

WORKSHOP CALCULATION & SCIENCE

(NSQF)

2nd YEAR

(As per Revised Syllabus July 2022)

Technician Power Electronic System



Directorate General of Training

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



**NATIONAL INSTRUCTIONAL
MEDIA INSTITUTE, CHENNAI**

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Workshop Calculation & Science

Technician Power Electronic System - 2nd Year NSQF

As per Revised Syllabus July 2022

Developed & Published by



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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 Power Electronic System 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 Power Electronic System 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 Power Electronic System 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 Power Electronic System 2nd Year** as per NSQF Revised 2022.

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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 Power Electronic System 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 - 2.2.14	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.**

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SYLLABUS

2nd Year

Workshop Calculation & Science - Technician Power Electronic System
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.

$$+7 + 22 = +29$$

$$(-8) - 34 = -42$$

$$(-27) + 19 = -8$$

$$44 + (-18) = +26$$

$$37 + (-52) = -15$$

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. $-20 \times -3 = 60$

$$5 \times 8 = 40$$

$$4 \times -13 = -52$$

$$-5 \times 12 = -60$$

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.

$$\frac{+28}{+4} = +7$$

$$\frac{+56}{-4} = -14$$

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

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

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 :

$$\begin{aligned} 1 \text{ Add } 7a, -2a, a, 3a \\ 7a + (-2a) + (a) + 3a \\ 7a - 2a + a + 3a \\ = 11a - 2a \\ = 9a \end{aligned}$$

$$\begin{aligned} 2 \text{ Add } 25xy, + 2xy, - 6xy, - 3xy \\ 25xy + 2xy + (- 6xy) + (- 3xy) \\ = 27xy - 9xy \\ = 18xy \end{aligned}$$

$$\begin{aligned} 3 \text{ Add } 9m, + 4m, - 2 \\ 9m + 4m + (- 2) \\ 9m + 4m - 2 \\ = 13m - 2 \end{aligned}$$

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

$$\begin{aligned} 1 \quad 8a + 12b - a - 14b \\ = 8a - a + 12b - 14b \\ = 7a - 2b \\ 2 \quad 14a + 3a + 25b + 2b + b \\ = 17a + 28b \\ 3 \quad (2a + 3b - c) + (4a - b - c) + (a - 8) \\ 2a + 3b - c + 0 \\ 4a - b - c + 0 \\ a + 0 + 0 - 8 \\ \hline 7a + 2b - 2c - 8 \end{aligned}$$

$$\begin{aligned} 4 \text{ Add : } (3x + 3z) ; (5x - 4y) ; (9y - 3z) \\ 3x + 0 + 3z \\ 5x - 4y + 0 \\ 0 + 9y - 3z \\ \hline 8x + 5y \end{aligned}$$

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

1. $10x + 14 - 7y^2 - 11a + 2x - 4 - 3y^2 - 4a + 8$

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

$$= 12x - 10y^2 - 15a + 18$$

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

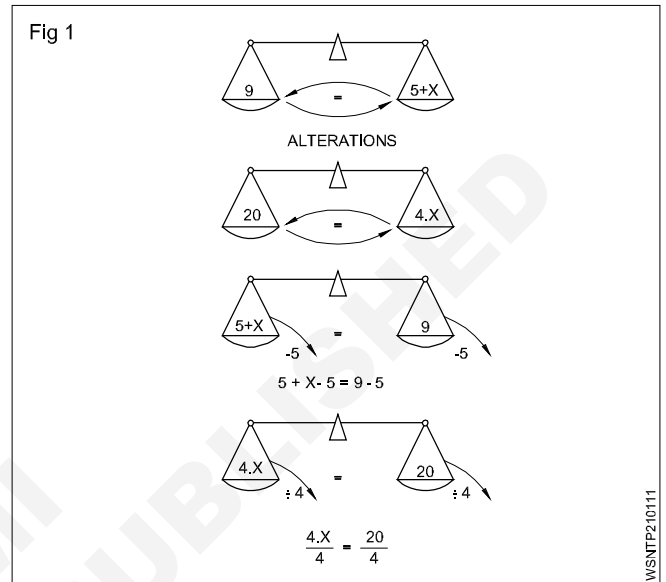
+ plus

- 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.

$$\left(1\frac{3}{4}\right)^2 = \left(\frac{7}{4}\right)^2$$

$$= \frac{7}{4} \times \frac{7}{4} = \frac{49}{16}$$

Indices

- The indices are added in multiplication
 $a^m \times a^n = a^{m+n}$.

- The indices are subtracted in division

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

- In case of index of an index, both the indices are multiplied mutually

$$[a^m]^n = a^{m \cdot n}$$

- A fractional index shows root of a number

$$a^{1/m} = \sqrt[m]{a}$$

- In case of an index having minus sign, the sign can be changed by taking the number from numerator to denominator or vice versa

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

$$\text{and } \frac{1}{a^{-m}} = a^m$$

- If an index contains both the numerator and denominator then it means that the number has 'index' as well as 'root'.

