11, PC12, PC13, PC14, PC15, PC16, PC17, PC18, PC19, PC20 KU5, KU6, KU9, KU10			8 Theory (3:00) Practical (5:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Employ voltage regulators to maintain a stable output voltage despite varying loads. • Install filters to reduce harmonics, which can distort waveforms and cause inefficiencies. • Choose transformers with high efficiency and appropriate turns ratios for voltage transformation. • Ensure proper grounding to improve safety and signal integrity. • Select components with lower ESR (Equivalent Series Resistance) and higher Q factors for better performance. • Avoid operating at resonant frequencies that can lead to excessive currents and voltage magnification. • Prevent overheating by designing circuits that efficiently dissipate heat.				
		RLC Circuits, Resonance, and Efficiency Optimization	• Analyze the circuit using Kirchhoff's laws and impedance/admittance relationships to determine current, voltage, and resonance conditions. • Choose appropriate component values (R, L, C) based on desired frequency response and application requirements. • Design for resonance frequency if you need a specific peak response.	TEL/N4306 PC25, PC26, PC27, PC28, PC29, PC30, PC31, PC32, KU11			8 Theory (3:00) Practical (5:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Consider the trade-offs between bandwidth and Q-factor for your application. • Implement power factor correction to improve system efficiency and reduce costs. • Simulate and analyze the circuit using software tools like SPICE to predict its behavior accurately. • Regularly monitor and maintain the circuit's performance, especially in power factor correction setups. • Analyze the circuit's behavior across a range of frequencies. At resonance, the current is maximized, and voltage across the components can be significantly affected.				
		Advanced Circuit Design Considerations	• Analyze the behavior of resonant circuits and their impact on system performance. • Optimize component choices for best performance in specific applications.	TEL/N4306 PC30, PC31, PC32 KU11			6 Theory (1:00) Practical (5:00)
3	**Simulation Based Operation of Series and Parallel Circuits**	**Introduction to Circuit Simulation and Design**	• Open the simulation software and create a new project or circuit design • Connect the components as per the circuit design • Set the resistance values for the resistors and the voltage values for the voltage sources	TEL/N4307 PC1, PC2, PC3, PC4 KU5, KU6	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Training Kit - Trainer Guide, Presentations, Whiteboard, Marker, Projector, Laptop, Video Films, Multimeter, Power supply unit, Transformers, Capacitors, Voltage regulators,	8 Theory (3:00) Practical (5:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Measuring and Monitoring Circuit Parameters	• Insert an ammeter (current measurement tool) in series with the circuit to measure the current • Insert a voltmeter (voltage measurement tool) across each resistor to measure the voltage drops	TEL/N4307 PC5, PC6 KU1, KU2		Electronic components (resistors, diodes, etc.), Breadboards, Wiring and connectors, AC waveform generator, Filter capacitors, Safety equipment (gloves, safety glasses), Soldering iron and solder	8 Theory (3:00) Practical (5:00)
		Simulation and Observing Circuit Behaviour	• Run the simulation and observe the results • Observe how changing values affect current distribution, voltage drops, and overall circuit behaviour	TEL/N4307 PC7, PC8 KU3, KU4			8 Theory (3:00) Practical (5:00)
		Circuit Behaviour in Context	• Explain total current entering the circuit • Discuss voltage drops across each resistor • Explain voltage across all parallel branches	TEL/N4307 KU1, KU2, KU3			6 Theory (1:00) Practical (5:00)
4	**DC Power Supply Systems Operations and Management**	**Voltage and Current Requirements for Electrical Devices**	• Identify the voltage (V) and current (I) requirements for different electrical devices like batteries, inverters, UPS, circuit boards, and other electrical devices.	TEL/N4308 PC1	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Training Kit - Trainer Guide, Presentations, Whiteboard, Marker, Projector, Laptop, Video Films, Multimeter, Power supply unit, Transformers, Capacitors, Voltage regulators, Electronic components (resistors, diodes, etc.), Breadboards, Wiring and connectors,	8 Theory (3:00) Practical (5:00)
