

WORKSHOP CALCULATION & SCIENCE

(NSQF)

2nd YEAR

(As per Revised Syllabus July 2022)

**Technician Electronics System
Design and Repair**



Directorate General of Training

**DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA**



**NATIONAL INSTRUCTIONAL
MEDIA INSTITUTE, CHENNAI**

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

Workshop Calculation & Science

Technician Electronics System Design and Repair - 2nd Year NSQF

As per Revised Syllabus July 2022

Developed & Published by



National Instructional Media Institute

Post Box No.3142

Guindy, Chennai - 600032

INDIA

Email: chennai-nimi@nic.in

Website: www.nimi.gov.in

Copyright © 2023 National Instructional Media Institute, Chennai

First Edition : December 2023

Copies: 1000

Rs. 70/-

All rights reserved.

No part of this publication can be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording or any information storage and retrieval system, without permission in writing from the National Instructional Media Institute, Chennai.

FOREWORD

The Government of India has set an ambitious target of imparting skills one out of every four Indians, to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of comprising various stakeholder's viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Workshop Calculation & Science - Technician Electronics System Design and Repair 2nd Year** NSQF (Revised 2022) under CTS will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Director General of Training, Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

ATUL KUMAR TIWARI, I.A.S.

Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

December 2023
New Delhi - 110 001

PREFACE

The National Instructional Media Institute(NIMI) was set up at Chennai, by the Directorate General of Training, Ministry of skill Development and Entrepreneurship, Government of India, with the technical assistance from the Govt of the Federal Republic of Germany with the prime objective of developing and disseminating instructional Material for various trades as per prescribed syllabus and Craftsman Training Programme(CTS) under NSQF levels.

The Instructional materials are developed and produced in the form of Instructional Media Packages (IMPs), consisting of Trade Theory, Trade Practical, Test and Assignment Book, Instructor Guide and Wall charts. The above material will enable to achieve overall improvement in the standard of training in ITIs.

A national multi-skill programme called SKILL INDIA, was launched by the Government of India, through a Gazette Notification from the Ministry of Finance (Dept of Economic Affairs), Govt of India, dated 27th December 2013, with a view to create opportunities, space and scope for the development of talents of Indian Youth, and to develop those sectors under Skill Development.

The emphasis is to skill the Youth in such a manner to enable them to get employment and also improve Entrepreneurship by providing training, support and guidance for all occupation that were of traditional types. The training programme would be in the lines of International level, so that youths of our Country can get employed within the Country or Overseas employment. The **National Skill Qualification Framework (NSQF)**, anchored at the National Skill Development Agency(NSDA), is a Nationally Integrated Education and competency-based framework, to organize all qualifications according to a series of **levels of Knowledge, Skill and Aptitude**. Under NSQF the learner can acquire the Certification for Competency needed at any level through formal, non-formal or informal learning.

The **Workshop Calculation & Science** - Technician Electronics System Design and Repair 2nd Year NSQF (Revised 2022) under CTS is one of the book developed by the core group members as per the NSQF syllabus.

The **Workshop Calculation & Science** - Technician Electronics System Design and Repair 2nd Year NSQF (Revised 2022) under CTS as per NSQF is the outcome of the collective efforts of experts from Field Institutes of DGT, Champion ITI's for each of the Sectors, and also Media Development Committee (**MDC**) members and Staff of **NIMI**. NIMI wishes that the above material will fulfill to satisfy the long needs of the trainees and instructors and shall help the trainees for their Employability in Vocational Training.

NIMI would like to take this opportunity to convey sincere thanks to all the Members and Media Development Committee (MDC) members.

Chennai - 600 032

EXECUTIVE DIRECTOR

ACKNOWLEDGEMENT

The National Instructional Media Institute (NIMI) sincerely acknowledge with thanks the co-operation and contribution of the following Media Developers to bring this IMP for **Workshop Calculation & Science - Technician Electronics System Design and Repair 2nd Year** as per NSQF Revised 2022.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

- | | | |
|-------------------------------------|---|---|
| Shri. M. Sangara pandian | - | Training Officer (Retd.)
CTI, Govt. of India, Guindy, Chennai - 32. |
| Shri. G. Sathiamoorthy | - | Jr. Training Officer - SG (Retd.)
Govt. I.T.I, Trichy, DET - Tamilnadu. |
| Smt. P. J. Philomina Jeffy Jennifar | - | Principal (Retd.)
Govt. I.T.I, Kuttikol, Kasaragod District,
Kerala - 671541. |

NIMI CO-ORDINATORS

- | | | |
|------------------------|---|--|
| Shri. Nirmalya Nath | - | Deputy General Manager,
NIMI, Chennai - 32. |
| Shri. G. Michael Johny | - | Manager,
NIMI, Chennai - 32. |

NIMI records its appreciation of the **Data Entry, CAD, DTP Operators** for their excellent and devoted services in the process of development of this IMP.

NIMI also acknowledges with thanks, the efforts rendered by all other staff who have contributed for the development of this book.

INTRODUCTION

The material has been divided into independent learning units, each consisting of a summary of the topic and an assignment part. The summary explains in a clear and easily understandable fashion the essence of the mathematical and scientific principles. This must not be treated as a replacement for the instructor's explanatory information to be imparted to the trainees in the classroom, which certainly will be more elaborate. The book should enable the trainees in grasping the essentials from the elaboration made by the instructor and will help them to solve independently the assignments of the respective chapters. It will also help them to solve the various problems, they may come across on the shop floor while doing their practical exercises.

The assignments are presented through 'Graphics' to ensure communications amongst the trainees. It also assists the trainees to determine the right approach to solve the problems. The required relevant data to solve the problems are provided adjacent to the graphics either by means of symbols or by means of words. The description of the symbols indicated in the problems has its reference in the relevant summaries.

At the end of the exercise wherever necessary assignments, problems are included for further practice.

Time allotment - 2nd Year : 16 Hrs

Time allotment for each title of exercises has been given below. **Workshop Calculation & Science - Technician Electronics System Design and Repair** 2nd Year NSQF Revised Syllabus 2022.

S.No	Title	Exercise No.	Time in Hrs
1	Algebra	2.1.01 & 2.1.02	8
2	Estimation and Costing	2.2.03 & 2.2.04	8
		Total	<u>16 Hrs</u>

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

- **Demonstrate basic mathematical concept and principles to perform practical operations.**
- **Understand and explain basic science in the field of study.**

CONTENTS

Exercise No.	Title of the Exercise	Page No.
	Algebra	
2.1.01	Algebra - Addition , subtraction, multiplication & division	1
2.1.02	Algebra - Theory of indices, algebraic formula, related problems	5
	Estimation and Costing	
2.2.03	Estimation and costing - Simple estimation of the requirement of material etc., as applicable to the trade	10
2.2.04	Estimation and costing - Problems on estimation and costing	16

SYLLABUS

2nd Year

Workshop Calculation & Science - Technician Electronics System Design and Repair Revised syllabus July 2022 under CTS

S.no.	Syllabus	Time in Hrs
I	Algebra 1 Addition, Subtraction, Multiplication & Divisions 2 Algebra – Theory of indices, Algebraic formula, related problems	8
II	Estimation and Costing 1 Simple estimation of the requirement of material etc., as applicable to the trade 2 Problems on estimation and costing	8
	Total	16

Algebra - Addition, subtraction, multiplication & division

Introduction

Algebra is a form of mathematics in which letters may be used in place of unknown. In this mathematics numbers are also used in addition to the letters and the value of number depends upon its place. For example in $3x$ and x^3 , the place of x is different. In $3x = 3$ is multiplied with x , whereas in $x^3 - 3$ is an Index of x .

Positive and negative numbers

Positive numbers have a + sign in front of them, and negative numbers have – sign in front of them. The same applies to letters also.

Example $+x$, $-y$.

+8 or simply 8 positive number.

–8 negative number.

Addition and subtraction

Two positive numbers are added, by adding their absolute magnitude and prefix the plus sign.

To add two negative numbers, add their absolute magnitude and prefix the minus sign.

To add a positive and a negative number, obtain the difference of their absolute magnitudes and prefix the sign of the number having the greater magnitude.

$$\begin{aligned} +7 + 22 &= +29 \\ (-8) - 34 &= -42 \\ (-27) + 19 &= -8 \\ 44 + (-18) &= +26 \\ 37 + (-52) &= -15 \end{aligned}$$

Multiplication of positive and negative numbers

The product of two numbers having like signs is positive and the product of two numbers with unlike signs is negative. Note that, where both the numbers are negative, their product is positive.

Ex.

$$\begin{aligned} -20 \times -3 &= 60 \\ 5 \times 8 &= 40 \\ 4 \times -13 &= -52 \\ -5 \times 12 &= -60 \end{aligned}$$

Division

The number that is divided is the dividend, the number by which we are dividing is the divisor and the answer is the quotient. If the signs of the dividend and the divisor are the same then the quotient will have a + sign. If they are unlike then the quotient will have a negative sign.

$$\begin{aligned} \frac{+28}{+4} &= +7 \\ \frac{+56}{-4} &= -14 \end{aligned}$$

$$\frac{-72}{+9} = -8$$

$$\frac{-96}{-6} = +16$$

When an expression contains addition, subtraction, multiplication and division, perform the multiplication and division operations first and then do the addition and subtraction.

Example

$$12 \times 8 - 6 + 4 \times 12 = 96 - 6 + 48 = 138$$

$$102 \div 6 - 6 \times 2 + 3 = 17 - 12 + 3 = 8$$

Parentheses and grouping symbols

() Brackets

{ } Braces

$$7 + (6-2) = 7 + 4 = 11$$

$$6 \times (8-5) = 6 \times 3 = 18$$

Parentheses

These are symbols that indicate that certain addition and subtraction operations should precede multiplication and division. They indicate that the operations within them should be carried out completely before the remaining operations are performed. After completing the grouping, the symbols may be removed.

In an expression where grouping symbols immediately preceded or followed by a number but with the signs of operation omitted, it is understood, that multiplication should be performed.

Grouping symbols are used when subtraction and multiplication of negative number is done.

To remove grouping symbols which are preceded by negative signs, the signs of all terms inside the grouping symbols must be changed (from plus to minus and minus to plus).

Parentheses which are preceded by a plus sign may be removed without changing the signs of the terms within the parentheses.

When one set of grouping symbols is included within another set, remove the innermost set first.

When several terms connected by + or – signs contain a common quantity, this common quantity may be placed in front of a parentheses.

$$8 + 6(4-1) = 8 + 6 \times 3 = 26$$

$$(6+2)(9-5) = 8 \times 4 = 32$$

Plus 4 less negative 7 is written as $4 - (-7)$.

Plus 4 times negative 7 is written as $4(-7)$.

$$4 - (-7) = 4 + 7 = 11$$

$$8 - (7-4) = 8 - 3 = 5$$

$$3 + (-8) = 3 - 8 = -5$$

$$7 + (4 - 19) = 7 + (-15) = 7 - 15 = -8$$

$$\begin{aligned} 3 \{40 + (7 + 5) (8-2)\} \\ = 3 \{40 + 12 \times 6\} \\ = 3 \times 112 = 336. \end{aligned}$$

$8x + 12$ - quantity 4 may be factored out giving the expression $8x + 12$ as $4(2x + 3)$.

The innermost set in a grouping symbols of an expression is to be simplified first.

Algebraic symbols and simple equations

Algebraic symbol

An unknown numerical value of a quantity is represented by a letter which is the algebraic symbol.

Factor

A factor is any one of the numbers or letters or groups which when multiplied together give the expression. Factors of 12 are 4 and 3 or 6 and 2 or 12 and 1.

$8x + 12$ is the expression and this may be written as $4(2x + 3)$, 4 and $(2x + 3)$ are the factors.