$$a^{m/n} = \sqrt[n]{a^m}$$

Basic problem

Addition

$$1 \quad 5x^2y + 3xy^2 + 8x^2y + 7xy^2$$

$$= 5x^2y + 8x^2y + 3xy^2 + 7xy^2$$

$$= 13x^2y + 10xy^2$$

$$2 \quad \text{Add } 5a^3, + 12b^3, - c^3, + a^3, - 4b^3, + 3$$

$$5a^3 + 12b^3 + (-c^3) + a^3 + (-4b^3) + 3$$

$$= 6a^3 + 8b^3 - c^3 + 3$$

Subtract

$$1 \quad \text{Subtract } 2x^2 - 3y^2 \text{ from } 3x^2 + 2y^2$$

$$3x^2 + 2y^2$$

$$2x^2 - 3y^2$$

$$x^2 + 5y^2$$

Multiplication

$$1 \quad -4x^2 \times 8x^5 = -4 \times 8x^{2+5}$$

$$\quad \quad \quad (-) \quad (+)$$

$$= -32x^7$$

$$2 \quad (3d^2 - 2d) 3d$$

$$= 9d^3 - 6d^2$$

$$3 \quad (5x + 3y) (5x - 3y)$$

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

$$= 5x \times 5x - 3y \times 3y$$

$$= 25x^2 - 9y^2$$

$$4 \quad 5x^2y \times 8x^5y^3$$

$$= 40x^7y^4$$

$$5 \quad (2a+b)(a+2b)$$

$$= 2a^2 + 4ab + ab + 2b^2$$

$$= 2a^2 + 2b^2 + 5ab$$

$$6 \quad 8a^3b^5c^{-5} \times 3a^2b^{-5}c^5$$

$$= 24a^5$$

Division

$$1 \quad \frac{12x^3y^2}{4x^2y} = 3xy$$

$$2 \quad \frac{15y^{15}}{15y^5} = y^{10}$$

$$3 \quad 9c^5d^3 \div c^2d^2$$

$$= 9c^3d$$

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

$$= \frac{60a^6}{60a^5} = a$$

$$5 \quad -25a^{15} \div -5a^8$$

$$= \frac{-25a^{15}}{-5a^8}$$

$$= 5a^{15-8} = 5a^7$$

$$6 \quad 4x^2y \div 2y$$

$$= \frac{4x^2y}{2y} = 2x^2$$

$$7 \quad 3x^2y^3 \div -6x^5y$$

$$= \frac{3x^2y^3}{-6x^5y} = -\frac{y^2}{2x^3}$$

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

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

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

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

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

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

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

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

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

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

$$\hline 4xy = 2$$

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

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

$$= 4 \times 4 = 16$$

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

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

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

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

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

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

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

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

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

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

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 - Check and repair PCB's single, double layer and important test for PCB

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.

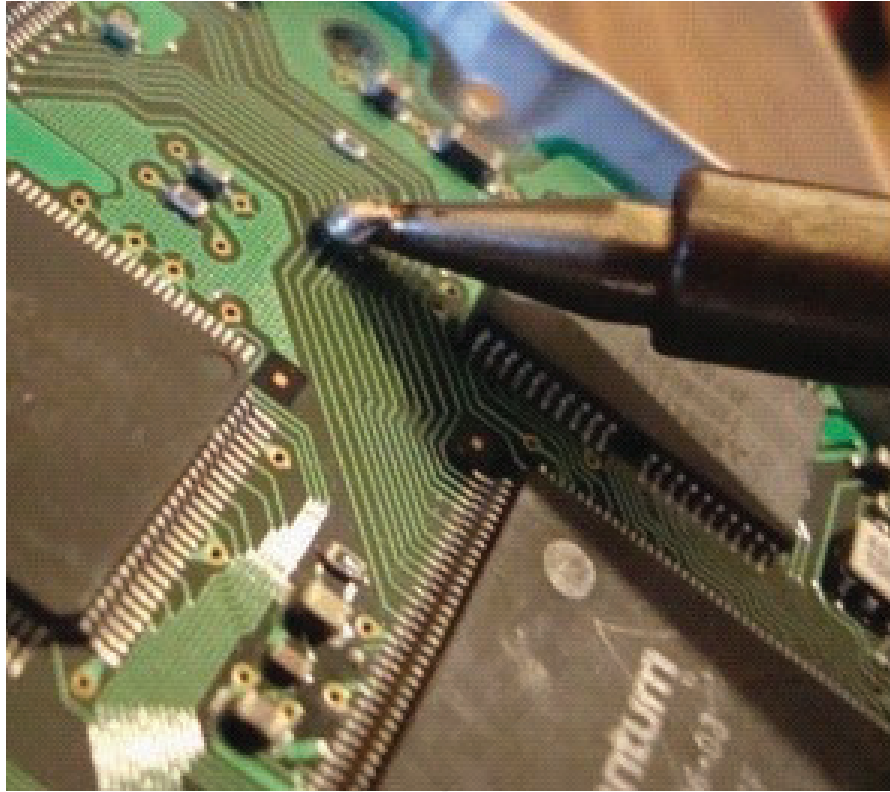
Cumulative Costing - this type of costing looks at the total cost for all phases of work, but it can be difficult to ensure that estimates are accurate.

Exercise: Check and repair PCB's single, double layer and important test for PCB (Fig 1)

Materials / Components

• Magnifer with lamp	- 1 No.	• Small C/G clamp	- 1 No.
• Rosin cored solder	- 1 No.	• Solder flux	- 1 No.
• IPA cleaning solution	- 1 No.	• Single/double layer PCB	- 1 No.

Fig 1



Cost of Materials

1	Magnifer with lamp	=	Rs. 800
2	Rosin cored solder	=	Rs. 300
3	IPA cleaning solution	=	Rs. 200
4	Small C/G clamp	=	Rs. 100
5	Solder flux	=	Rs. 100
6	Single/double layer PCB	=	Rs. 100
	Total cost	=	Rs.1,600

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

Assemble the desktop computer system (Fig 1)

Materials / Components

• Monitor 21"	- 1 No.	• Keyboard	- 1 No.
• Motherboard with processor	- 1 No.	• Mouse	- 1 No.
• Cabinet with SMPS	- 1 No.	• Blu-ray DVD drive	- 1 No.
• Harddisk - 2TB	- 1 No.	• RAM	- 1 No.