		DC Power Supplies and Voltage Regulation	• Choose the type of DC power supplies. • Ensure that the output voltage remains constant even if the input voltage or load changes. • Work with linear regulators and switching regulators as common methods for voltage regulation.	TEL/N4308 PC2, PC3 KU1			8 Theory (3:00) Practical (5:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Transformers and Output Voltage	• Choose a transformer that converts your input AC voltage to the desired output AC voltage. • Transformer's turns ratio determines the output voltage. • Calculate the required transformer turns ratio. • Transformer's secondary winding connects to the rectifier, followed by the filter capacitor and the voltage regulator.	TEL/N4308 PC4, KU2, KU8		AC waveform generator, Filter capacitors, Safety equipment (gloves, safety glasses), Soldering iron and solder	8 Theory (3:00) Practical (5:00)
		Transformers and Output Voltage	• Choose a transformer that converts your input AC voltage to the desired output AC voltage. • Transformer's turns ratio determines the output voltage. Calculate the required transformer turns ratio. • Transformer's secondary winding connects to the rectifier, followed by the filter capacitor and the voltage regulator.	TEL/N4308 PC4, PC8 KU2, KU8			8 Theory (3:00) Practical (5:00)
		Rectification and Filtering	• Place a capacitor across the rectified output to smoothen the pulsating DC voltage. • Reduce the ripple (fluctuations) in the pulsating DC waveform by adding a filter capacitor to the circuit. • Smoothing capacitors further reduce the ripple in the output DC voltage.	TEL/N4308 PC5, PC14 KU7			8 Theory (3:00) Practical (5:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Steady Output Voltage and Protection	• Ensure a steady output voltage. • Limit the maximum current, especially for protection purposes.	TEL/N4308 PC6, PC7			8 Theory (1:00) Practical (7:00)
		AC to DC Conversion	• Work with AC waveform which is allowed to pass through, while the other half is blocked. • Utilize both halves of the AC input waveform.	TEL/N4308 PC12, PC13			8 Theory (1:00) Practical (7:00)
		DC-DC Converters	• DC-DC converters, such as buck, boost, and buck-boost converters, are used to step down or step up the DC voltage to a desired level.	TEL/N4308 KU4			8 Theory (1:00) Practical (7:00)
		Voltage Regulation and Galvanic Isolation	• Convert voltage regulation and provide galvanic isolation between input and output circuits. • Use a voltage regulator (such as a linear regulator or switching regulator) to ensure a constant output voltage regardless of input voltage variations. • DC voltage outputs even when the input voltage changes.	TEL/N4308 PC15 KU5, KU6			4 Theory (3:00) Practical (1:00)
5	**Power Backup System Testing**	**Power Backup System Assembly and Testing**	• Ensure that the power backup system is properly assembled and connected, including the DC-DC converter, battery, controller, and any associated components • Check for any loose connections or damaged components before starting the testing process	TEL/N4309 PC1, PC2, PC3, PC4, PC5, PC6, PC7, PC8, PC9, PC10, PC11, PC13 KU1, KU2, KU4, KU14	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Training Kit - Trainer Guide, Presentations, Whiteboard, Marker, Projector, Laptop, Video Films, Multimeter, Resistor, Capacitor, DC-DC Converter, Battery,	8 Theory (3:00) Practical (5:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Work in a well-ventilated area to prevent exposure to fumes or gases • Connect a variable DC power supply to the input of the DC-DC converter • Set the input voltage to the typical operating range of the DC-DC converter • Measure the output voltage of the DC-DC converter using a multimeter or an oscilloscope • Gradually change the input voltage while monitoring the output voltage • Connect a stable load (resistor, electronic load, or equivalent) to the output of the DC-DC converter • Measure the output voltage of the converter with the load connected and varying load conditions • Connect the DC-DC converter to a stable input voltage • Measure the input and output power using appropriate instruments • Calculate the efficiency of the DC-DC converter using the formula: Efficiency (%) = (Output Power / Input Power) * 100 • Connect the battery to the DC-DC converter's output and the controller			Controller, UPS Systems, Safety gears	