Algebraic terms

If an expression contains two or more parts separated by either + or -, each part is known as the term.

$y - 5x$ is the expression. y and $-5x$ are the terms.

The sign must precede the term.

Kinds of terms:

1 Like terms

a $13a, 15a, 19a, -12a, -18a$

b $5xy, 11xy, -xy, -14xy$

c $27m^2, 25m^2, -3m^2, 11m^2$

2 Unlike terms

a $3ac, -4b, 8x, 3yz$

b $2xy, y^2, a^2b, xz, 3bc$

c $13m^2n, 3mn^2, 14lm^2, 15a^2b, 5lm$

Examples :

1 Add $7a, -2a, a, 3a$

$$7a + (-2a) + (a) + 3a$$

$$7a - 2a + a + 3a$$

$$= 11a - 2a$$

$$= 9a$$

2 Add $25xy, + 2xy, - 6xy, - 3xy$

$$25xy + 2xy + (-6xy) + (-3xy)$$

$$= 27xy - 9xy$$

$$= 18xy$$

3 Add $9m, + 4m, - 2$

$$9m + 4m + (-2)$$

$$9m + 4m - 2$$

$$= 13m - 2$$

Coefficient

When an expression is formed into factors whose product is the expression, then each factor is the coefficient of the remaining factors.

$$48x = 4 \times 12 \times x$$

4 is the coefficient of $12x$. x is the coefficient of 48.

Equation

It is a statement of equality between numbers or numbers and algebraic symbols.

$$12 = 6 \times 2, 13 + 5 = 18.$$

$$2x + 9 = 5, y - 7 = 4y + 5.$$

Simple equation

Equations involving algebraic symbols to the first power are simple equations.

$$2x + 4 = 10. \quad 4x + 12 = 14.$$

Addition

1 $8a + 12b - a - 14b$

$$= 8a - a + 12b - 14b$$

$$= 7a - 2b$$

2 $14a + 3a + 25b + 2b + b$

$$= 17a + 28b$$

3 $(2a + 3b - c) + (4a - b - c) + (a - 8)$

$$2a + 3b - c + 0$$

$$4a - b - c + 0$$

$$a + 0 + 0 - 8$$

$$7a + 2b - 2c - 8$$

4 Add : $(3x + 3z) ; (5x - 4y) ; (9y - 3z)$

$$3x + 0 + 3z$$

$$5x - 4y + 0$$

$$0 + 9y - 3z$$

$$8x + 5y$$

Subtraction

1 $38xy - 15xy = 23xy$

2 Subtract $3xy$ from $-4xy$

$$\begin{array}{r} -4xy \\ +3xy \\ \hline (-) \\ \hline -7xy \\ \hline \end{array}$$

3 Subtract $5x$ from $12x$

$$= 12x - (5x)$$

$$= 12x - 5x$$

$$= 7x$$

4 Subtract $18x$ from $7x$

$$= 7x - (18x)$$

$$= 7x - 18x$$

$$= -11x$$

5 Subtract $3x - 2y$ from $4y - 2x$

$$= (4y - 2x) - (3x - 2y)$$

$$= 4y - 2x - 3x + 2y$$

$$= 6y - 5x$$

Addition and subtraction

Quantities with algebraic symbols are added or subtracted by considering those terms involving same symbols and powers.

Example

$$\begin{aligned} 1. \quad & 10x + 14 - 7y^2 - 11a + 2x - 4 - 3y^2 - 4a + 8 \\ & = 10x + 2x - 7y^2 - 3y^2 - 11a - 4a + 14 - 4 + 8 \\ & = 12x - 10y^2 - 15a + 18 \end{aligned}$$

2. $2x = 10$, $2x + 6 = 10 + 6$

3. $y + 12 = 20$, $y + 12 - 8 = 20 - 8$

4. $x + 10 = 12$,

$$x + 10 - 10 = 12 - 10$$

5. $3x = 6$, $2 \times 3x = 2 \times 6$, $6x = 12$

6. $5y = 20$, $\frac{5y}{5} = \frac{20}{5}$.

The same number may be added or subtracted to both members of an equation without changing its equality.

Each member of an equation may be multiplied or divided by the same number or symbol without changing its equality.

The equality of an equation is not altered when the numbers or symbols are added or subtracted from both sides. Multiplication and division by the same numbers or symbols on both sides also will not affect the equality.

Transposition of the terms of the equations

= equals to

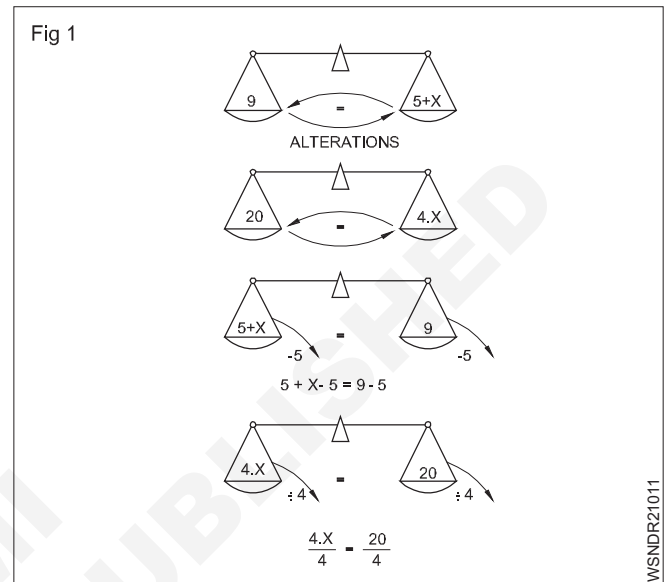
+ plus

- minus

x multiply

÷ divided by

Concept of equality (Fig 1)



An equation can be compared to a pair of scales which always remain in equilibrium. The two sides of the equation can fully be transposed. $9 = 5 + x$ may also be written as $5 + x = 9$.

We must always perform the same operation on both sides of the equation to keep the equilibrium. Add or subtract the same amount from both sides. $5 + x = 9$ By adding 3 on both sides, the equation becomes $5 + x + 3 = 9 + 3$ or $x + 8 = 12$.

$5 + x = 9$ Subtract 5 from both sides then $5 + x - 5 = 9 - 5$.

$$x = 4.$$

5 is transposed from left side to the right side by changing its sign from + to -.

$\frac{x}{4} = 20$. Multiply both sides by 4. Then $\frac{x}{4} \times 4 = 20 \times 4$.

$$x = 80,$$

$$5x = 25.$$

Divide both sides by 5 then $\frac{5x}{5} = \frac{25}{5}$

$$x = 5.$$

When transposing numbers or letter symbols from one side to the other side multiplication becomes division and the division becomes multiplication.

The equality of an equation remains unchanged when both sides of the equation are treated in the same way. When transposing from one side to the other side,

a plus quantity becomes minus quantity.

a minus quantity becomes a plus quantity

a multiplication becomes a division

a division becomes a multiplication.

To solve simple equations isolate the unknown quantity which is to be found on the left side of the equation.

Example

• Solve for x if $4x = 3(35 - x)$

$$4x = 105 - 3x \text{ (brackets removed)}$$

$$4x + 3x = 105 \text{ (By transposing } -3x \text{ on the right side to the left side)}$$

$$7x = 105$$

$$x = 15 \text{ (dividing both sides by 7)}$$

Assignment

Add

1 $14f - 2f + 5f - 7f + 9f$

2 $3xy + 5xy - 2xy + 8xy - 4xy$

3 $17xy - 4xy + 13 - xy - 6$

4 $2a + a + 3a + 6a - 5b$

5 $8c + 5c + 3c + 2c$

6 $14d + 3d + 25e + 2e$

7 $5p + 3r - r - 2p$

8 $8t + 12u - t - 14u$

9 $x - z + y + z$

10 $15a + 13a - 37a$

11 $17a - 4b - 7a + 3b$

12 $9c - 15e + 4c + 3e$

13 $13f + 40g - 16f + 7f + 2g - 17g$

14 $30x + 45y - 17x - 16y$

15 $8a + 3c - 6b - 5c + 4a + 8b$

16 $27i + 17k - 5l + 12i - 31k + 19l$

17 $230m + 472P - 320n - 75m + 180n - 141p$

18 $230m + 420s + 370y + 225m - 510y - 110s$

19 $45b + 25c + 18b + 40c$

20 $14d + 3d + 25e + 2e + e + d$

21 $15a - (4a + 3a - 5a)$

22 $5x + 3y - (2x - 5y)$

23 $(x + 2y + 3z) + (4x - y + z)$

24 $(2x + 5y) + (4x - 8z) + (15z - 6y) + (z - 2x)$

25 $(-2x + 3y - 3z) + (-6y - 5x + z)$

26 $(a - 3b + 4c) + (-7c - a + 4b)$

27 $(2x + 5y) + (4x - 8z) + (15z - 2y)$

Subtract

1 $38xy - 25xy$

2 Subtract $2a - 3b - c$ from $3a - 2b + 4c$

3 $2a - 3(a - (a - b))$

Add and Subtract

1 $230a + 420b + 370c + 225a - 510c - 110b$

2 $15d - (4d + 3d - 5d)$

3 $8x + 3z - 6y - 5z + 4x + 8y$

Multiplication

1 $5yzx \times (-5ab)$

2 $3ax - 9b$

3 $2ab \times -7pq$

Division

1 $\frac{10a}{2a}$

2 $-3ax \div -6x$

3 $15xy \div -5$

4 $-\frac{8ac}{2bc}$

5 $\frac{-5m \times -6n - 7p}{-28mn}$

6 $\frac{5a + 20}{7a + 28}$

Algebra - Theory of indices, Algebraic formula, related problems

Calculations involving powers

Power : Concept

a.a.a... upto n times is = a^n

a is the base, n is the exponent.

When a number, say 2 is multiplied by itself 4 times, we write it as 2^4 (two to the power of 4) and it is equal to $2 \times 2 \times 2 \times 2 = 16$.

The exponent denotes how many times the base number is multiplied by itself.

Powers with a positive base have a positive result.

Powers with a negative base and with an exponent that is even will have a positive result.

The sign

$$(+a)^n = a^n$$

$$(-a)^{2n} = a^{2n}$$

$$(2)^2 = 2 \times 2 = 4 \text{ and}$$

$$(-2)^2 = -2 \times -2 = +4 \text{ but}$$

$$(-2)^3 = -2 \times -2 \times -2 = -8$$

Addition and subtraction of powers

Powers with the same base and exponents can be added or subtracted by addition or subtraction of the coefficients.

$$x.a^n + y.a^n = a^n(x + y)$$

$$x.a^n - y.a^n = a^n(x - y)$$

$$\text{Ex } .4x^2 + x^2 - 3x^2 = x^2(4 + 1 - 3) = 2x^2.$$

Multiplication

Powers with the same bases are multiplied by involving the common base raised to the power of sum of the exponents.

$$a^m \times a^n = a^{m+n}.$$

$$2^3 \times 2^2 = 2^{3+2} = 2^5$$

$$(2 \times 2 \times 2) \times (2 \times 2) = 2 \times 2 \times 2 \times 2 \times 2 = 2^5$$

$$8 \times 4 = 32.$$

Powers with the same exponent of different base numbers are multiplied by involving the product of the base numbers raised to the common exponent.

$$a^n \times b^n = (a \times b)^n$$

$$2^2 \times 3^2 = (2 \times 3)^2$$

$$2 \times 2 \times 3 \times 3 = 6 \times 6 = 36$$

Division

Powers with like bases are divided by involving the base raised to the difference between the exponents.

$$\frac{a^m}{a^n} = a^{m-n}$$

$$\frac{2^3}{2^2} = 2^{3-2} = 2^1 = 2$$

$$\frac{2 \times 2 \times 2}{2 \times 2} = \frac{8}{4} = 2$$

Powers with the same exponents are divided by involving the quotient of the bases by the common exponent.

$$\frac{a^n}{b^n} = \left(\frac{a}{b}\right)^n$$

$$\frac{2^2}{3^2} = \left(\frac{2}{3}\right)^2 = \frac{2 \times 2}{3 \times 3} = \frac{4}{9}$$

Only like powers can be added or subtracted.