Fig 1



Cost of Materials

1	Monitor 21"	=	Rs. 6,500
2	Motherboard with processor	=	Rs. 30,000
3	Cabinet with SMPS	=	Rs. 5,500
4	Harddisk - 2TB	=	Rs. 6,000
5	Keyboard	=	Rs. 3,500
6	Mouse	=	Rs. 1,200
7	Blu-ray DVD drive	=	Rs. 1,400
8	RAM	=	Rs. 2,000
	Total cost	=	Rs. 56,100

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

Installation of SMPS in PC (Fig 1)

Tools/Instruments - Service persons owns

- Digital multimeter - 1 No.

Materials / Components

- SMPS - 1 No.

Fig 1



Cost of materials/components

1 SMPS = Rs.2,000

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

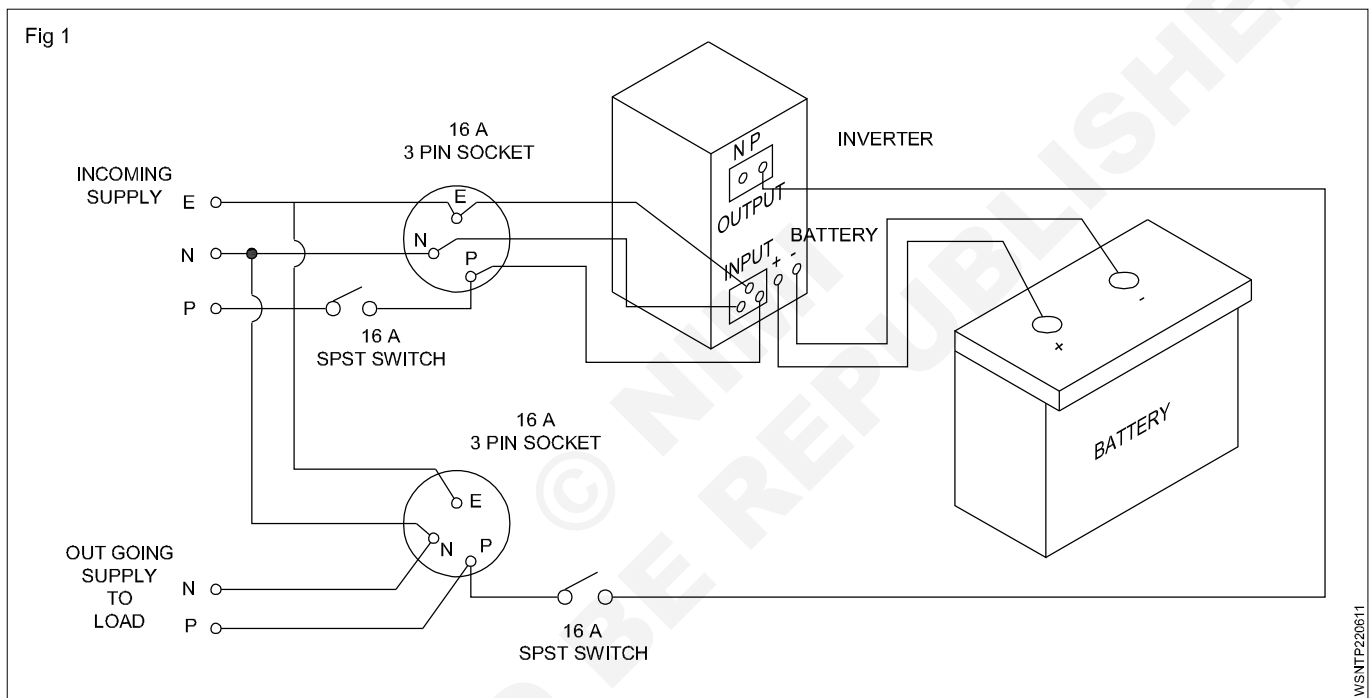
Installation of single phase inverter (Fig 1)

Tools/Instruments - Installation persons owns

- Tool kit -1 No.
- Digital multimeter -1 No.
- Line tester - 1 No.
- Double ended spanner - 1 No.
- Test lamp - 1 No.

Materials / Components

- Inverter - 1 No.
- Battery 12V, 150AH - 1 No.
- 240V / 16A SPST switch - 1 No.
- 240V / 16A 3 pin socket - 1 No.



Cost of materials/components

1 Inverter	=	Rs. 7,000
2 Battery 12V, 150AH	=	Rs. 14,000
3 240V / 16A SPST switch	=	Rs. 500
4 240V / 16A 3 pin socket	=	Rs. 50
Total cost	=	<u>Rs. 21,550</u>

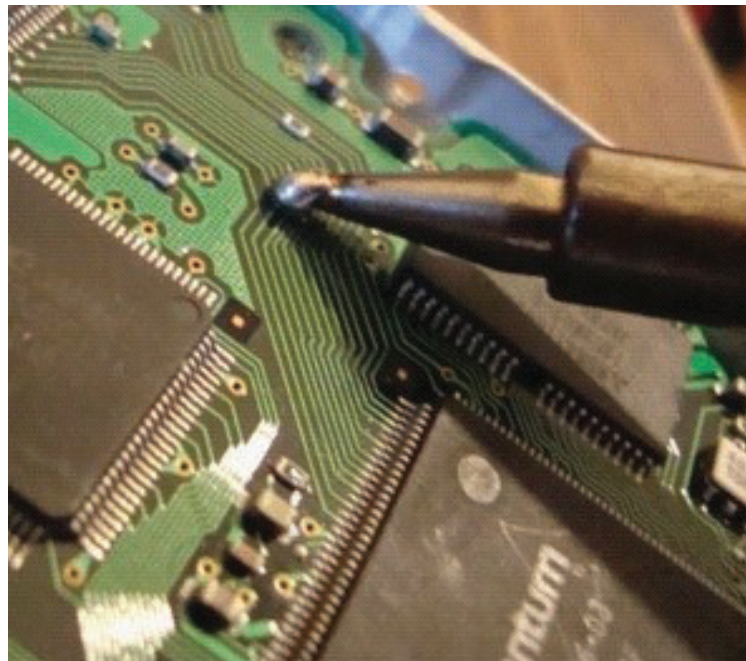
Estimation and Costing - Problems on estimation and costing - Check and repair PCB's single, double layer and important test for PCB