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Battery Monitoring and Testing	• Monitor the charging process to ensure that the battery voltage rises steadily and does not exceed the safe charging voltage limit • Monitor the discharging process to ensure that the battery voltage remains within the safe discharge voltage range • Connect a known resistive load to the battery output and start discharging • Measure the discharge time until the battery voltage reaches its lower safe limit. Calculate the battery capacity using the formula: Capacity (Ah) = (Current × Discharge Time) / 3600	TEL/N4309 PC14, PC15, PC16, PC17			8 Theory (3:00) Practical (5:00)
		Controller Testing and Integration	• Test the various functions of the controller, such as input/output voltage regulation, overvoltage/ undervoltage protection, and temperature monitoring • Simulate fault conditions to ensure that the controller responds appropriately • Verify that the controller can communicate data accurately and respond to commands • Integrate the DC-DC converter, battery, and controller into the full power backup system	TEL/N4309 PC18, PC19, PC20, PC21 KU3, KU10, KU11			8 Theory (3:00) Practical (5:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		UPS System Setup and Protection	• Simulate power outage or disruption scenarios to ensure the system switches to battery power seamlessly • Monitor the system's behaviour during transitions and ensure that the voltage regulation, battery charging, and protection mechanisms function as intended • Determine the power capacity (measured in volt-amperes or watts) required for the devices you want to protect • Choose between online, offline, and line-interactive UPS systems based on your needs • Plug the UPS into a power outlet • Connect the devices you want to protect to the UPS's output sockets • Connect the UPS to your computer if you want to monitor its status and configure settings	TEL/N4309 PC22, PC23, PC24, PC25, PC26, PC27, PC28 KU7, KU9, KU12, KU13			6 Theory (1:00) Practical (5:00)
6	**Surge Protection System Installation Procedure**	**Surge Protection Assessment and Selection**	• Determine the critical electrical and electronic equipment that need protection. • Assess the potential sources of surges, such as lightning strikes, power grid fluctuations, and electromagnetic interference.	TEL/N4310 PC1, PC2, PC3, PC4 KU2	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Training Kit - Trainer Guide, Presentations, Whiteboard, Marker, Projector, Laptop, Video Films, Multimeter, Resistor, Capacitor,	8 Theory (3:00) Practical (5:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Select the appropriate types of surge protection devices based on your assessment: Type 1 for service entrance, Type 2 for distribution boards, and Type 3 for individual devices. • Ensure that the chosen SPDs have voltage ratings suitable for the system's operating voltage. • Surge protection levels for equipment based on industry standards and the equipment's sensitivity.			DC-DC Converter, Battery, Controller, UPS Systems, Safety gears	
		Installation and Connection of Surge Protection Devices (SPDs)	• Install SPDs at strategic points where electrical surges are likely to enter your system. • Follow grounding standards and guidelines to create a low-resistance path for surge currents to dissipate. • Use appropriate wiring and cables to connect the SPDs to the system. Keep wire lengths short and avoid sharp bends to minimize impedance. • Ensure coordination between different types of SPDs to prevent unwanted interaction and improve overall protection. • Install a Type 1 SPD at the main electrical service entrance to divert high-energy surges. • Connect it to the main grounding system and the supply lines.	TEL/N4310 PC5, PC6, PC7, PC8, PC9, PC10			8 Theory (3:00) Practical (5:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Testing, Inspection, and Maintenance	• Test the SPDs to ensure they're working as intended. Some SPDs come with built-in indicators or monitoring systems. • Inspect and maintain the surge protection system. • Replace SPDs if they've been subjected to a significant surge event or if their performance is compromised.	TEL/N4310 PC11, PC12, PC13			8 Theory (3:00) Practical (5:00)
		Grounding and Documentation	• Proper grounding techniques for effective surge protection. • Documentation of surge protection system. • Surge protection strategy should adapt accordingly to provide reliable and effective protection against transient voltage surge.	TEL/N4310 KU4, KU5, KU6			6 Theory (1:00) Practical (5:00)
7	**Process of organizing work and resources as per health and safety standards**	**Workspace Maintenance and Personal Safety**	• Keep workspace clean and tidy • Perform individual role and responsibilities as per the job role while taking accountability for the work • Record/document tasks completed as per the requirements within specific timelines • Implement schedules to ensure timely completion of tasks • Identify the cause of a problem related to own work and validate it • Analyse problems accurately and communicate different possible solutions to the problem	TEL/N9101 PC1, PC2, PC3, PC4, PC5, PC6, PC7, PC8, PC9, PC10, PC11, PC12, PC13 KU9, KU10, KU11, KU12, KU16	Classroom lecture / PowerPoint Presentation / Question & Answer / Group Discussion	Training Kit - Trainer Guide, Presentations, Whiteboard, Marker, Projector, Laptop, Relevant stationery, First Aid Kit and Equipment used in Medical Emergencies	8 Theory (3:00) Practical (5:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Comply with organisation's current health, safety, security policies and procedures • Check for water spills in and around the work space and escalate these to the appropriate authority • Report any identified breaches in health, safety, and security policies and procedures to the designated person • Use safety materials such as goggles, gloves, ear plugs, caps, ESD pins, covers, shoes, etc. • Avoid damage of components due to negligence in ESD procedures or any other loss due to safety negligence • Identify hazards such as illness, accidents, fires or any other natural calamity safely, as per organisation's emergency procedures, within the limits of individual's authority • Participate regularly in fire drills or other safety related workshops organised by the company				
		Health and Hygiene Manage-ment	• Report any hazard outside the individual's authority to the relevant person in line with organisational procedures and warn others who may be affected • Maintain appropriate posture while sitting/ standing for long hours	TEL/N9101 PC14, PC15, PC16, PC17, PC18, PC19, PC20, PC21, PC22 KU14, KU15, KU16			8 Theory (3:00) Practical (5:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Handle heavy and hazardous materials with care, while maintaining appropriate posture • Sanitize workstation and equipment regularly • Clean hands with soap, alcohol-based sanitizer regularly • Avoid contact with anyone suffering from communicable diseases and take necessary precautions • Take safety precautions while travelling e.g. maintain 1m distance from others, sanitize hands regularly, wear masks, etc. • Report hygiene and sanitation issues to appropriate authority • Follow recommended personal hygiene and sanitation practices, for example, washing/ sanitizing hands, covering face with a bent elbow while coughing/sneezing, using PPE, etc.				
		Resource and Energy Conserva-tion	• Optimize usage of material including water in various tasks/ activities/processes • Use resources such as water, electricity and others responsibly • Carry out routine cleaning of tools, machine and equipment • Optimize use of electricity/energy in various tasks/ activities/processes	TEL/N9101 PC23, PC24, PC25, PC26, PC27, PC28, PC29 KU17, KU18			8 Theory (3:00) Practical (5:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Perform periodic checks of the functioning of the equipment/machine and rectify wherever required • Report malfunctioning and lapses in maintenance of equipment • Use electrical equipment and appliances properly				
		Waste Management and Safety	• Identify recyclable, non-recyclable and hazardous waste • Deposit recyclable and reusable material at identified location • Dispose non-recyclable and hazardous waste as per recommended processes • Waste management and methods of waste disposal • Common sources of pollution and ways to minimize it.	TEL/N9101 PC30, PC31, PC32 KU19, KU20, KU21, KU22			6 Theory (1:00) Practical (5:00)
Total Duration							Theory: 90:00 Practical: 150:00
Employability Skills (DGT/VSQ/N0101) (https://www.skillindiadigital.gov.in/content/list)							30:00
OJT							120:00
Total Duration							PR + TH + OJT + ES= 390 : 00

