Course Handbook Sample Pages

Practical Maths for Electrical Installation Students and Apprentices.

Introduction

Electrical installation is a practical trade – but it is also a mathematical one. Every cable you size, every circuit you test, and every load you calculate depends on your ability to apply mathematics accurately and confidently.

Many learners entering electrical training feel uncertain about maths. This book has been written to remove that fear and replace it with clarity, confidence, and practical skill.

Who This Book Is For

This book is designed for:

1. Electrical installation students Level 2 & 3
2. Apprentices in the electrical trade
3. Vocational and technical learners
4. Anyone returning to studying who needs a maths refresher
5. Trainees preparing for trade assessments

No advanced mathematical background is required. The content begins with the fundamentals and progresses step-by-step toward the calculations commonly used in electrical installation.

International Users

This handbook is suitable for electrical installation learners in all English-speaking countries because the mathematics it teaches is independent of local wiring rules and national codes. The topics covered – such as number operations, fractions, decimals, percentages, ratios, algebra, and trigonometry – are universal foundations that underpin electrical calculations everywhere.

Whether a learner is working to BS 7671, NEC, AS/NZS, or any other standard, they still need to calculate current, voltage, resistance, power, voltage drop, and cable ratings accurately.

By focusing on clear explanations, step-by-step methods, and practical electrical examples rather than country-specific regulations and standards, this ebook provides a solid mathematical toolkit that supports electrical study and practice in any English-speaking context.

Why Maths Is Essential in Electrical Installation

Accurate mathematical skills enable you to:

1. Calculate current, voltage, resistance, and power
2. Determine cable sizes
3. Work out voltage drop
4. Understand efficiency and energy consumption
5. Interpret test instrument readings
6. Apply electrical formulae correctly
7. Calculate conduit bends and cable runs

Accuracy in these calculations is directly linked to safety, compliance, and professional competence.

How This Book Is Structured

This book follows a logical learning progression:

1. Core number skills (basic operations, fractions, decimals, percentages)
2. Ratios and proportional thinking
3. Powers, standard form, and SI units
4. Algebra and formula manipulation
5. Trigonometry for practical installation work

Each chapter includes clear explanations, step-by-step worked examples, electrical installation applications, and practice exercises to build confidence.

The aim is not just to teach mathematics, but to teach electrical mathematics in a way that makes sense on-site and in the workshop.

How to Use This Book

For best results:

1. Work through chapters in order
2. Attempt all practice exercises
3. Do not skip foundational topics
4. Revisit earlier sections if needed
5. Practice calculations without a calculator first, where possible

Confidence in maths comes from consistent practice, not memorisation.

A Final Word

Becoming a skilled electrician is about more than installing cables and fittings. It requires precision, logical thinking, and the ability to solve problems.

Mathematics is one of your most important tools.

Develop it, practice it, and apply it – and it will strengthen every aspect of your electrical career.

Why This Book?

The Author wrote this mathematics guide based on a consistent observation throughout his teaching career: many electrical installation learners struggle not because the calculations are too advanced, but because their foundational mathematical skills were never fully strengthened.

His approach combines:

- Deep understanding of electrical installation requirements
- Recognition of common mathematical challenges faced by learners
- Ability to explain concepts clearly without unnecessary complexity
- Practical examples drawn from real electrical work
- Step-by-step progression from fundamentals to applied calculations

This book represents the Author's commitment to providing learners with the mathematical foundation they need to succeed in the electrical installation trade – not just in the classroom, but throughout their professional career.

1.7 Working with Brackets

Brackets Indicate Priority

Anything inside brackets **must** be calculated before other operations, as per BODMAS.

Addition with Brackets

The use of brackets when adding does not affect the result.

Example:

$$(3 + 4) + 5 = 3 + (4 + 5) = 12$$

Multiplication with Brackets

A number outside brackets multiplies everything inside.