Check and repair PCB's single, double layer and important test for PCB (Fig 1)

Material / Components

- | | | | |
|-------------------------|---------|---------------------------|---------|
| • Magnifier with lamp | - 1 No. | • Small C/G clamp | - 1 No. |
| • Rosin cored solder | - 1 No. | • Solder flux | - 1 No. |
| • IPA cleaning solution | - 1 No | • Single/double layer PCB | - 1 No. |

Fig 1



- 1 Identify the single and double layer PCB.
- 2 Physically check the PCB for any damage.
- 3 Use magnifying glass and observe for check in any of tracks on the PCB.
- 4 Scrape both sides on the cracked track and clean the surface.
- 5 Use soldering iron and tin both the sides on the cracked track.
- 6 Select a small piece of a thin wire suitable to the width of the track.
- 7 Solder the tinned copper wire piece over the track completely covering the crack.
- 8 Check the continuity of the repaired track using ohm meter.

1	Checking and repair PCB and testing charge	= Rs. 500
2	Cost of Materials / Components	= Rs. 1,600
	Total cost	= Rs. 2,100

Estimation and Costing - Problems on estimation and costing - Assemble the desktop computer system

Assemble the desktop computer system (Fig 1)

Material / Components

• Monitor 21"	- 1 No.	• Keyboard	- 1 No.
• Motherboard with processor	- 1 No.	• Mouse	- 1 No.
• Cabinet with SMPS	- 1 No.	• Blueraay DVD drive	- 1 No.
• Harddisk - 2TB	- 1 No.	• RAM	- 1 No.

Fig 1



- 1 Place the SMPS at right position and screw it.
- 2 Place the properly the motherboard first and screw it before fixing SMPS.
- 3 Fix the processor and fan RAM, PCI cards which ever removed at proper places.
- 4 Fix the harddisk, DVD drive, floppy drive, other components that to be screwd with the cabinet.
- 5 Connect the connectors form motherboard to various devices like SATA, IDE, USB extensions etc.,
- 6 Plug the SMPS connections to motherboard CPU, PSU, devices, which are on power required connections.
- 7 Screw up the side cover to close the cabiner.
- 8 Connect the devices and external devices using connectors into motherboard.
- 9 Connect the power chord finally to the cabinet.

1 Charge for Assembling of computer	=	Rs. 2,000
2 Cost of Materials / Components	=	Rs. 56,100
Total cost	=	Rs. 58,100

Estimation and Costing - Problems on estimation and costing - Installation of SMPS in PC

Installation of SMPS in PC (Fig 1)

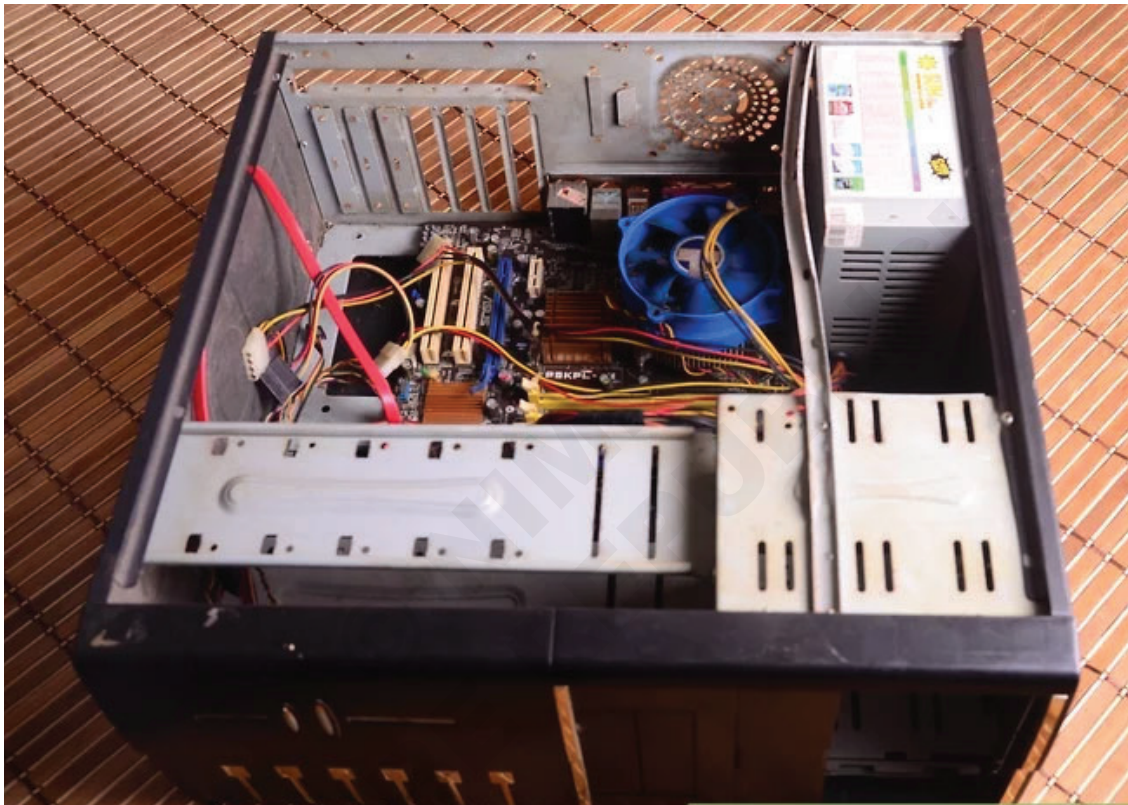
Tools/Instruments - Service persons owns

- Digital multimeter - 1 No.