Annexure II

Assessment Criteria

CRITERIA FOR ASSESSMENT OF TRAINEES

Assessment Criteria for Telecom Electrician (Basic)	
Job Role	**Telecom Electrician (Basic)**
Qualification Pack	**TEL/Q4304, V1.0**
Sector Skill Council	**Telecom Sector Skill Council**

S. No.	Guidelines for Assessment
1	The assessment for the theory part will be based on knowledge bank of questions approved by the SSC.
2	Assessment will be conducted for all compulsory NOS, and where applicable, on the selected elective/ option NOS/ Set of NOS.
3	Individual assessment agencies will create unique question papers for theory part for each candidate at each examination/training centre (as per assessment criteria below).
4	Individual assessment agencies will create unique evaluations for skill practical for every student at each examination/training centre based on this criterion.
5	To pass the Qualifications File, every trainee should score a minimum of 50% of aggregate marks.
6	In case of unsuccessful completion, the trainee may seek reassessment on the Qualification File.

Assessment Outcomes	Assessment Criteria for Outcomes	Marks Allocation		
		Theory	Practical	Viva
TEL/N4306: Optimize DC and AC Circuits with RLC Components	DC Circuits	13	14	6
	PC1. identify simple components such as resistors, voltage sources, and current sources	2	2	-
	PC2. solve Ohm's Law (V = IR) to relate voltage, current, and resistance	1	2	1
	PC3. calculate power dissipation using P = IV or P = I^2R	1	2	1
	PC4. apply KCL and KVL to solve complex circuits with multiple elements and loops	1	1	2
	PC5. resolve and repair any issues related to series and parallel connection for voltage, current and resistance	1	1	-
	PC6. choose components with appropriate specifications to match the design requirements	2	1	-
	PC7. Minimize power losses by selecting resistors with lower values and efficient components	2	1	-
	PC8. use voltage dividers or current dividers to achieve desired voltage or current levels	1	1	-
	PC9. balance series and parallel connections to distribute loads and minimize stress on components	1	1	1
	PC10. use circuit simulation software to model and analyze circuits before implementing them physically	1	2	1
	AC Circuits	17	24	1

	PC11. simulate AC waveforms with characteristics such as amplitude, frequency, and phase	1	1	-
	PC12. analyse AC by converting sinusoidal waveforms into complex numbers, considering magnitude and phase angle	1	1	-
	PC13. relate uniform load distribution system to develop electrical circuits for whole beam or slab	2	3	-
	PC14. work with Phasor Diagrams	2	5	-
	PC15. distribute loads uniformly to avoid overloading specific parts of the circuit	1	1	-
	PC16. add capacitors to offset inductive loads and improve the power factor	1	1	-
	PC17. use thicker conductors with lower resistance to decrease energy loss as heat	1	1	-
	PC18. employ voltage regulators to maintain a stable output voltage despite varying loads	1	1	-
	PC19. install filters to reduce harmonics, which can distort waveforms and cause inefficiencies	1	1	-
	PC20. choose transformers with high efficiency and appropriate turns ratios for voltage transformation	1	1	-
	PC21. ensure proper grounding to improve safety and signal integrity	1	1	-
	PC22. select components with lower ESR (Equivalent Series Resistance) and higher Q factors for better performance	1	1	1
	PC23. avoid operating at resonant frequencies that can lead to excessive currents and voltage magnification	1	2	-
	PC24. prevent overheating by designing circuits that efficiently dissipate heat	2	4	-
	RLC Circuits and Resonance	10	12	3
	PC25. analyze the circuit using Kirchhoff's laws and impedance/ admittance relationships to determine current, voltage, and resonance conditions	1	1	1
	PC26. choose appropriate component values (R, L, C) based on desired frequency response and application requirements	2	3	1
	PC27. design for resonance frequency if you need a specific peak response	1	1	-
	PC28. consider the trade-offs between bandwidth and Q-factor for your application	1	1	-
	PC29. implement power factor correction to improve system efficiency and reduce costs	1	1	-
	PC30. simulate and analyze the circuit using software tools like SPICE to predict its behavior accurately	1	2	1
	PC31. regularly monitor and maintain the circuit's performance, especially in power factor correction setups	1	1	-
	PC32. analyze the circuit's behavior across a range of frequencies. At resonance, the current is maximized, and voltage across the components can be significantly affected	2	1	-
	NOS Total	**40**	**50**	**10**