Examples

(The exponent 1 is usually not written.)

$$a^1 = a$$

$$2^1 = 2$$

$$2a^2 + 3a^2 = 5a^2$$

(Any number raised to the power of 0 is 1.)

$$a^0 = 1$$

$$2^0 = 1$$

A number raised to a negative power corresponds to its reciprocal with the exponent's sign changed to +.

$$a^{-n} = \frac{1}{a^n}$$

$$2^{-2} = \frac{1}{2^2}$$

Powers are involved by multiplying the exponents.

$$(a^n)^m = a^{nm}$$

$$(2^2)^3 = 2^{2 \cdot 3} = 2^6$$

Powers can be transposed without affecting the result.

$$(a^n)^m = (a^m)^n$$

$$(2^2)^3 = (2^3)^2$$

$$(2 \times 2) \times (2 \times 2) \times (2 \times 2) = (2 \times 2 \times 2) (2 \times 2 \times 2)$$

$$4 \times 4 \times 4 = 64$$

$$8 \times 8 = 64$$

A mixed number raised to a power is first converted into an improper fraction and then the result is evaluated.

$$8 \quad 3x^3y^2 \div xy$$

$$= \frac{3x^3y^2}{xy} = 3x^2y$$

9 Divide $45a^2b^2c$ by $9a^2c$

$$= \frac{45a^2b^2c}{9a^2c}$$

$$= 5b^2$$

Algebraic Formulae

1	$(a + b)^2$	$= a^2 + b^2 + 2ab$
2	$(a - b)^2$	$= a^2 + b^2 - 2ab$
3	$(a + b)^2$	$= (a - b)^2 + 4ab$
4	$(a - b)^2$	$= (a + b)^2 - 4ab$; $(a + b)^2 - (a - b)^2 = 4ab$
5	$a^2 + b^2$	$= (a + b)^2 - 2ab = (a - b)^2 + 2ab$
6	$a^2 - b^2$	$= (a + b)(a - b)$
7	$a^3 + b^3$	$= (a + b)(a^2 + b^2 - ab)$
8	$a^3 - b^3$	$= (a - b)(a^2 + b^2 + ab)$
9	$(a + b)^3$	$= a^3 + b^3 + 3ab(a + b)$
10	$(a - b)^3$	$= a^3 - b^3 - 3ab(a - b)$
11	$(a + b + c)^2$	$= a^2 + b^2 + c^2 + 2(ab + bc + ca)$
12	$a^4 - b^4$	$= (a^2 + b^2)(a + b)(a - b)$

Examples

1 If $x + y = 9$ and $xy = 20$

Find i) $x^2 + y^2$ ii) $x - y$ iii) $x^2 - y^2$
 iv) $x^3 + y^3$ v) $x^3 - y^3$ vi) x and y

i $(a + b)^2 = a^2 + b^2 + 2ab$

$$(x + y)^2 = x^2 + y^2 + 2xy$$

$$(9)^2 = x^2 + y^2 + 2(20)$$

$$81 = x^2 + y^2 + 40$$

$$x^2 + y^2 = 81 - 40$$

$$x^2 + y^2 = 41$$

ii $(a - b)^2 = (a + b)^2 - 4ab$

$$(x - y)^2 = (x + y)^2 - 4xy$$

$$= (9)^2 - 4(20)$$

$$= 81 - 80$$

$$= 1$$

$$x - y = \sqrt{1} = 1$$

iii $a^2 - b^2 = (a + b)(a - b)$

$$x^2 - y^2 = (x + y)(x - y)$$

$$= 9 \times 1$$

$$x^2 - y^2 = 9$$

iv $a^3 + b^3 = (a + b)(a^2 + b^2 - ab)$

$$x^3 + y^3 = (x + y)(x^2 + y^2 - xy)$$

$$= 9(41 - 20)$$

$$= 9 \times 21$$

$$x^3 + y^3 = 189$$

v $a^3 - b^3 = (a - b)(a^2 + b^2 + ab)$

$$x^3 - y^3 = (x - y)(x^2 + y^2 + xy)$$

$$= 1(41 + 20)$$

$$= 1 \times 61$$

$$= 61$$

$$x^3 - y^3 = 61$$

vi $x + y = 9$
 $x - y = 1$

$$2x = 10$$

$$x = \frac{10}{2} = 5$$

If $x = 5$, $5 + y = 9$
 $y = 9 - 5 = 4$

$$x = 5; y = 4$$

2 Solve $(x + 5)^2 - (x - 5)^2$

If $x + 5 = a$ and $x - 5 = b$

$$a^2 - b^2 = (a + b)(a - b)$$

$$(x + 5)^2 - (x - 5)^2 = [(x + 5) + (x - 5)][(x + 5) - (x - 5)]$$

$$= (x + 5 + x - 5)(x + 5 - x + 5)$$

$$= (2x)(10)$$

$$= 20x$$

3 If $(x - y) = 4$ and $xy = 12$, find the value of $(x^2 + y^2)$

$$(x - y)^2 = x^2 + y^2 - 2xy$$

$$(4)^2 = x^2 + y^2 - 2 \times 12$$

$$16 = x^2 + y^2 - 24$$

$$x^2 + y^2 - 24 = 16$$

$$x^2 + y^2 = 16 + 24$$

$$x^2 + y^2 = 40$$

4 If $x - y = 7$ and $xy = 60$ then find the value of $x^4 + y^4$

$$(x - y)^2 = x^2 + y^2 - 2xy = 7^2$$

$$x^2 + y^2 - 2 \times 60 = 49$$

$$x^2 + y^2 = 169$$

$$(x^2 + y^2)^2 = (169)^2 \text{ (take square on both side)}$$

$$x^4 + y^4 + 2x^2y^2 = (169)^2$$

$$x^4 + y^4 + 2(xy)^2 = 28561$$

$$x^4 + y^4 + 2(60)^2 = 28561$$

$$x^4 + y^4 + 2(3600) = 28561$$

$$x^4 + y^4 + 7200 = 28561$$

$$x^4 + y^4 = 28561 - 7200$$

$$x^4 + y^4 = 21361$$

5 $x + y = \sqrt{5}$; $x - y = \sqrt{3}$ Find the value of $8xy(x^2 + y^2)$

$$x + y = \sqrt{5}; x - y = \sqrt{3} \text{ (take square on both sides)}$$

$$(x + y)^2 = 5; (x - y)^2 = 3$$

Solve the equations

$$(x + y)^2 = x^2 + y^2 + 2xy = 5$$

$$(x - y)^2 = x^2 + y^2 - 2xy = 3$$

$$2(x^2 + y^2) = 8$$

$$(x^2 + y^2) = \frac{8}{2} = 4$$

$$= x^2 + y^2 + 2xy = 5$$

$$= x^2 + y^2 - 2xy = 3$$

$$\begin{array}{cccc} (-) & (-) & (+) & (-) \end{array}$$

$$4xy = 2$$

$$xy = \frac{2}{4} = \frac{1}{2}$$

$$8xy(x^2 + y^2) = 8 \times \frac{1}{2} \times 4$$

$$= 4 \times 4 = 16$$

6 If $(a - \frac{1}{a}) = 6$. Find the value of $a^2 + \frac{1}{a^2}$

$$\left(a - \frac{1}{a}\right) = 6$$

$$\left(a - \frac{1}{a}\right)^2 = 6^2 \text{ (take square on both sides)}$$

$$a^2 + \left(\frac{1}{a}\right)^2 - 2(a) \left(\frac{1}{a}\right) = 36$$

$$a^2 + \frac{1}{a^2} - 2 = 36$$

$$a^2 + \frac{1}{a^2} = 36 + 2$$

$$a^2 + \frac{1}{a^2} = 38$$

7 If $x - \frac{1}{x} = 2$, Find the value of $x^3 - \frac{1}{x^3}$

$$(a - b)^3 = a^3 - b^3 - 3ab(a - b)$$

$$\left(x - \frac{1}{x}\right)^3 = x^3 - \frac{1}{x^3} - 3(x) \left(\frac{1}{x}\right) \cdot \left(x - \frac{1}{x}\right)$$

$$= x^3 - \frac{1}{x^3} - 3 \left(x - \frac{1}{x}\right)$$

$$2^3 = x^3 - \frac{1}{x^3} - 3 \left(x - \frac{1}{x}\right)$$

$$8 = x^3 - \frac{1}{x^3} - 3(2)$$

$$8 = x^3 - \frac{1}{x^3} - 6$$

$$8 + 6 = x^3 - \frac{1}{x^3}$$

$$14 = x^3 - \frac{1}{x^3}$$

$$x^3 - \frac{1}{x^3} = 14$$

8 If $x - \frac{1}{x} = 4$, Find the value of $x^4 + \frac{1}{x^4}$

$$x - \frac{1}{x} = 4 \text{ (take square on both sides)}$$

$$\left(x - \frac{1}{x}\right)^2 = 4^2 [(a - b)^2 = a^2 + b^2 - 2ab]$$

$$x^2 + \frac{1}{x^2} - 2 \times x \times \frac{1}{x} = 4^2$$

$$x^2 + \frac{1}{x^2} - 2 = 16$$

$$x^2 + \frac{1}{x^2} = 16 + 2$$

$$x^2 + \frac{1}{x^2} = 18$$

$$\left(x^2 - \frac{1}{x^2}\right)^2 = (18)^2 \text{ (take square on both sides)}$$

$$(x^2)^2 + \left(\frac{1}{x^2}\right)^2 + 2 \times x^2 \times \frac{1}{x^2} = 324$$

$$x^4 + \frac{1}{x^4} + 2 = 324$$

$$x^4 + \frac{1}{x^4} = 324 - 2$$

$$x^4 + \frac{1}{x^4} = 322$$

Assignment

Add

1 $(5x^2 - 3y^2 + z) + (-x^2 + 2y^2 - 4z)$

2 $7a^2 - 5a^2 + a^2 + 3a^2$

3 $3m^2n - 2m^2n + 4m^2n - m^2n + 7m^2n$

4 $18 + 13x^2 - 13 + 2x^2 - 15x^2$

5 $6l^2m + 3lm^2 - 2l^2m - 17lm^2 + 1$

6 $3a^2b - 2ab - 2a^2b - 3ab - 2a^2b + ab$

Subtract

1 Subtract $2a^2 - 3b^2$ from $3a^2 + 2b^2$

2 Subtract $-2y^2 + 3xy - 5$ from $3x^2 - 4xy + 7y^2 - 5$

3 Subtract $3x - 4x^2 + 2y^2$ from $4y^2 - 2x + 8x^2$

Add and Subtract

1 $48m^2 + 24m^2n + 12m^2 - 6m^2 - 12m^2n$

2 $3x^2y - 2xy - 2x^2y - 3xy - 2x^2y + xy$

3 $10x + 14 - 7y^2 - 11a + 2x - 4 - 3y^2 - 4a + 8$

Multiplication

1 $7pq^2 \times 5r$

2 $(4x^2 + 3y^2) \times (-2z)$

3 $-7p \times 4q^2$

4 $p^2q^3 \times 3p^3q^2$

5 $(3b^2 - 2b)3b^2$

6 $5y \times 2y^3y^2$

7 $ab^{-1} \times ba^{-1}$

Division

1 $4a^8 \div 2a^3$

2 $-15a^8 \div 3a^5$

3 $\frac{8a^4}{12a^{-7}}$

4 $\frac{3p^2 \times 4p \times 5p^3 \times p}{6p^4 \times 10p}$

5 $\frac{25m^2n}{5m^3n^2}$

Estimation and Costing - Simple estimation of the requirement of material etc., as applicable to the trade

Introduction

Estimation is the method of calculating the various quantities and the expenditure to be incurred on a particular job or process.