Materials / Components

- SMPS - 1 No.

Fig 1



- 1 Place the SMPS in the PC cabinet and screw it.
- 2 Press firmly by holding the SMPS connectors to get proper contact with motherboard and peripherals.
- 3 Close the computer cabinet cover, by fixing door screws.
- 4 Connect the SMPS power cord to the mains and switch on the supply.
- 5 Switch on the PC, wait few minutes for booting and check the display on the monitor.

1 Charge for Installation of SMPS in computer	= Rs. 500
2 Cost of Materials	= Rs.2,000
Total cost	= Rs. 2,500

Estimation and Costing - Problems on estimation and costing - Installation of single phase inverter

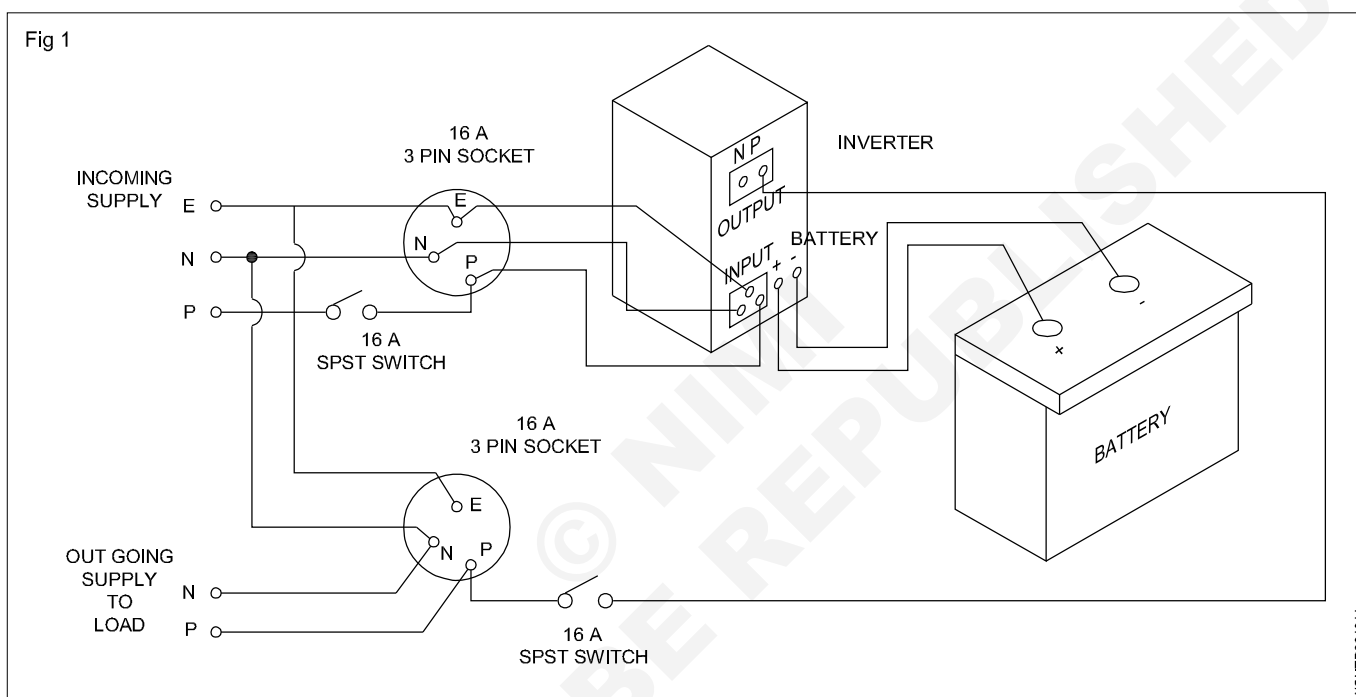
Installation of single phase inverter (Fig 1)

Tools/Instruments - Installation persons owns

- Tool kit - 1 No.
- Digital multimeter - 1 No.
- Line tester - 1 No.
- Double ended spanner - 1 No.
- Test lamp - 1 No.

Materials / Components

- Inverter - 1 No.
- Battery 12V, 150AH - 1 No.
- 240V / 16A SPST switch - 1 No.
- 240V / 16A 3 pin socket - 1 No.