TEL/N4307: Operate series and parallel circuit using circuit simulation software	Practical Electrical Exercises	40	50	10
	PC1. choose Circuit Simulation Software like LTSpice, CircuitLab, Tinkercad, and Multisim	4	5	1
	PC2. open the simulation software and create a new project or circuit design	4	5	2
	PC3. connect the components as per the circuit design	3	8	1
	PC4. set the resistance values for the resistors and the voltage values for the voltage sources	7	5	1
	PC5. insert an ammeter (current measurement tool) in series with the circuit to measure the current	6	9	2
	PC6. insert a voltmeter (voltage measurement tool) across each resistor to measure the voltage drops	6	4	1
	PC7. run the simulation and observe the results	3	7	1
	PC8. observe how changing values affect current distribution, voltage drops, and overall circuit behaviour	7	7	1
	NOS Total	**40**	**50**	**10**
TEL/N4308: Work with DC power supply system	Introduction to DC Power Systems	30	35	5
	PC1. identify the voltage (V) and current (I) requirements for different electrical devices like batteries, inverters, UPS, circuit boards and others electrical devices	3	4	1
	PC2. choose the type DC power supplies	3	3	1
	PC3. ensures that the output voltage remains constant even if the input voltage or load changes	4	4	-
	PC4. choose a transformer that converts your input AC voltage to the desired output AC voltage	3	3	-
	PC5. place a capacitor across the rectified output to smoothen the pulsating DC voltage	2	3	-
	PC6. ensures a steady output voltage	2	4	1
	PC7. to limit the maximum current, especially for protection purposes	2	3	-
	PC8. calculate the required transformer turns ratio	3	2	1
	PC9. connect the components as per design	2	3	-
	PC10. power up the circuit and measure the output voltage and current using a multimeter	4	3	-
	PC11. adjust the voltage regulator if necessary to achieve the desired output voltage	2	3	1
	Rectifiers and Power Conversion	10	15	5
	PC12. work with AC waveform which is allowed to pass through, while the other half is blocked	2	6	1
	PC13. utilizes both halves of the AC input waveform	3	2	2
	PC14. reduce the ripple (fluctuations) in the pulsating DC waveform, a filter capacitor is added to the circuit	2	4	2
	PC15. convert voltage regulation and can provide galvanic isolation between input and output circuits	3	3	-
	NOS Total	**40**	**50**	**10**

TEL/N4309: Test the power backup system to ensure proper working of DC-DC converter, battery, and controller	DC-DC Converters and Voltage Regulation	24	45	8
	PC1. ensure that the power backup system is properly assembled and connected, including the DC-DC converter, battery, controller, and any associated components	2	3	-
	PC2. check for any loose connections or damaged components before starting the testing process	1	2	1
	PC3. work in a well-ventilated area to prevent exposure to fumes or gases	1	-	-
	PC4. connect a variable DC power supply to the input of the DC-DC converter	1	2	1
	PC5. set the input voltage to the typical operating range of the DC-DC converter	1	-	1
	PC6. measure the output voltage of the DC-DC converter using a multimeter or an oscilloscope	1	3	1
	PC7. gradually change the input voltage while monitoring the output voltage	1	2	-
	PC8. connect a stable load (resistor, electronic load, or equivalent) to the output of the DC-DC converter	1	2	-
	PC9. measure the output voltage of the converter with the load connected and varying load conditions	1	3	1
	PC10. connect the DC-DC converter to a stable input voltage	1	-	-
	PC11. measure the input and output power using appropriate instruments	1	2	-
	PC12. calculate the efficiency of the DC-DC converter using the formula: Efficiency (%) = (Output Power / Input Power) * 100	1	-	-
	PC13. connect the battery to the DC-DC converter's output and the controller	1	3	1
	PC14. monitor the charging process to ensure that the battery voltage rises steadily and does not exceed the safe charging voltage limit	1	2	1
	PC15. monitor the discharging process to ensure that the battery voltage remains within the safe discharge voltage range	1	2	-
	PC16. connect a known resistive load to the battery output and start discharging	1	3	-
	PC17. measure the discharge time until the battery voltage reaches its lower safe limit. Calculate the battery capacity using the formula: Capacity (Ah) = (Current × Discharge Time) / 3600	1	2	-
	PC18. test the various functions of the controller, such as input/output voltage regulation, overvoltage/undervoltage protection, and temperature monitoring	1	2	1
	PC19. simulate fault conditions to ensure that the controller responds appropriately	1	1	-
	PC20. verify that the controller can communicate data accurately and respond to commands	1	2	-
	PC21. integrate the DC-DC converter, battery, and controller into the full power backup system	1	3	-
	PC22. simulate power outage or disruption scenarios to ensure the system switches to battery power seamlessly	1	3	-
	PC23. monitor the system's behavior during transitions and ensure that the voltage regulation, battery charging, and protection mechanisms function as intended	1	3	-
	Power Backup Systems and UPS	16	5	2