Estimate is the method used to measure or quantify the different quantities and the expected expenditure to be incurred on a particular work or project.

We know that the estimation is a long procedure, and it is totally depends upon the projects,

In case the funds available are less than the estimated cost the work is done in part or by reducing it or specifications are altered,

The following essential details are required for preparing an estimate.

Drawings like plan, elevation and sections of important parts.

Detailed specifications about workmanship & properties of materials, etc.

Standard schedule of rates of the current year.

Estimating is the process of preparing an approximation of quantities which is a value used as input data and it is derived from the best information available.

An estimate that turns out to be incorrect will be an overestimate if the estimate exceeded the actual result, and an underestimate if the estimate fell short of the actual result.

A cost estimate contains approximate cost of a product process or operation. The cost estimate has a single total value and it is inclusive of identifiable component values.

Purpose of Estimating and Costing

- 1 Estimates provide a rough idea of the cost of the job and therefore its feasibility can be calculated, i.e. whether or not the project would be included in the funds available.
- 2 Estimate gives an idea of the time needed to complete the work.
- 3 Estimates are required to invite tenders and quotations and to arrange the contracts.

4 Estimates are also required to control expenditure during the execution of the work.

5 Estimates decide whether or not proposed plan matches the funds available.

Estimation Methods

Estimate involves the following operations

- Preparing detailed Estimate.
- Calculating the rate of each unit of work.
- Preparing abstract of estimate.

Estimation is the process of calculating or evaluating a quantity by estimation, that is, without reference to specific measurements. Estimating is a fundamental process in all engineering.

This is usually done before purchase or construction begins or during preliminary planning stages. Estimating is usually more accurate, but there are a few limitations - namely that if your estimate relies on labour costs, you'll need to know how many man-hours will take to complete the project.

Estimates are developed from observations and knowledge of past experience. The accuracy of an estimate often depends on the level of detail available and the amount of time for which data are available for analysis.

Costing is the process of estimating the cost of a project before it's completed. It can be done with an itemized list, or through estimation using a construction cost calculator.

Costing includes three steps: estimating, bidding, and finalizing. It helps predict how much money will be required to construct the project.

A "costing" typically refers to how much it will cost someone to produce a single unit.

There are two types of costings

Independent costing - this is the cost of direct material and labour costs. This type of costing only takes into account the cost of a single-phase, so it's not representative of the overall project cost.

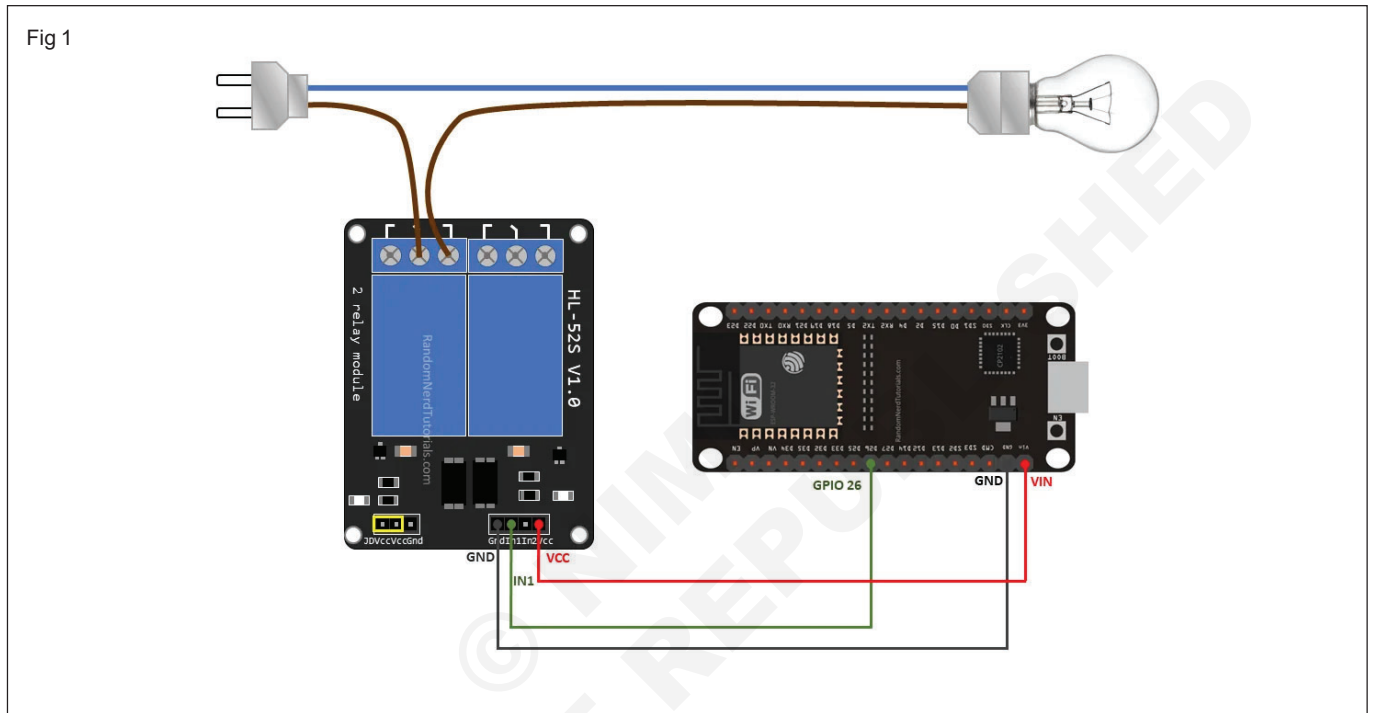
Cumulative Costing - this type of costing looks at the total cost for all phases of work, but it can be difficult to ensure that estimates are accurate.

Exercise:

1 Estimate the items required for the installation work to build and operate a relay circuit with node MCU and also calculate the cost of the items required. (Fig 1)

Tools/Instruments/Equipments - Service persons owns

1	USB Cable	-1 No.	5	Realy module 5V	- 1 No.
2	Node MCU ESP8266 Cp 2102 wireless module	- 1 No.	6	Bulb	- 1 No.
3	Jumper wire (Male to female)	- 40 pcs	7	Lamp holder	- 1 No.
4	Single strand wire	- 5 m.	8	Plug (2 pin)	- 1 No.



Estimation of Items

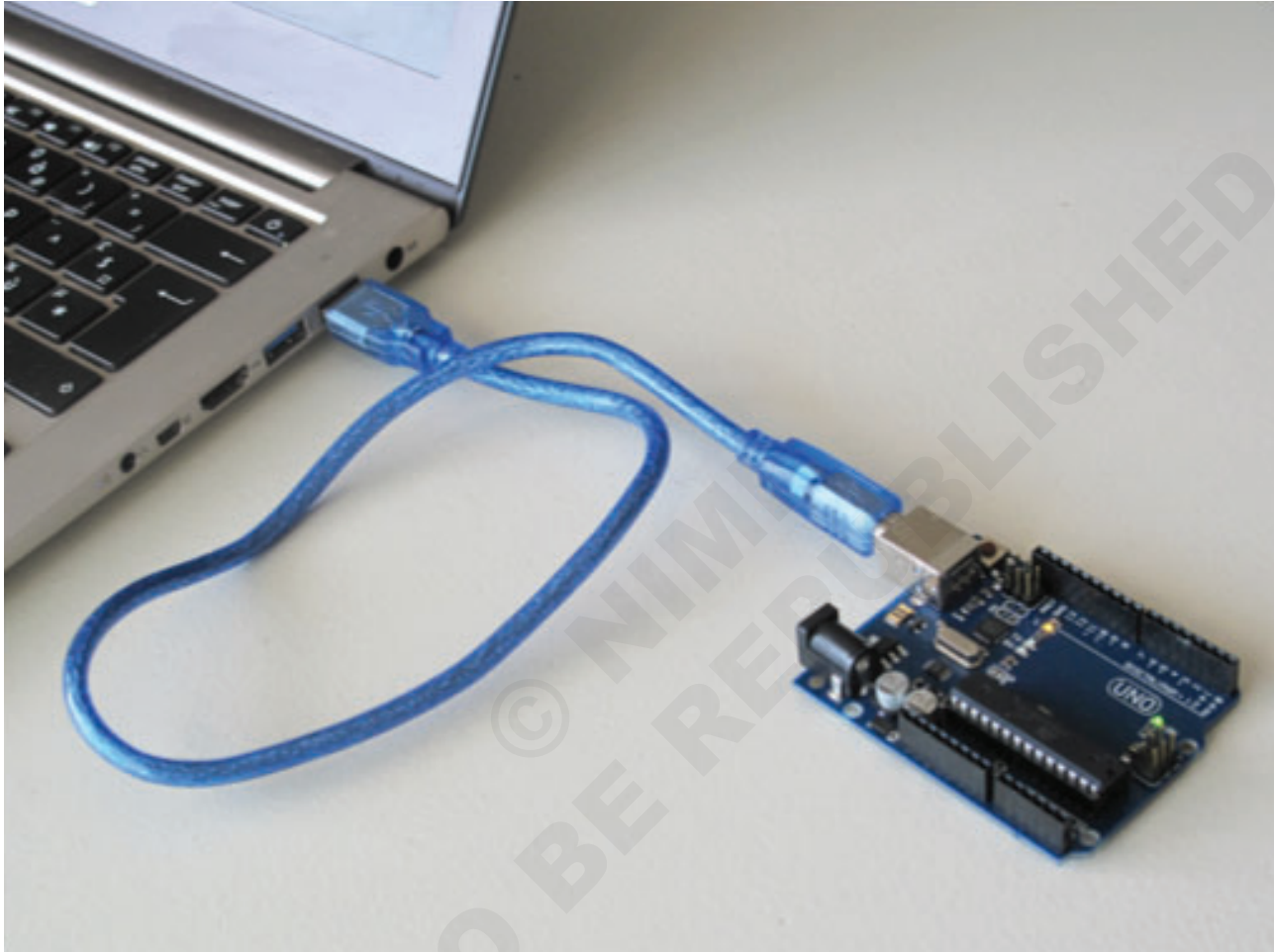
1	USB cable	=	Rs. 190
2	Node MCU ESP 8266 cp2102 wireless module	=	Rs. 400
3	Jumper wire (Male to Female) 40 x 50	=	Rs.2,000
4	Single strand wire	=	Rs. 60
5	Relay module	=	Rs. 340
6	Lamp holder	=	Rs. 60
7	Plug (2 pin)	=	Rs. 100
8	Bulb	=	Rs. 60
Total items cost		=	Rs. 3,210

2 Estimate the items required for the installation work To connect arduino with PC and configuring for Arduino board and also calculate the cost of the items required. (Fig 2)

Tools/Instruments/Equipments - Service persons owns

- 1 Arduino uno board - 1 No.
- 2 PC with Arduino IDE installed - 1 No.