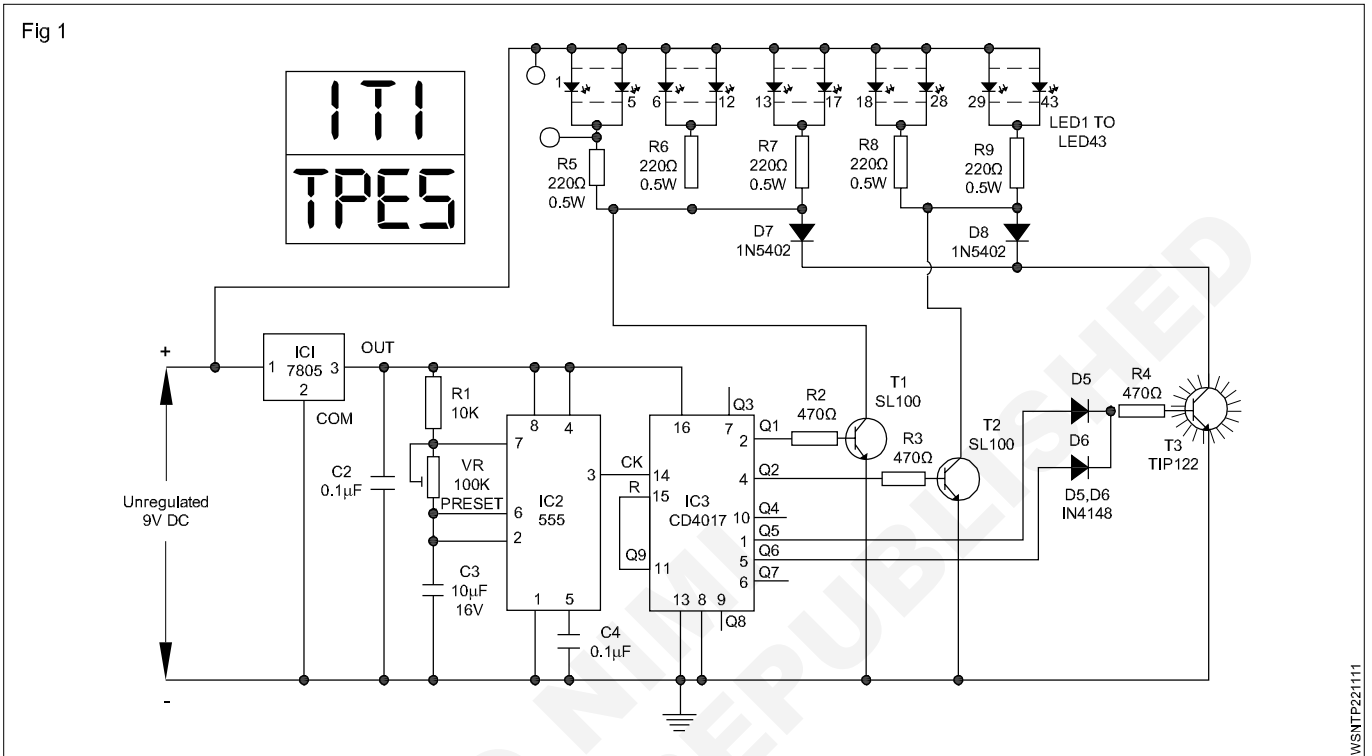


- 1 Read the user manual of the given inverter unit and check the capacity of battery.
- 2 Identify the colour code used for the battery cables and polarity marked on the terminals of the battery.
- 3 Select the red colour cable and terminals of the battery.
- 4 Double ended spanners, tighten the bolt & nuts with connect force.
- 5 Connect the AC main supply to the inverter unit through 16A switch & socket.
- 6 Connect the power cord of the inverter to the AC main supply.
- 7 Connect the test lamp across the output terminals, switch ON the UPS and observe the lamp is glowing.
- 8 Switch OFF AC mains and measure output battery voltage.

1 Installation of Single phase Inverter charge	= Rs. 1,000
2 Cost of Materials / Components	= Rs.21,550
Total cost	= <u>Rs.22,550</u>

Estimation and Costing - Problems on estimation and costing - Test the display a word on a two line LED

Test the display a word on a two line LED (Fig 1)