	PC24. determine the power capacity (measured in volt-amperes or watts) required for the devices you want to protect	3	1	-
	PC25. choose between online, offline, and line- interactive UPS systems based on your needs	2	1	1
	PC26. plug the UPS into a power outlet	4	-	-
	PC27. connect the devices you want to protect to the UPS's output sockets	3	-	1
	PC28. connect the UPS to your computer if you want to monitor its status and configure settings	4	3	-
	NOS Total	**40**	**50**	**10**
TEL/N4310: Install the surge protection system	Practical DC Power Systems Exercises	30	60	10
	PC1. determine the critical electrical and electronic equipment that need protection	2	6	1
	PC2. assess the potential sources of surges, such as lightning strikes, power grid fluctuations, and electromagnetic interference	3	6	1
	PC3. select the appropriate types of surge protection devices based on your assessment: Type 1 for service entrance, Type 2 for distribution boards, and Type 3 for individual devices.	4	3	1
	PC4. ensure that the chosen SPDs have voltage ratings suitable for system's operating voltage	3	4	1
	PC5. install SPDs at strategic points where electrical surges are likely to enter your system	2	4	-
	PC6. follow grounding standards and guidelines to create a low-resistance path for surge currents to dissipate	2	4	1
	PC7. use appropriate wiring and cables to connect the SPDs to the system. Keep wire lengths short and avoid sharp bends to minimize impedance	2	4	1
	PC8. ensure coordination between different types of SPDs to prevent unwanted interaction and improve overall protection	2	4	1
	PC9. install a Type 1 SPD at the main electrical service entrance to divert high-energy surges	4	5	1
	PC10. connect it to the main grounding system and the supply lines	2	5	1
	PC11. test the SPDs to ensure they're working as intended. Some SPDs come with built-in indicators or monitoring systems	2	5	1
	PC12. inspect and maintain the surge protection system	1	5	-
	PC13. replace SPDs if they've been subjected to a significant surge event or if their performance is compromised	1	5	-
	NOS Total	**30**	**60**	**10**
TEL/N9101: Organize Work and Resources as per Health and Safety Standards	PC1. keep workspace clean and tidy	-	1	-
	PC2. perform individual role and responsibilities as per the job role while taking accountability for the work	1	1	1
	PC3. record/document tasks completed as per the requirements within specific timelines	-	1	1
	PC4. implement schedules to ensure timely completion of tasks	-	2	-
	PC5. identify the cause of a problem related to own work and validate it	2	2	-
	PC6. analyse problems accurately and communicate different possible solutions to the problem	1	2	-