Fig 2



Estimation of Items

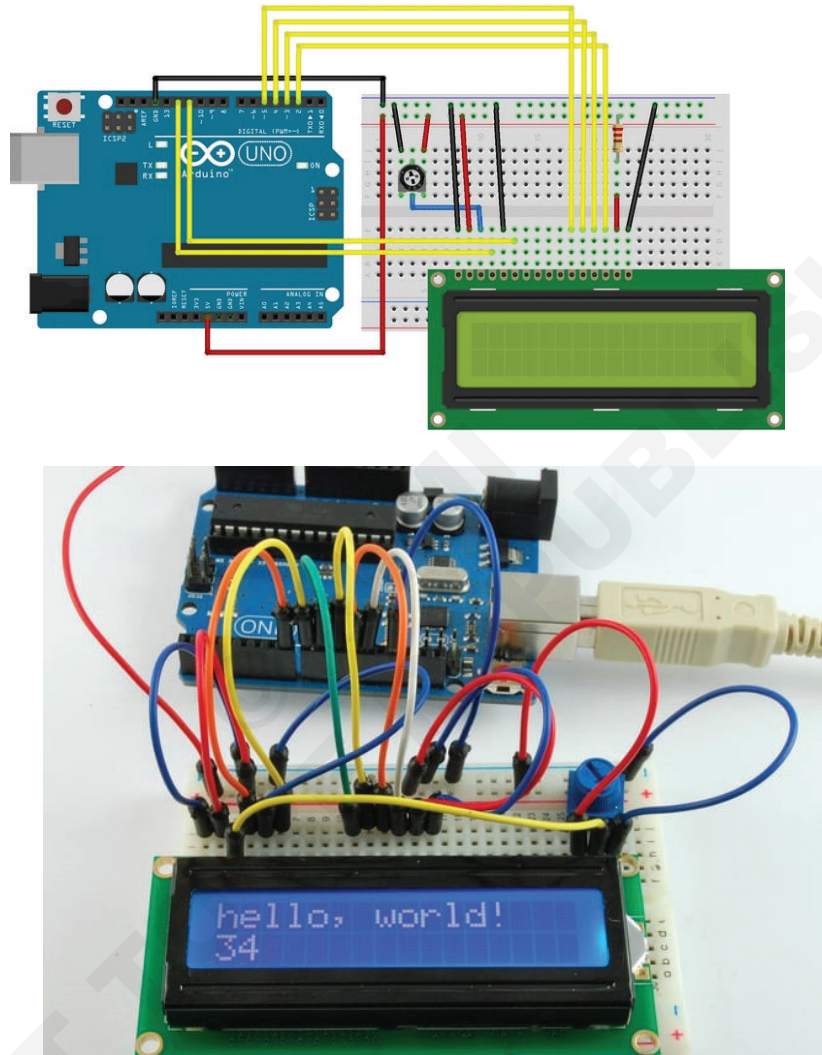
1	Arduino uno board	=	Rs.	350
2	PC with Arduino IDE installed	=	Rs.	35,000
	Total items cost	=	Rs.	35,350

3 Estimate the items required for installing hello world display on serial monitor from Arduino and also calculate the cost of the items required for the work. (Fig 3)

Tools/Instruments/Equipments - Service persons owns

- | | | | | | |
|---|------------------------|---------|---|---------------------|----------|
| 1 | Arduino uno board | - 1 No. | 5 | LCD screen v.o. Pin | - 3 Nos. |
| 2 | LCD display 16 x 2 | - 1 No. | 6 | Hook up wires | |
| 3 | 10K ohm potentio meter | - 1 No | 7 | Bread board | - 1 No. |
| 4 | 220 ohm resistor | - 1 No. | | | |

Fig 3



Estimation of Items

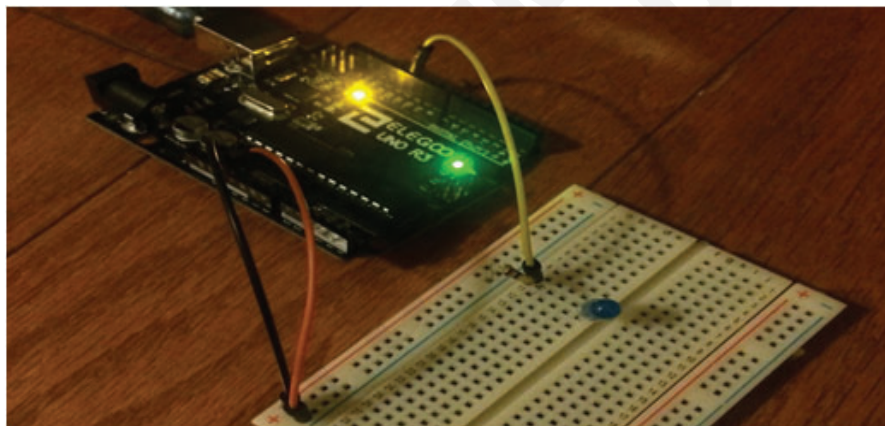
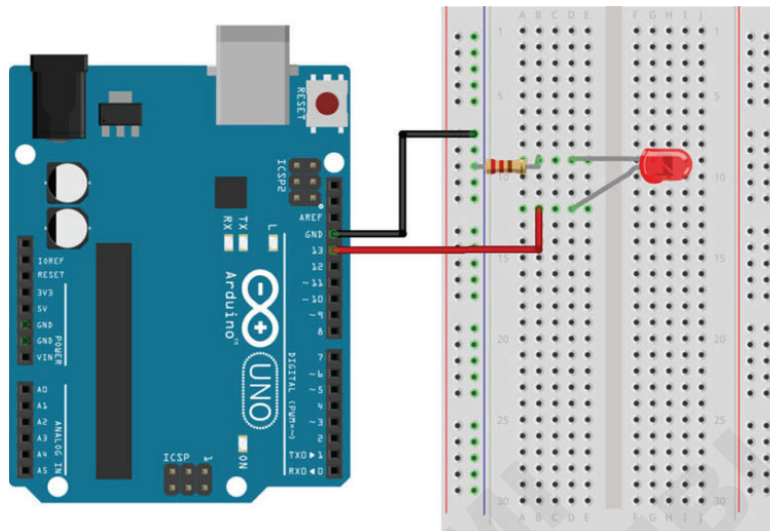
1	Ardino uno board	=	Rs. 400
2	LCD display 16 x 2	=	Rs. 250
3	10K ohm potentio meter	=	Rs. 200
4	220 ohm resistor	=	Rs. 150
5	Bread board	=	Rs. 200
6	LCD screen V.o.pin	=	Rs. 180
7	Hook up wires	=	Rs. 300
Total items cost		=	Rs.1,680

4 Estimate the quantity of items required for installation and uploading computer code to node MCU to blink on board LED with 1 sec. Duration the work and also calculate the cost of the items required. (Fig 4)

Tools/Instruments/Equipments - Service persons owns

1	Arduino uno board	- 1 No.	4	Jumper wires	- 40 pcs.
2	PC with arduino IDE installed	- 1 No.	5	Resistor	- 10 Nos.
3	LED Bulb	- 1 No.	6	Bread board	- 1 No.

Fig 4



Estimation of Items

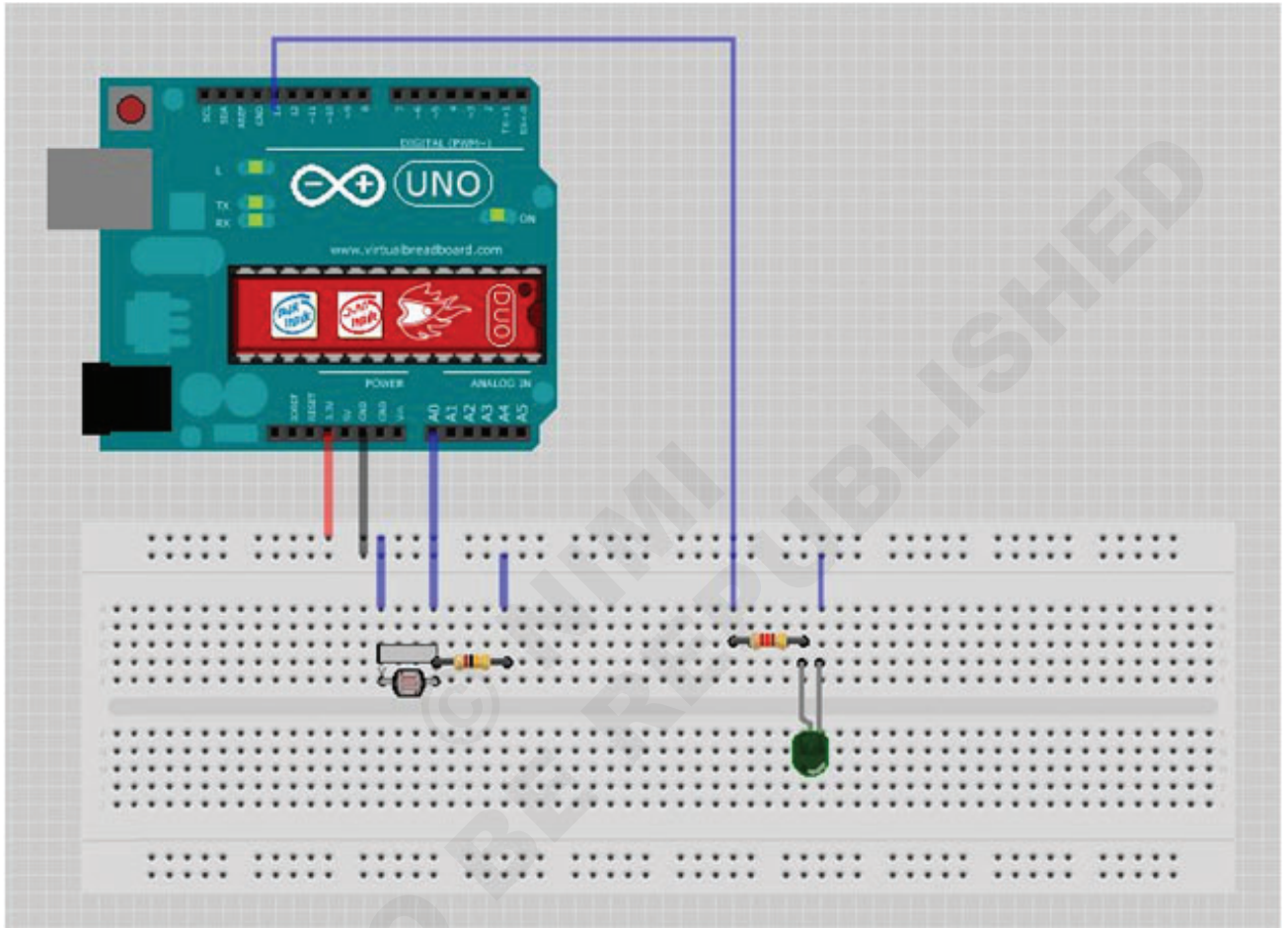
1	Arduino uno board	=	Rs. 400
2	P.C with arduino 1 DE installed	=	Rs.2740
3	LED bulb		
4	Jumper wires	=	Rs.2000
5	Resistor	=	Rs. 150
6	Bread board	=	Rs. 200
Total items cost		=	Rs. 5490

5 Estimate the items required for installing Building light intensity reader circuit with node MCU and also calculate the cost of the items. (Fig 5)

Tools/Instruments/Equipments - Service persons owns

- | | | | | | |
|---|------------------------------|---------|---|-------------------------------|----------|
| 1 | Ardion uno board | - 1 No | 4 | PC with arduino IDE installed | - 1 No. |
| 2 | LED | - 1 No | 5 | Jumper wires | - 4 pcs. |
| 3 | 10K ohm and 220 ohm resistor | - 1 No. | | | |