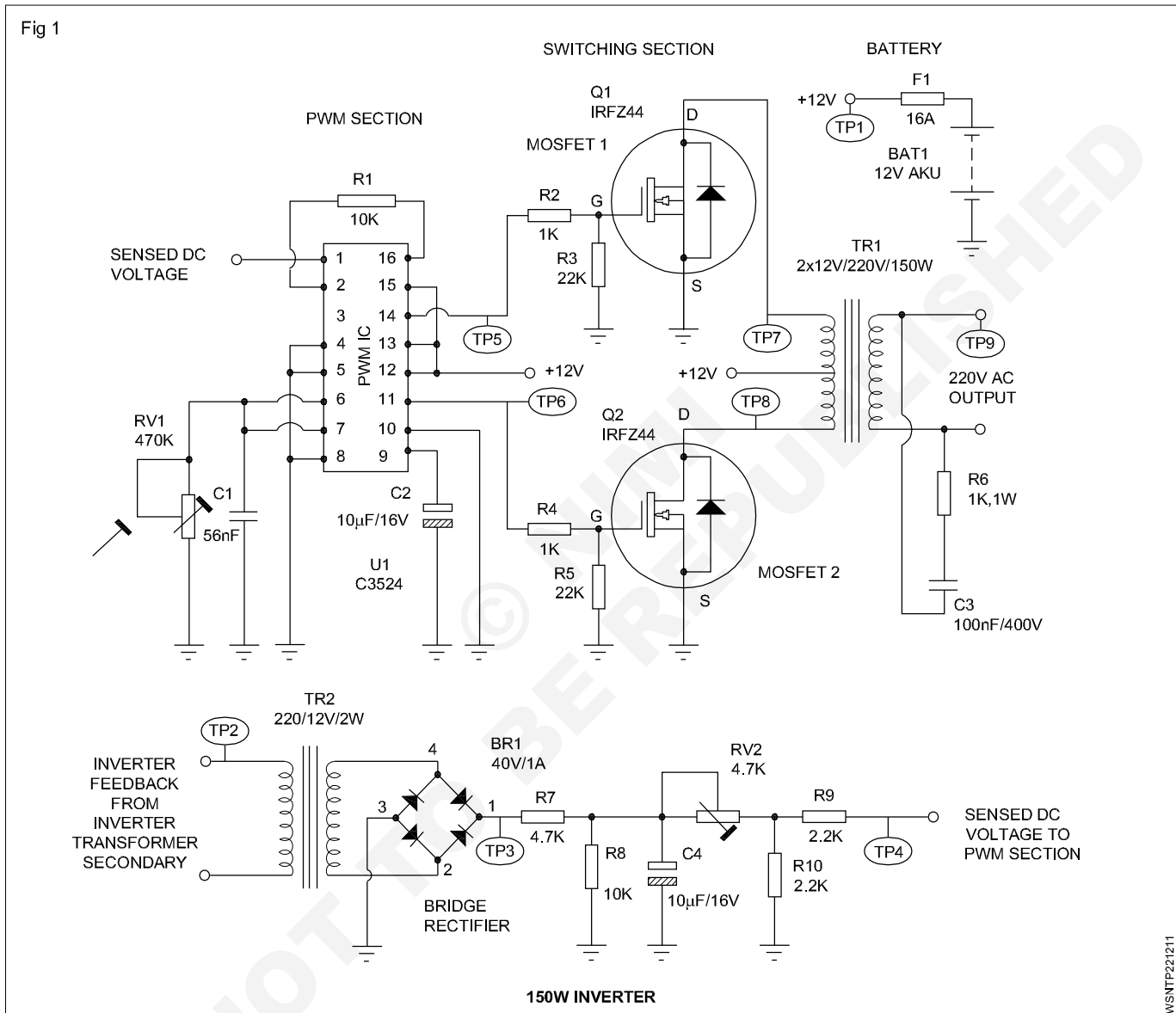


- 1 Check components of the circuit diagram as shown in figure.
- 2 Apply 230V, 50Hz, single phase AC supply to the primary of the transformer.
- 3 Switch on the 9V DC power supply and check the circuit operation.
- 4 Adjust the preset VR of a stable multivibrator to change the clock frequency of decade counter to vary the display time.
- 5 Replace the IC and transistor
- 6 Observe the display output for the time/sequence of LED letters.

1 Construction of two line LED circuit to display word	= Rs.1,000
2 Cost of IC and transistor	= Rs.3,200
Total cost	= Rs.4,200

Estimation and Costing - Problems on estimation and costing - Check the fault in the given inverter unit, rectify the defects and verify the output with load

Check the fault in the given inverter unit, rectify the defects and verify the output with load (Fig 1)



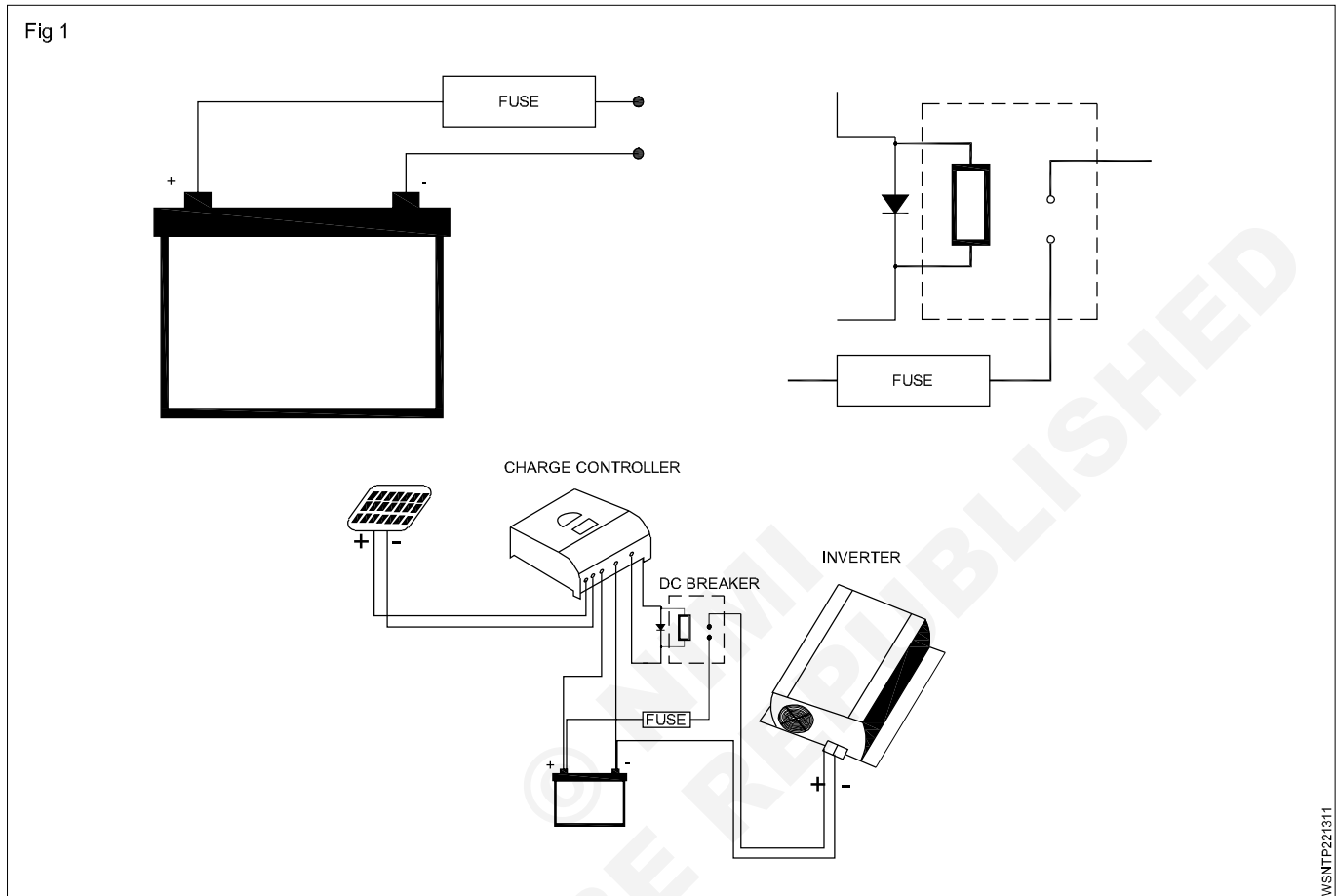
- 1 Open the inverter cover and carry out the visual inspection of the board.
- 2 Identify the damaged components and connectors.
- 3 Remove the damage components and check the condition.
- 4 Referring the circuit diagram and identify the sections.
- 5 Mark the different test points by using sketch pen.