	PC7. comply with organisation's current health, safety, security policies and procedures	1	1	-
	PC8. check for water spills in and around the work space and escalate these to the appropriate authority	1	2	1
	PC9. report any identified breaches in health, safety, and security policies and procedures to the designated person	1	2	1
	PC10. use safety materials such as goggles, gloves, ear plugs, caps, ESD pins, covers, shoes, etc.	1	2	1
	PC11. avoid damage of components due to negligence in ESD procedures or any other loss due to safety negligence	2	3	1
	PC12. identify hazards such as illness, accidents, fires or any other natural calamity safely, as per organisation's emergency procedures, within the limits of individual's authority	2	1	-
	PC13. participate regularly in fire drills or other safety related workshops organised by the company	1	3	-
	PC14. report any hazard outside the individual's authority to the relevant person in line with organisational procedures and warn others who may be affected	1	3	-
	PC15. maintain appropriate posture while sitting/standing for long hours	1	1	-
	PC16. handle heavy and hazardous materials with care, while maintaining appropriate posture	1	1	-
	PC17. sanitize workstation and equipment regularly	1	2	-
	PC18. clean hands with soap, alcohol-based sanitizer regularly	-	1	-
	PC19. avoid contact with anyone suffering from communicable diseases and take necessary precautions	-	1	-
	PC20. take safety precautions while travelling e.g. maintain 1m distance from others, sanitize hands regularly, wear masks, etc.	1	2	-
	PC21. report hygiene and sanitation issues to appropriate authority	1	1	-
	PC22. follow recommended personal hygiene and sanitation practices, for example, washing/sanitizing hands, covering face with a bent elbow while coughing/sneezing, using PPE, etc.	1	1	-
	PC23. optimize usage of material including water in various tasks/ activities/processes	1	2	-
	PC24. use resources such as water, electricity and others responsibly	1	2	1
	PC25. carry out routine cleaning of tools, machine and equipment	1	2	-
	PC26. optimize use of electricity/energy in various tasks/activities/ processes	1	3	1
	PC27. perform periodic checks of the functioning of the equipment/ machine and rectify wherever required	1	3	1
	PC28. report malfunctioning and lapses in maintenance of equipment	1	2	-
	PC29. use electrical equipment and appliances properly	1	2	-
	PC30. identify recyclable, non-recyclable and hazardous waste	1	2	1
	PC31. deposit recyclable and reusable material at identified location	1	3	-
	PC32. dispose non-recyclable and hazardous waste as per recommended processes	1	3	-
	NOS Total	**30**	**60**	**10**

DGT/VSQ/N0101: Employability Skills (30 Hours)	Introduction to Employability Skills	1	1	-
	PC1. understand the significance of employability skills in meeting the job requirements	-	-	-
	Constitutional values – Citizenship	1	1	-
	PC2. identify constitutional values, civic rights, duties, personal values and ethics and environmentally sustainable practices	-	-	-
	Becoming a Professional in the 21st Century	1	3	-
	PC3. explain 21st Century Skills such as Self- Awareness, Behavior Skills, Positive attitude, self-motivation, problem-solving, creative thinking, time management, social and cultural awareness, emotional awareness, continuous learning mindset etc.	-	-	-
	Basic English Skills	2	3	-
	PC4. speak with others using some basic English phrases or sentences	-	-	-
	Communication Skills	1	1	-
	PC5. follow good manners while communicating with others	-	-	-
	PC6. work with others in a team	-	-	-
	Diversity & Inclusion	1	1	-
	PC7. communicate and behave appropriately with all genders and PwD	-	-	-
	PC8. report any issues related to sexual harassment	-	-	-
	Financial and Legal Literacy	3	4	-
	PC9. use various financial products and services safely and securely	-	-	-
	PC10. calculate income, expenses, savings etc.	-	-	-
	PC11. approach the concerned authorities for any exploitation as per legal rights and laws	-	-	-
	Essential Digital Skills	4	6	-
	PC12. operate digital devices and use its features and applications securely and safely	-	-	-
	PC13. use internet and social media platforms securely and safely	-	-	-
	Entrepreneurship	3	5	-
	PC14. identify and assess opportunities for potential business	-	-	-
	PC15. identify sources for arranging money and associated financial and legal challenges	-	-	-
	Customer Service	2	2	-
	PC16. identify different types of customers	-	-	-
	PC17. identify customer needs and address them appropriately	-	-	-
	PC18. follow appropriate hygiene and grooming standards	-	-	-
	Getting ready for apprenticeship & Jobs	1	3	-
	PC19. create a basic biodata	-	-	-
	PC20. search for suitable jobs and apply	-	-	-
	PC21. identify and register apprenticeship opportunities as per requirement	-	-	-
	NOS Total	**20**	**30**	**-**

Annexure III

List of QR Codes Used in PHB

Module No.	Unit No.	Topic Name	Page No. in PHB	Link for QR Code (s)	QR code (s)
Module 1: Introduction to the role of a Telecom Electrician (Basic) (Bridge Module)	Unit 1.1: Understanding the Telecom Industry in India and Role of a Telecom Electrician	1.1.1 Overview of the Telecom Industry and its Sub-Sectors in India	18	https://youtu.be/6G5o8IN-WV74?si=uIFhdzwyn60IS3Fi	Telecom Sector in India
	Unit 1.2: Workplace Practices and Operations Management	1.2.1 Organizational Policies and Best Practices	18	https://youtu.be-/ZwFyA-So-p8nc?si=5AkjSQ-FKgSkdSz4B	Ethics Case Study: It was Just a Careless Mistake
Module 2: DC and AC Circuits Optimization with RLC Components (TEL/N4306)	Unit 2.1 Fundamentals of Circuit Components and Laws	2.1.1 Fundamental Components in Electronic Circuits (Resistors, Voltage Sources, and Current Sources)	81	https://youtu.be/XfQs-PQa-C_E?si=TKFVHRx_nJ95ppL2	10 Basic Electronics Components and their functions
	Unit 2.2: Application of Circuit Design and Analysis	2.2.1 Balancing Series and Parallel Connections to Distribute Loads Evenly	81	https://youtu.be/8Z0jhQeY-DUE?si=4A8Zdp1mfOGIqh9-	Series and Parallel Circuits | Electricity | Physics | Fuse-School