Fig 5



Estimation of Items

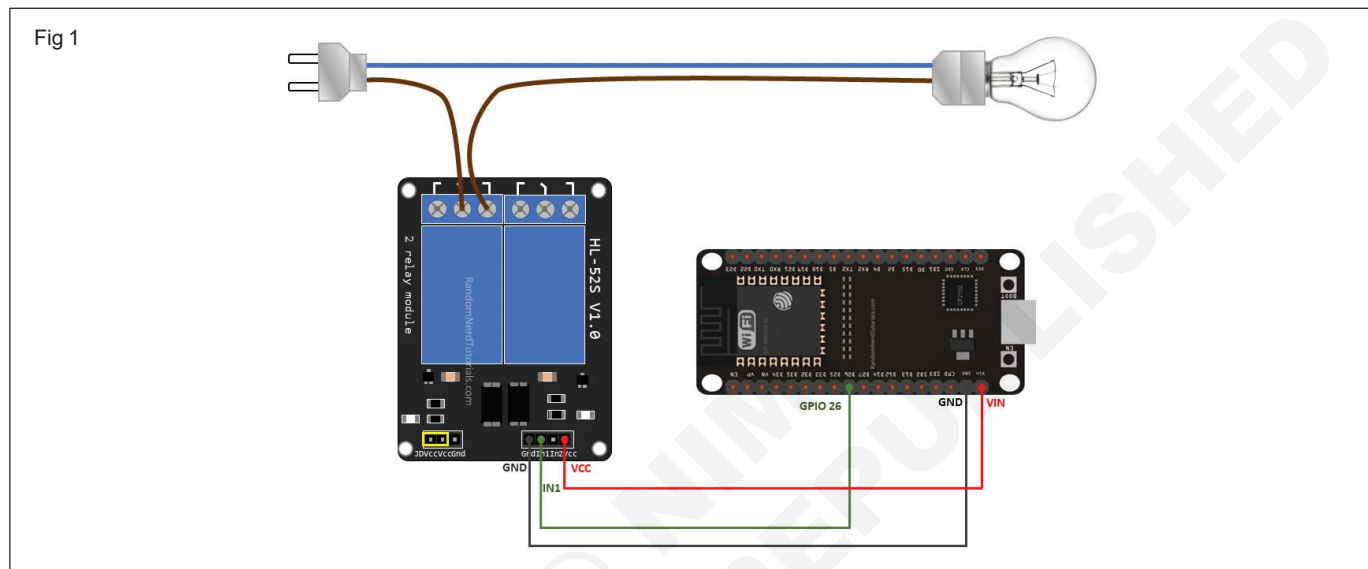
1	Arduino uno board	=	Rs. 300
2	LED	=	Rs. 80
3	Resistor 10K ohm	=	Rs. 200
4	Resistor 220 ohm	=	Rs. 150
5	PC with arduino IDE installed	=	Rs.2740
6	Jumper wires	=	Rs. 400
Total items cost		=	Rs. 3870

Estimation and Costing - Problems on estimation and costing

- 1 Estimate the items required for the installation work to build and operate a relay circuit with node MCU and also calculate the total cost. (Fig 1)

Tools/Instruments/Equipments - Service persons owns

1 USB Cable	-1 No.	5 Realy module 5V	- 1 No.
2 Node MCUESP8266 Cp 2102 wireless module	- 1 No.	6 Bulb	- 1 No.
3 Jumper wire (Male to female)	- 40 pcs	7 Lamp holder	- 1 No.
4 Single strand wire	- 5 m.	8 Plug (2 pin)	- 1 No.



- 1 Check relay is a electrically operated switch. Generally used relay modules are 5v / 12v.
- 2 The relay uses an electromagnet to mechanically switch ON electric appliances.
- 3 Check the relay operated by a relatively small electric current that can turn ON or OFF a much larger electric current.
- 4 Check the relay is safe as there is no physical contact between NodeMCU and AC devices.
- 5 Relay basically act as a switch between electrical load and NodeMCU.
- 6 Check the relay has two configuration NOs (Normally Open) & NC (Normally Close).
- 7 Check the relay coil which is energized by 5v, when coil energized switching action takes place, based on NO-NC configuration.
- 8 Check relay is in NO configuration then when coil is energized switching action takes place from NO-NC then load will be connected.
- 9 Check the connections are very simple, initially you need to power-up the Relay Module.
- 10 Check and connect NodeMCU Ground (GND) pin to -ve pin of Relay, Connect NodeMCU Supply (3v3) pin to +ve pin of Relay and Connect NodeMCU Digital pin (D4) to Input pin of Relay.

Calculation

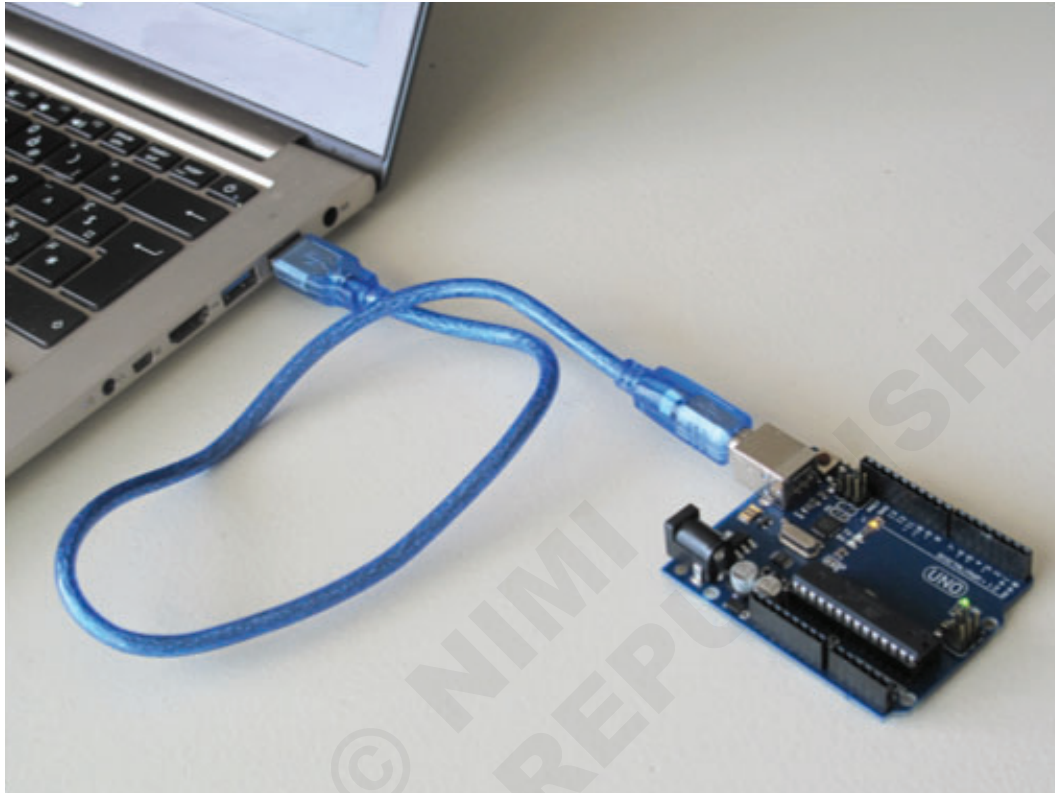
1 Total items cost	=	Rs.3,210
2 Labour charge	=	Rs.1,000
Total cost	=	Material cost + Labour charge
	=	Rs.3,210 + Rs.1,000
	=	Rs.4,210

2 Estimate the items required for the installation work To connect Arduino with PC and configuring for Arduino board and calculate the total cost. (Fig 2)

Tools/Instruments/Equipments - Service persons owns

- 1 Arduino uno board - 1 No.
- 2 PC with Arduino IDE installed - 1 No.

Fig 2



Step 1: Download and Install the IDE

You can download the IDE from the official Arduino website. Ensure that you download the correct version of the IDE if you do not have Windows 10.

Once downloaded, install the IDE and ensure that you enable most (if not all) of the options, INCLUDING the drivers.

Step 2: Get the Arduino COM Port Number

The easiest way to do this is to type "device manager" into Windows Search and select Device Manager when it shows.

In my Device Manager, the Arduino shows up as COM7.

If your Arduino is not recognized. then uninstall the driver, remove the Arduino, reinsert the Arduino, find the unrecognized device, right click "Update driver", and then click "Search automatically". This should fix 99 out of 100 problems.

Step 3: Configure the IDE

To do this, navigate to Tools > Port > COM7. Obviously, if your Arduino is on a different port, select that port instead.

Step 4: Loading a Basic Example

Loan an example project that the Arduino IDE comes with.

This example will make the onboard LED blink for a second continuously. To load this example, click File > Examples > 01.Basics > Blink.

To verify and compile the code, press the check mark button in the upper left window.

If the compilation stage was successful, you should see the following message in the output window at the bottom of the IDE. You might also see a similar message-just it's one that does not have words like "ERROR" and "WARNING".

With the code compiled, you must now upload it the Arduino Uno. To do this, click the arrow next to the check mark.

Calculation

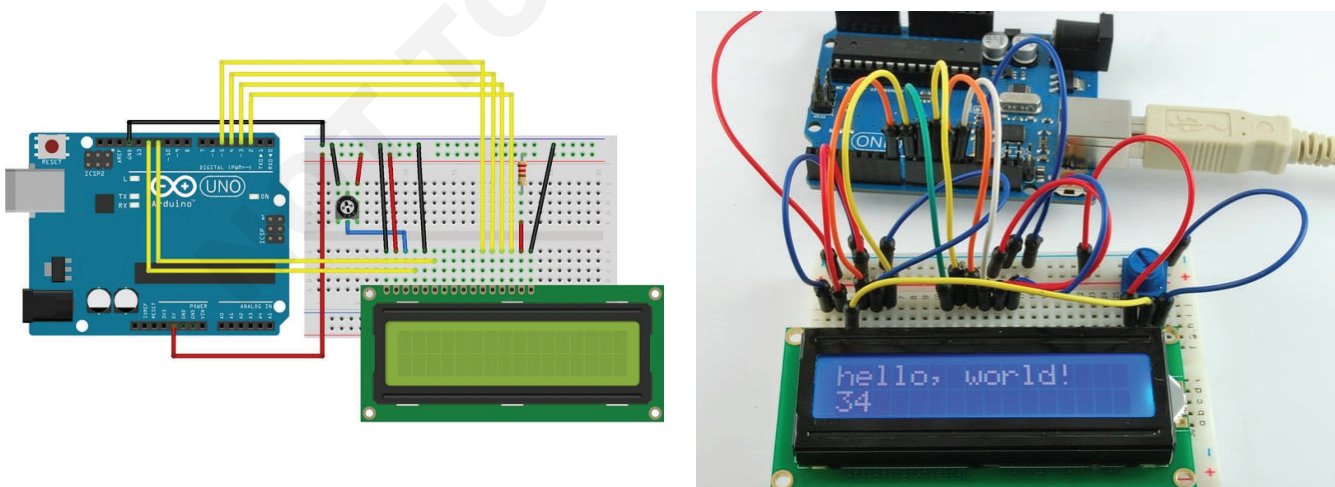
1	Total item cost	=	Rs.35,350
2	Labour charge	=	Rs.1000
	Total cost	=	Material cost + Labour charge
		=	Rs.35,350 + Rs.1000
		=	Rs.36,350

3 Estimate the items required for installing hello world display on serial monitor from Arduino and also calculate the total cost required for the work. (Fig 3)

Tools/Instruments/Equipments - Service persons owns

1	Arduino uno board	- 1 No.	5	LCD screen v.o. Pin	- 3 No.
2	LCD display 16 x 2	- 1 No.	6	Hook up wires	
3	10K ohm potentiometer	- 1 No.	7	Bread board	- 1 No.
4	220 ohm resistor	- 1 No.			

Fig 3



- 1 A Read/Write (R/W) pin that selects reading mode or writing mode
- 2 An Enable pin that enables writing to the registers
- 3 8 data pins (D0 -D7). The states of these pins (high or low) are the bits that you're writing to a register when you write, or the values you're reading when you read.
- 4 There's also a display constrast pin (Vo), power supply pins (+5V and Gnd) and LED Backlight (Bklt+ and Bklt-) pins that you can use to power the LCD, control the display contrast, and turn on and off the LED backlight, respectively.
- 5 The process of controlling the display involves putting the data that form the image of what you want to display into the data registers, then putting instructions in the instruction register.
- 6 The Hitachi-compatible LCDs can be controlled in two modes: 4-bit or 8-bit. The 4-bit mode requires seven I/O pins from the Arduino, while the 8-bit mode requires 11 pins. For displaying text on the screen, you can do most everything in 4-bit mode.