- 6 Apply supply to the inverter unit and measure voltage at marked test points.
- 7 Observe the waveforms using CRO at switch device input/output.
- 8 Remove the suspected components from PCB and test it.
- 9 Replace the defective components.
- 10 Identify the faulty section/component in the inverter.
- 11 Connect a 240V, 100W lamp load at the output terminals.
- 12 Switch on the inverter, observe the lamp light.
- 13 Measure the output AC voltage and confirm that it remains constant.

1	Charge for check and rectification	=	Rs. 1,000
2	Cost of components	=	Rs. 500
	Total cost	=	Rs. 1,500

Estimation and Costing - Problems on estimation and costing - Connect storage batteries to a power inverter

Connect storage batteries to a power inverter (Fig 1)

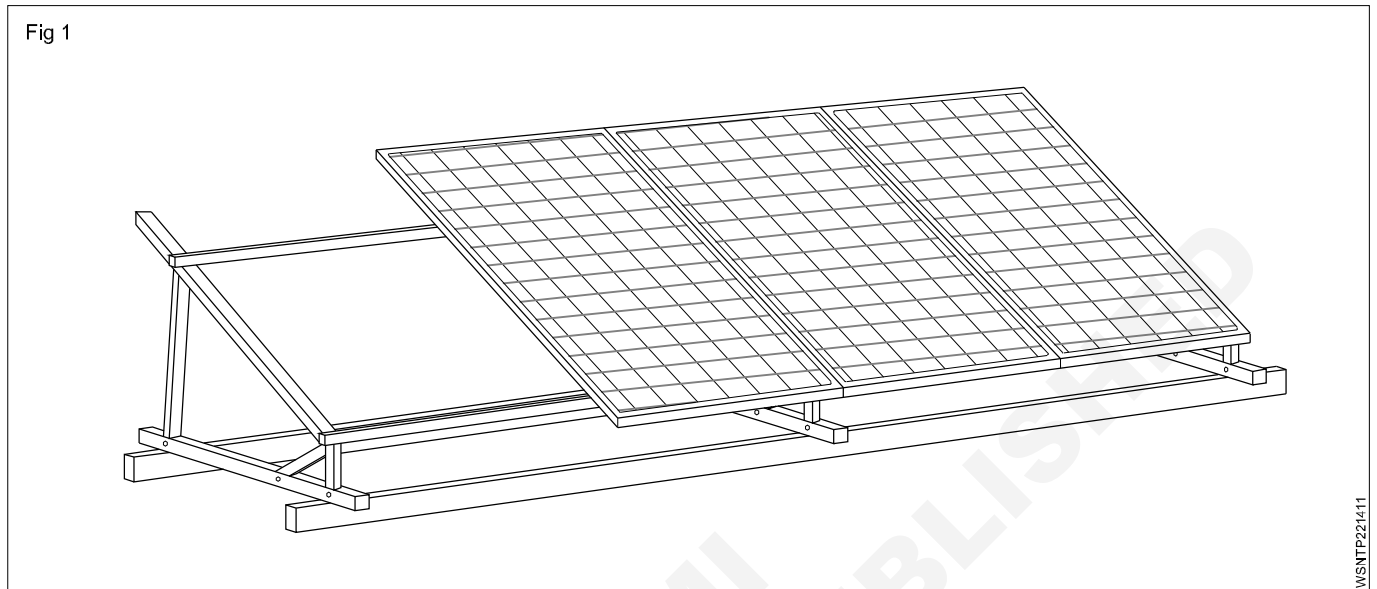


- 1 Connect the battery +ve terminal to fuse holder.
- 2 Connect the fuse holder to DC circuit breaker one end.
- 3 Remove wiring cover in the inverter.
- 4 Check the nominal voltage of batteries.
- 5 Use two battery cables, remove insulating sleeve 12mm and fix it on both cables.
- 6 Connect the terminal marked battery negative (-) on the solar inverter to the negative (-) battery terminal and tighten the screw.
- 7 Connect the DC breaker one end to solar inverter (+) terminal and tighten the screw.
- 8 Make sure the wires are securely connected.

1 Connection of storage battery and charge controller to inverter	= Rs. 1,500
2 Cost of Materials	= Rs. 2,500
Total cost	= Rs. 4,000

Estimation and Costing - Problems on estimation and costing - Installation of a solar panel to a roof

Installation of a solar panel to a roof (Fig 1)



- 1 Select the roof without shading for the solar panel installation.
- 2 Leave a safe working area between the edge of the roof and the external edge of the solar array for installation.
- 3 Make sure the direction of installation of the solar panel takes sun into consideration.
- 4 Pick an area of you roof to install the solar panel that gets the sun light rays as long as possible each day.
- 5 The solar panels can either be mounted flush on the roof or stand, or mounted at an angle to maximise the position of accessibility to the Sun's direct rays.
- 6 Use contact pipe with M8 x 25 contact base pipe.
- 7 Use M8 x 25 contact suport pipe.
- 8 Rail AC with M8 x 25 fixed on contact pipe.
- 9 Take 2 fixed tile rack and position them with rail.
- 10 Slide the splice on the rear side of the Pre-assembled rails. Fasten the first solt. Then slide the next rail into the splice.
- 11 Put on panel on the rack, use 2 end clamps to hold.
- 12 Install the method for mid clamp and end clamp.
- 13 Follow and use mid clamp fixed between panels.

1	Charge of Installation of Solar Panel	= Rs. 3,000
2	Cost of Materials	= Rs. 8,000
	Total cost	= Rs.11,000