Module No.	Unit No.	Topic Name	Page No. in PHB	Link for QR Code (s)	QR code (s)
Module 3: Simulation Based Operation of Series and Parallel Circuits (TEL/N4307)	Unit 3.1: Fundamentals of Circuit Simulation and Measurement	3.1.1 Circuit Simulation Software Tools	92	https://youtu.be/6Ptzs-FUqdL8?si=A-yWunNMTJIlCL-X	Top 3 Online Electrical & Electronics Circuit Simulator Software
	Unit 3.2: Analysis, Evaluation, and Experimentation in Circuit Simulations	3.4. Set Voltage Values for Voltage Sources	92	https://youtu.be-/O2hF-h6w-0FRw?si=1cSHeCc5-HR-7Ad6Jp	How to select Resistor Value for LED with simple calculation
Module 4: DC Power Supply Systems Operations and Management (TEL/N4308)	Unit 4.1: Fundamentals of Power Supply Design and Components	4.1. Voltage and Current Requirements of Electronic Devices	106	https://youtu.be/w82aS-jLuD_8?si=x86kVu5toWh-D17P1	Voltage Explained - What is Voltage? Basic electricity potential difference
	Unit 4.2: Power Supply Circuit Design and Practical Implementation	4.2 Describe the Sequential Connection of Components in a Power Supply Circuit	106	https://youtu.be-/Dq6zbN-WB-0VI?si=r2Wlghs-Z7D0_Wjsp	Series & Parallel Circuits

Module No.	Unit No.	Topic Name	Page No. in PHB	Link for QR Code (s)	QR code (s)
Module 5: Power Backup System Testing (TEL/ N4309)	Unit 5.1: Power Back-up System Components and Design	5.2 Summarize the Purpose of a DC-DC Converter and Its Typical Operating Range	119	https://youtu.be-/W6N-OV6b-8kxs?si=pTTr-ZlnII-toz5EOm	How does Buck Converter work? | DC-DC Converter - 1
	Unit 5.2: Testing and Simulation of Power Backup Systems	5.2.1 Demonstrate How to Measure and Monitor the Output Voltage of a DC-DC Converter	119	https://youtu.be/RAbTdeLU-2JQ?si=LPS16pGSR_oVUNhV	How to use LM2596 DC DC buck converter Step Down Voltage
Module 6: Surge Protection System Installation Procedures (TEL/ N4310)	Unit 6.1: Surge Protection Devices and Their Application	6.3. Define the Different Types of Surge Protection Devices (SPDs) and Their Purposes	128	https://youtu.be-/2jQdDg3-Q9oU?si=7QRT5E-JV7FkFezb5	Surge Protection | Why Mersen SPDs? from Automation-Direct
	Unit 6.2: Installation Considerations and Best Practices	6.1 Describe the Role of Grounding Standards in Surge Protection	128	https://youtu.be/-obkUN-BH1xn-Y?si=oIaMAm0_i6jFA-fOa	Basics of Lightning Protection and Earthing/ Grounding | IEC 62305

Module No.	Unit No.	Topic Name	Page No. in PHB	Link for QR Code (s)	QR code (s)
7. Communication and Interpersonal Skills	UNIT 7.2: Different Types of Health Hazards	7.1.2 First Aid Techniques	232	youtu.be/GrxevjEvk_s	First Aid at Work Place
	UNIT 7.3: Importance of Safe Working Practices	7.3.1 Basic Hygiene Practices	232	https://youtu.be/IsgLivAD-2FE	How to properly wash your hands
	UNIT 7.3: Importance of Safe Working Practices	7.3.3 Safe Workplace Practices	232	https://youtu.be/qzdLm-L4Er9E	How to give CPR to an Adult, a Child or an infant
	UNIT 7.5: time Management	7.5.6 Escalation Matrix	232	youtu.be/ccAZ9nCZSLc	Escalation Matrix PowerPoint Presentation Slides

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
RE>IMAGINE FUTURE

Telecom Sector Skill Council

Address: **Telecom Sector Skill Council of India**
Estel House, 3rd Floor, Plot No:- 126, Sector 44
Gurugram, Haryana 122003
Email: tssc@tsscindia.com
Web: www.tsscindia.com
Phone: 0124-2222222