Calculation

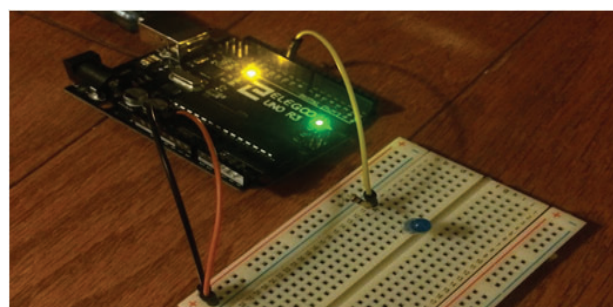
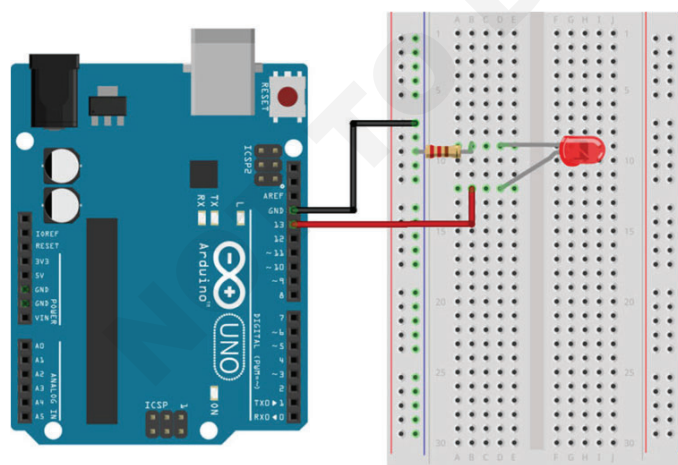
1	Total items cost	=	Rs.1,680
2	Labour charge	=	Rs.1,000
	Total cost	=	Material cost + Labour charge
		=	Rs.1,680 + Rs.1,000
		=	Rs.2,680

4 Estimate the items required for install and upload computer code to node MCU to blink on board LED with 1 sec. Duration) the work and also calculation the total cost required. (Fig 4)

Tools/Instruments/Equipments - Service persons owns

1	Arduino uno board	- 1 No.	4	Jumper wires	- 40 pcs
2	PC with arduino IDE installed	- 1 No.	5	Resistor	- 10 No.
3	LED Bulb	- 1 No.	6	Bread board	- 1 No.

Fig 4



- 1 Place the LED sensor in the bread board
- 2 Connect one pin to the A0 (analog pin) of Arduino, and connect another pin to the GND pin of Arduino.
- 3 Place another LED on a bread board and connect a 220-ohm resistor to its Anode.
- 4 Connect a wire from the resistor to pin 13 on Arduino (digital pin). Connect the Cathode of the LED to the GND of Arduino.
- 6 Install Arduino IDE
- 7 Copy the code from online and upload it to Arduino
- 8 Head to tools in Arduino IDE and open the serial monitor. Note the values in the dark and values after the light is applied. These values are used to trigger the switch.
- 9 If in the dark value is 100-150, and in the light, it is 50-100, the LED on pin 13 can be turned on by editing the if statement as below:
- 10 Now the LED will turn on when in the dark and if the greater than ">" is replaced with less than "<" then the LED will turn on in the light.

Calculation

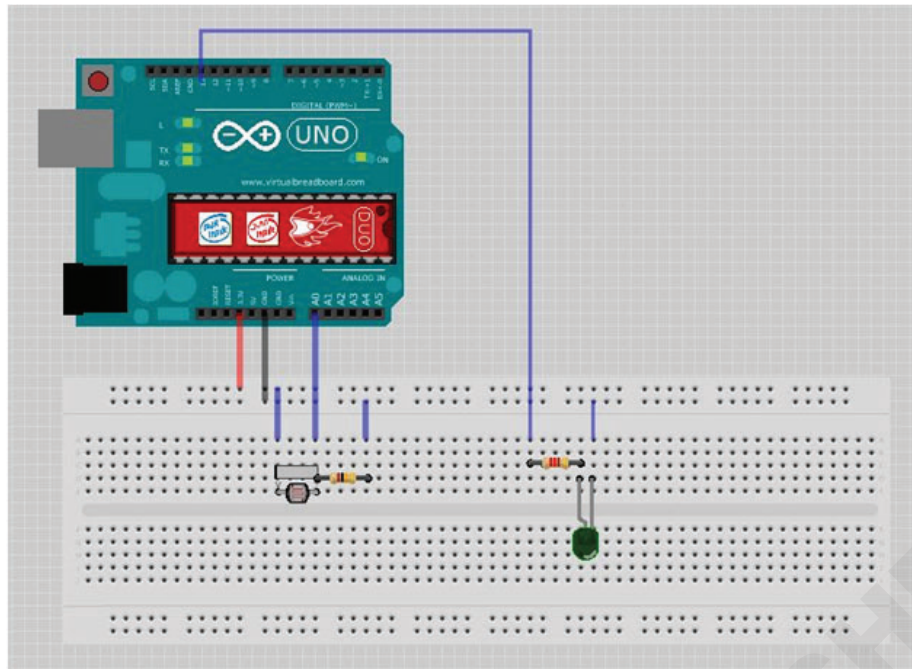
1	Total items cost	=	Rs.5,490
2	Labour charge	=	Rs.1,000
	Total cost	=	Material cost + Labour charge
		=	Rs.5,490 + Rs.1,000
		=	Rs.6,490

5 Estimate the items required for installation Building light intensity reader circuit with node MCU and also calculate the total cost. (Fig 5)

Tools/Instruments/Equipments - Service persons owns

1 Ardion uno board	- 1 No	4 PC with arduino IDE installed	- 1 No.
2 LED	- 1 No	5 Jumper wires	- 4 pcs.
3 10K and 220 ohm resistor	- 1 No.		

Fig 5



LED Connection

- 1 LED attach to board
- 2 Resistor (220 ohm) one leg attach to LED long leg
- 3 The green wire attach to resistor's empty leg
- 4 The brown wire attach to LED short leg

LDR Connection

- 5 LDR attach to board
- 6 Resistor (10k ohm) attach to LDR one leg
- 7 The purple wire attached to LDR other (empty) leg
- 8 The yellow wire attached to LDR and resistor same column
- 9 The white wire attached to resistor empty leg

Arduino Connections

- 10 The green wire connect to digital 13 from resistor leg
- 11 The brown wire connect to GND from LED short leg
- 12 The purple wire connect to +5V from LDR
- 13 The yellow wire connect to A0
- 14 The white wire connect to GND
- 15 Copy the code from online and upload it to Arduino

Calculation

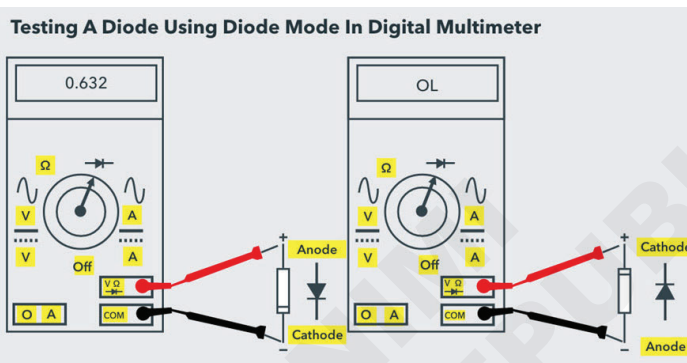
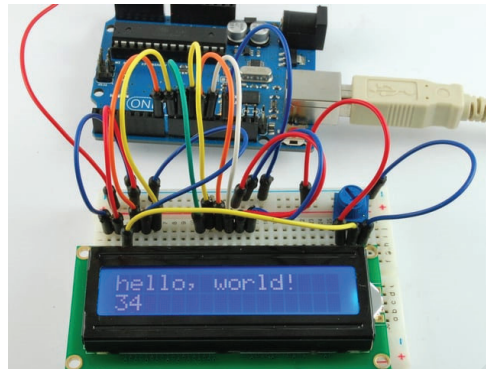
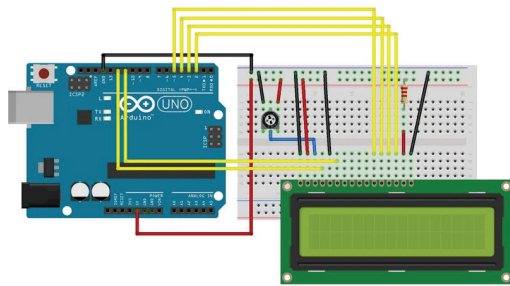
- | | | | |
|---|------------------|---|-------------------------------|
| 1 | Total items cost | = | Rs.3,870 |
| 2 | Labour charge | = | Rs.1,000 |
| | Total cost | = | Material cost + Labour charge |
| | | = | Rs.3,870 + 1,000 |
| | | = | Rs.4,870 |

6 Estimate the items required for Fault finding in bread board and replacement of diode in hello world display circuit with micro controller circuit and to calculate the total cost. (Fig 6)

Tools/Instruments/Equipments - Service persons owns

- | | | | | | |
|---|------------|--------|---|-------------|---------|
| 1 | Multimeter | - 1 No | 3 | Bread board | - 1 No. |
| 2 | Diode | - 1 No | | | |

Fig 6



Test the fault of diode in the given circuit

- 1 Identify the anode and cathode terminals of the diode
- 2 Keep the digital multimeter in diode checking mode by rotating the central knob to the position where the diode symbol is indicated. In this mode the multimeter is capable to supply a current of approximately 2mA between the test leads.
- 3 Connect the red probe of the multimeter to the anode and black probe to the cathode. This means the diode is forward biased.
- 4 Observe the reading on multimeters display. If the displayed voltage value is in between 0.6 to 0.7 then the diode is healthy and perfect.
- 5 Now reverse the terminals of the meters. Connect the red probe to cathode and black to anode. This is the reverse biased. Condition of the diode where no current flow through it. Hence the meter should read OL or L. If the diode is healthy.
- 6 If the meter shows irrelevant values to the above two conditions, then the diode is defective. The defect is the diode can be either open or short.
- 7 Diode found defective
- 8 Remove diode and insert another one.