Example:

$$3(4 + 5) = 3 \times 4 + 3 \times 5 = 12 + 15 = 27$$

Example:

$$5(2 + 3) = 5 \times 2 + 5 \times 3 = 10 + 15 = 25$$

Brackets Beside Each Other

Brackets beside each other indicate **multiplication**.

Example:

$$(3)(4) = 3 \times 4 = 12$$

$$(2 + 3)(4 + 1) = 5 \times 5 = 25$$

Nested Brackets

When calculations contain **inner and outer brackets**, work from the **innermost brackets outward**.

Example:

$$2[3 + (4 \times 2)] = 2[3 + 8] = 2 \times 11 = 22$$

Step-by-step:

1. Inner brackets: $4 \times 2 = 8$
2. Outer brackets: $3 + 8 = 11$
3. Multiply: $2 \times 11 = 22$

2.4 Converting Between Forms

Improper Fractions to Mixed Numbers

Method: *Divide numerator by denominator.*

Example 1: Convert $\frac{7}{3}$ to mixed number

$$7 \div 3 = 2 \text{ remainder } 1$$

$$\frac{7}{3} = 2\frac{1}{3}$$

Example 2: Convert $\frac{11}{4}$ to mixed number

$$11 \div 4 = 2 \text{ remainder } 3$$

$$\frac{11}{4} = 2\frac{3}{4}$$

Example 3: Convert $\frac{17}{5}$ to mixed number

$$17 \div 5 = 3 \text{ remainder } 2$$

$$\frac{17}{5} = 3\frac{2}{5}$$

Mixed Numbers to Improper Fractions

Method: *(Whole number × denominator) + numerator, all over denominator.*

Formula:

$$a\frac{b}{c} = \frac{(a \times c) + b}{c}$$

Example 1: Convert $2\frac{1}{3}$ to improper fraction

$$(2 \times 3) + 1 = 6 + 1 = 7$$

$$2\frac{1}{3} = \frac{7}{3}$$

2.10 Practice Exercises

Using the guidance examples above, work through the following practice questions. Answers are given at the end of this unit.

Set A: Simplifying Fractions

Simplify these fractions to lowest terms:

1. $\frac{12}{16}$
2. $\frac{15}{25}$
3. $\frac{18}{24}$
4. $\frac{20}{100}$
5. $\frac{50}{200}$

Set B: Converting Between Forms

6. Convert $\frac{7}{3}$ to a mixed number
7. Convert $3\frac{5}{8}$ to an improper fraction
8. Convert $\frac{5}{8}$ to a decimal
9. Convert 0.375 to a fraction
10. Convert $\frac{3}{4}$ to a percentage

2.11. Answers to Practice Exercises

Set A: Simplifying Fractions

1. $\frac{12}{16} = \frac{3}{4}$ (÷4)

2. $\frac{15}{25} = \frac{3}{5}$ (÷5)

3. $\frac{18}{24} = \frac{3}{4}$ (÷6)

4. $\frac{20}{100} = \frac{1}{5}$ (÷20)

5. $\frac{50}{200} = \frac{1}{4}$ (÷50)

Set B: Converting Between Forms

6. $\frac{7}{3} = 2\frac{1}{3}$ (7 ÷ 3 = 2 remainder 1)

7. $3\frac{5}{8} = \frac{29}{8}$ ((3 × 8) + 5 = 29)

8. $\frac{5}{8} = 0.625$ (5 ÷ 8)

9. $0.375 = \frac{375}{1000} = \frac{3}{8}$ (÷125)

10. $\frac{3}{4} = 0.75 = 75\%$

5.2 What Is a Ratio?

Definition

> A **ratio** is a way of comparing two or more quantities by showing how many times one value contains or is contained within another.

Ratios can be written in several ways:

- **Using a colon:** 3:1 (read as "3 to 1")
- **As a fraction:** $\frac{3}{1}$ or 3/1
- **Using the word "to":** 3 to 1
- **In sentences:** "For every 3 parts A, there is 1 part B"

Reading Ratios

Common ways to read ratios:

- 3:1 = "3 to 1" (3 parts to 1 part)
- 10:1 = "10 to 1" (10 turns to 1 turn in transformers)
- 2:5 = "2 to 5" (2 parts to 5 parts)
- 1:1 = "1 to 1" or "equal ratio"

Everyday Examples

1. Recipe: A mortar mix uses cement and sand in a ratio of 1:4
(1 part cement to 4 parts sand)

2. Map scale: 1:50000
(1 cm on the map represents 50,000 cm in real life)

3. Gear ratios: A bicycle gear ratio of 3:1
(3 turns of the pedals = 1 turn of the wheel)

Electrical Examples

1. Transformer ratio: 10:1
(10 turns on primary for every 1 turn on secondary)

2. Voltage divider: 2:1
(Voltage divided in a 2 to 1 ratio across resistors)

3. Current ratio: 1:4
(Primary current to secondary current relationship)

4. Three-phase load balance: 1:1:1
(Equal loads across three phases)

Order Matters

The order in which values appear in a ratio is important:

- **Cables to junction boxes** = 12:4
- **Junction boxes to cables** = 4:12

These are different ratios showing different relationships.

Three or More Values

Ratios can compare more than two quantities:

Example: A three-phase system has currents of 10 A, 15 A, and 20 A in each phase.

The ratio is: 10:15:20

This can be simplified to: 2:3:4

Simplified ratio: 3:1

Example 2: Simplify 24:16

HCF of 24 and 16 = 8

$$24 \div 8 = 3$$

$$16 \div 8 = 2$$

Simplified ratio: 3:2

Example 3: Simplify 10:15:20 (three values)

HCF of 10, 15, and 20 = 5

$$10 \div 5 = 2$$

$$15 \div 5 = 3$$

$$20 \div 5 = 4$$

Simplified ratio: 2:3:4

Example 4: Simplify 450:150

HCF of 450 and 150 = 150

$$450 \div 150 = 3$$

$$150 \div 150 = 1$$

Simplified ratio: 3:1

Example 5: Simplify 200:150:100

HCF of 200, 150, and 100 = 50

$$200 \div 50 = 4$$

$$150 \div 50 = 3$$

$$100 \div 50 = 2$$

Simplified ratio: 4:3:2

Electrical Application

Problem: Three-phase system has loads of 25 kW, 20 kW, and 15 kW on each phase.

As a ratio: 25:20:15
HCF = 5
Simplified: 25:20:15 = **5:4:3**

This shows the load imbalance clearly.

Example 4: Converting from Engineering Form

Problem: What is 340 mm in metres?

Solution:

1. Identify prefix: m = milli = $\times 10^{-3}$
2. Calculate: 340×10^{-3} m
3. Move decimal right 3 places (negative power)
4. Answer: 0.34 m

Example 5: Practical Electrical Calculation

Problem: A circuit has a current of 2500 mA. Express this in Amps.

Solution:

1. Identify prefix: m = milli = $\times 10^{-3}$
2. Calculate: 2500×10^{-3} A
3. Perform calculation: $2500 \div 1000 = 2.5$ A
4. Answer: 2.5 A

Example 6: Large Number Conversion

Problem: A power station generates 450 MW. Express this in Watts.

Solution:

1. Identify prefix: M = Mega = $\times 10^{6}$
2. Calculate: 450×10^{6} W
3. Move decimal right 6 places
4. Answer: $450{,}000{,}000$ W

6.9 Practice Exercises

Using the examples detailed above, calculate the answers to the practice questions below. The answers follow on from this section.

Set A: Powers of Ten

Write the decimal value of each:

1. $10^4 = ?$
2. $10^{-2} = ?$
3. $10^6 = ?$
4. $10^{-5} = ?$
5. $10^0 = ?$

Set B: Converting to Standard Form

Write the following in standard form:

6. 3891
7. 0.003764
8. 24578
9. 379.5
10. 0.0046
11. 0.045
12. 567000
13. 0.000089
14. 1500000
15. 0.0000003