Estimation of Items

1	Multimeter	=	Rs. 229
2	Bread board	=	Rs.1200
3	Diode	=	Rs. 10
Total items cost		=	Rs.1439

Calculation

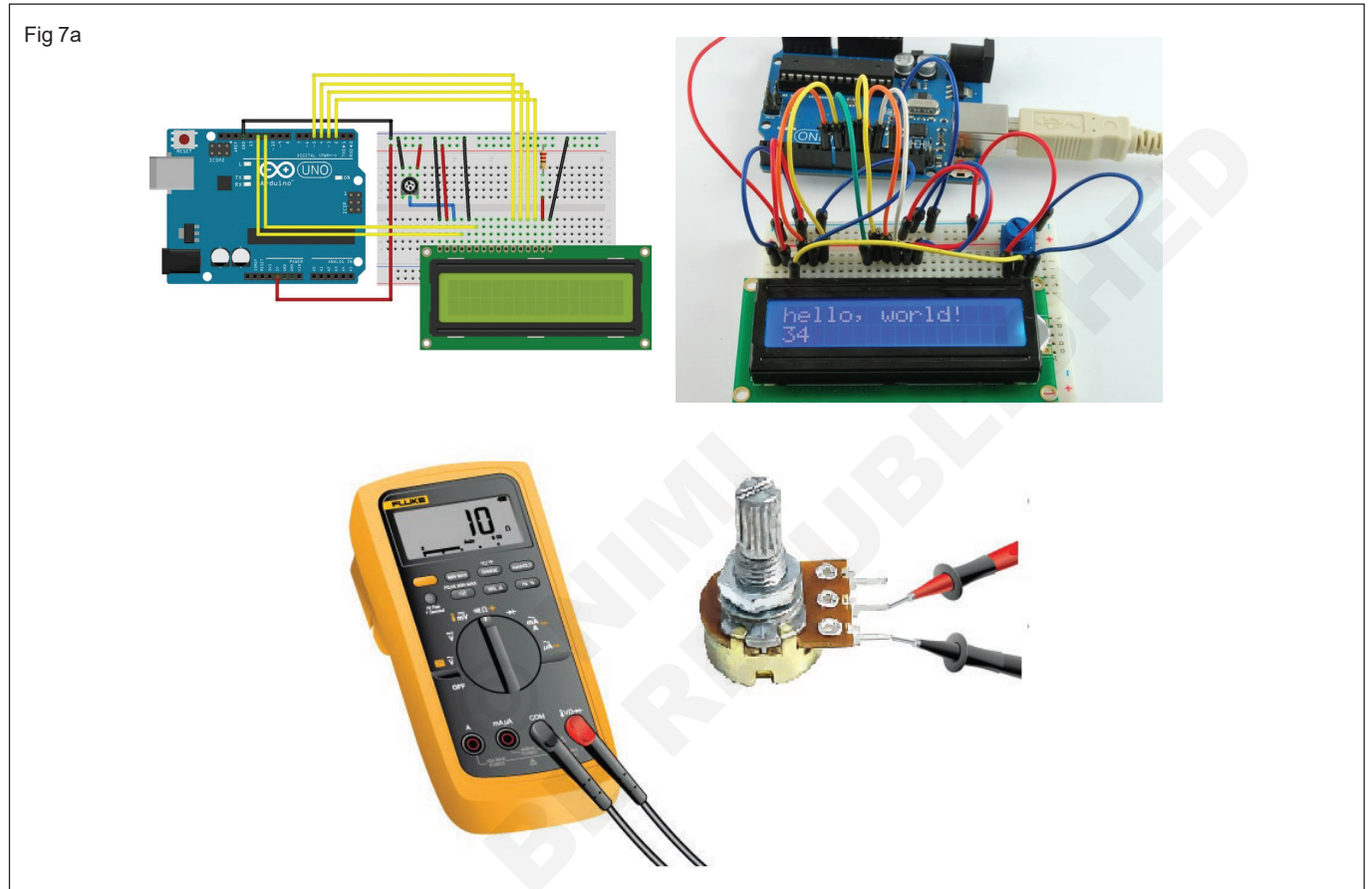
1	Total items cost	=	Rs.1,439
2	Labour charge	=	Rs.1,000
	Total cost	=	Material cost + Labour charge
		=	Rs.1,439 + 1,000
		=	Rs.2,439

7 Estimate the List of items required for Fault finding and repair of potentiometer in a Hello world display circuit and also calculate the total cost required for the work. (Fig 7a&b)

Tools/Instruments/Equipments - Service persons owns

1	Potentiometer	- 1 No.	4	Stepdown transformer 12V	- 1 No.
2	Multimeter	- 1 No.	5	Tin solder	- 200g (stick)
3	Soldering iron	- 1 No	6	Soldering flux	- 1 box

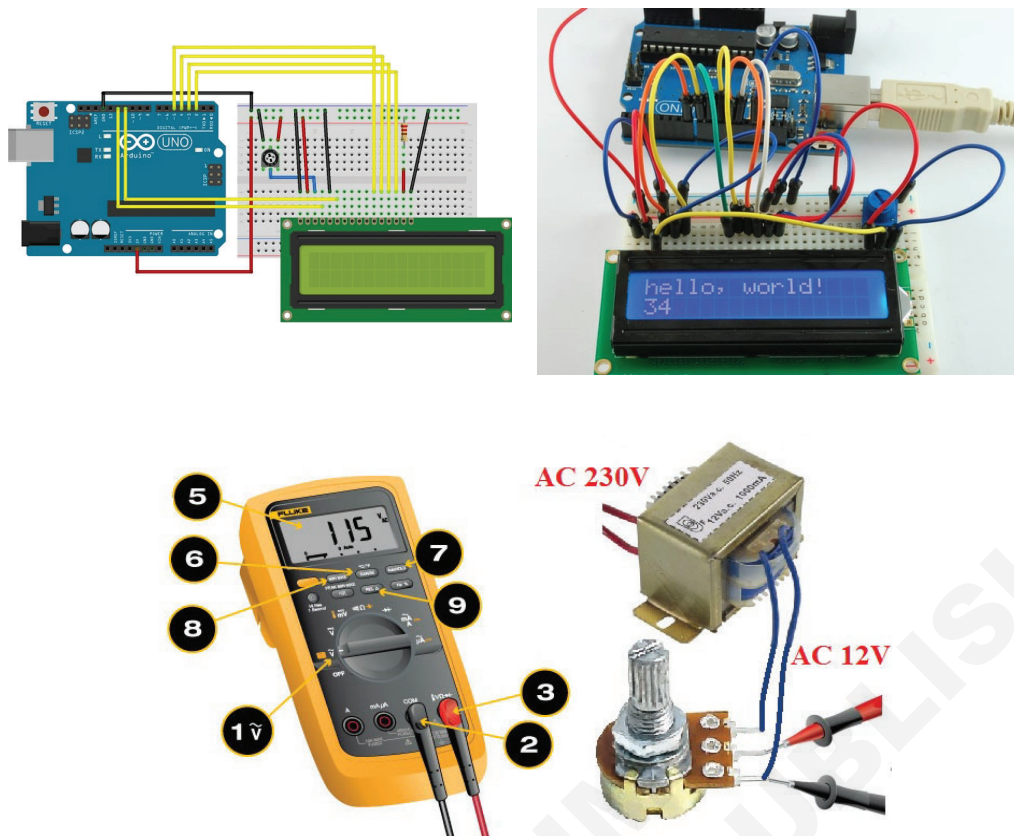
Method 1 - Fault finding of potentiometer by multimeter



- 1 Check for loose connections.
- 2 Check for short circuit.
- 3 Check for damaged component.
- 4 Check for incorrect wiring
- 5 Check for grounding issue.
- 6 Check all connections with multimeter to find out loose contact, short, damage, grounding / incorrect wiring.
- 7 Short circuit found in connections.
- 8 Loose connection found in connection terminals
- 9 Observe carefully the short circuited part of circuit and reconnect the circuit with proper terminal points as per wiring diagram.
- 10 Observe the fault connection carefully and after disconnect, fix the terminals tightly.

Method 2 - Fault finding of potentiometer by multimeter and stepdown transformer

Fig 7b



Condition of potentiometer can also be checked by multimeter connecting with stepdown transformer.

- 1 First turn ON the multimeter and select A.C voltage mode in your multimeter.
- 2 Connect the probes of your multimeter on the two ends like in the above image.
- 3 Now rotate the potentiometer knob using your finger, it will change the transformer AC voltage high to low or low to high in the multimeter. If AC voltage is changed, the potentiometer is good condition or AC voltage, the potentiometer is in bad condition.

Estimation of Items

1 Potentiometer	= Rs. 200
2 Multimeter	= Rs. 229
3 Soldering iron	= Rs. 499
4 Tin solder & Flux	= Rs. 100
Total items cost	= Rs. 1028

Calculation (For Method 1)

1 Total items cost	= Rs.1,028
2 Labour charge	= Rs.1,000
Total cost	= Material cost + Labour charge
	= Rs.1,028 + 1,000
	= Rs.2,028

Calculation (For Method 2)

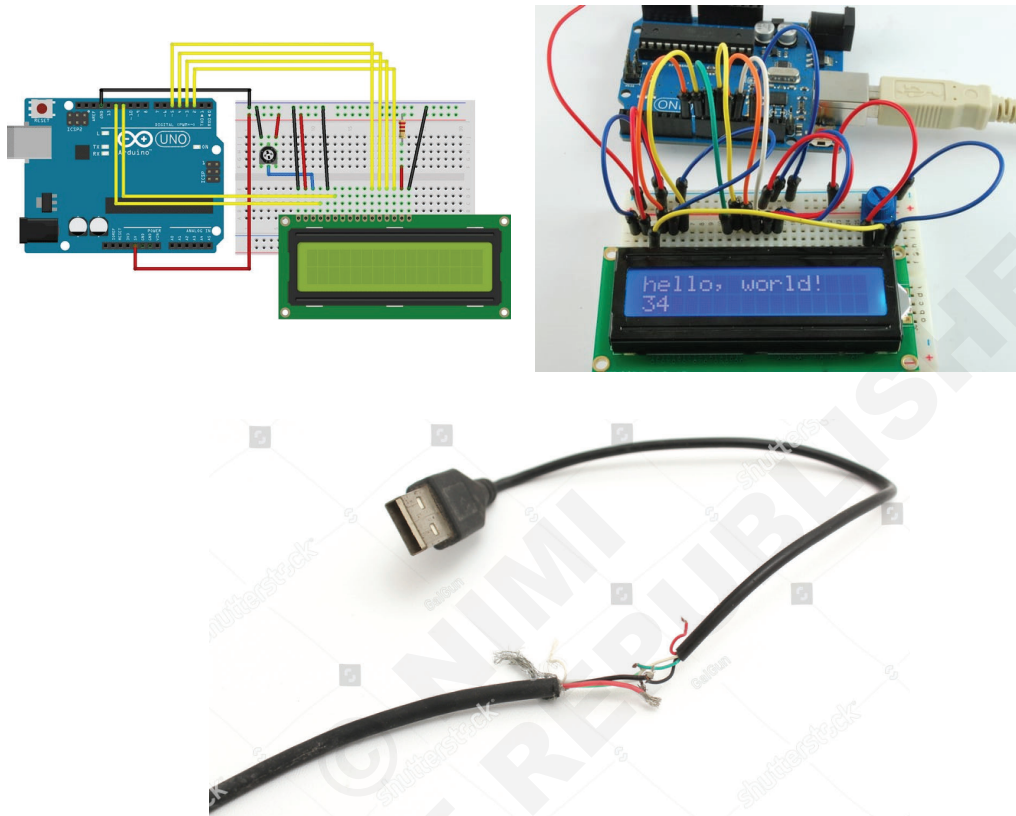
1 Total items cost	= Rs.1,028
2 Stepdown transformer - 1 Unit	= Rs.399
3 Labour charge	= Rs.1,000
Total cost	= Material cost + Labour charge
	= Rs.1,028 + 1,000 + Rs.399
	= Rs.2,427

8 Estimate the items required for Fault finding and repair of USE cable used in the Hello World display circuit and also calculate the total cost required. (Fig 8)

Tools/Instruments/Equipments - Service persons owns

1 Plier	- 1 No.	4 Tin & solder	- 200gm
2 Soldering iron	- 1 No	5 Flux	- 1 box
3 Wires	- 200	5 Multimeter	- 1 No.

Fig 8



- 1 First you find out the continuity of cable using multimeter.
- 2 Cable found to be open at inside.
- 3 Cut the wire.
- 4 Get the identity of wire by colour.
- 5 Solder the end wires.
- 6 Join the wire with plug correctly.

Estimation of Items

1 Cutting plier	=	Rs. 400
2 Soldering iron	=	Rs. 499
3 Wires	=	Rs. 100
4 Tin & solder and Flux	=	Rs. 100
5 Multimeter	=	Rs. 229
Total items cost	=	Rs.1328

Calculation

1 Total items cost	=	Rs.1,328
2 Labour charge	=	Rs.1,000
Total cost	=	Material cost + Labour charge
	=	Rs.1,328 + 1,000
	=	Rs.2,328