WORKSHOP CALCULATION & SCIENCE

(NSQF)

2nd YEAR

(As per Revised Syllabus July 2022)

Mechanic Consumer Electronic Appliances

Directorate General of Training

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

Nimi

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

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

Workshop Calculation & Science

Mechanic Consumer Electronic Appliances - 2ⁿᵈ Year NSQF

As per Revised Syllabus July 2022

Developed & Published by

First Edition **:** November 2023   Copies: 1000

Rs: 65/-

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 - Mechanic Consumer Electronic Appliances 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.

Novembers 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 -** Mechanic Consumer Electronic Appliances 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 -** Mechanic Consumer Electronic Appliances 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

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 replacment 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 relevent 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 - Mechanic Consumer Electronic Appliances** 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 - 2.2.10	8
		Total	**16 Hrs**

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

SYLLABUS

Workshop Calculation & Science - Mechanic Consumer Electronic Appliances

Revised syllabus July 2022 under CTS

S.no.	Syllabus	Time in Hrs
I	**Algebra**	8
	1 Addition, Subtraction, Multiplication & Divisions	
	2 Algebra – Theory of indices, Algebraic formula, related problems	
II	**Estimation and Costing**	8
	1 Simple estimation of the requirement of material etc., as applicable to the trade	
	2 Problems on estimation and costing	
	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 x 8 – 6 + 4 x 12 = 96 – 6 + 48 = 138

  102 ÷ 6 – 6 x 2 + 3 = 17 – 12 + 3 = 8

Parentheses and grouping symbols

  (   ) Brackets

  {   } Braces

  7 + (6–2) = 7 + 4 = 11

  6 x (8–5) = 6 x 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 x 3 = 26

  (6+2) (9–5) = 8 x 4 = 32

Plus 4 less negative 7 is written as 4 – (–7).

Plus 4 times negative 7 is written as 4(–7).

$$4 - (-7) = 4 + 7 = 11$$
$$8 - (7-4) = 8 - 3 = 5$$
$$3 + (-8) = 3 - 8 = -5$$
$$7 + (4 - 19) = 7 + (-15) = 7 - 15 = -8$$
$$3 \{40 + (7 + 5)(8-2)\}$$
$$= 3 \{40 + 12 \times 6\}$$
$$= 3 \times 112 = 336.$$

$8x + 12$ - 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 $5x$y, 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^{2}b, xz, 3bc

c   13m^{2}n, 3mn^2, 14lm^2, 15a^{2}b, 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.

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

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

   -4xy

   $_{(-)}$+3xy
   _____

   -7xy
   _____

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 x 3x = 2 x 6, 6x = 12

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

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)

Fig 1
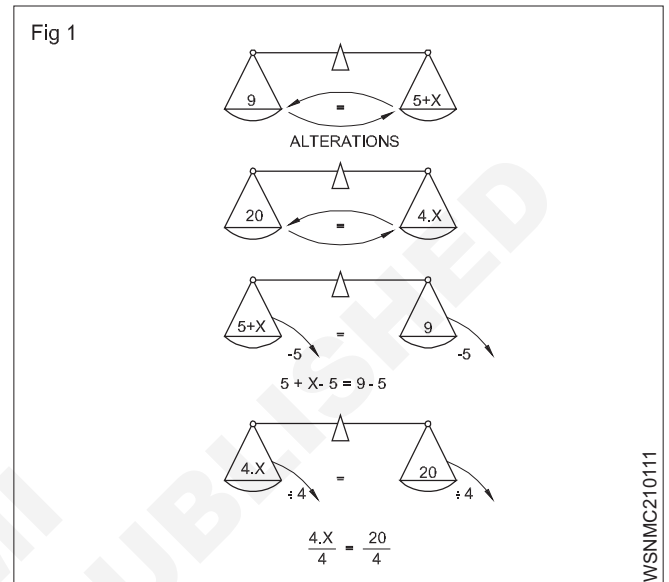
An equation can be compared to a pair of scales which always remain in equilibrium. The two sides of the equation can fully be transposed. $9 = 5 + x$ may also be written as $5 + x = 9$.

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 −.

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

$x = 80$,

$5x = 25$.

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

$x = 5$.

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

Example

- Solve for x if $4x = 3(35 - x)$

  $4x = 105 - 3x$ (brackets removed)

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

  $7x = 105$

  $x = 15$ (dividing both sides by 7)

Assignment

Add

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

2   $3x$y + $5x$y - $2x$y + $8x$y - $4x$y

3   $17x$y - $4x$y + 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   $38x$y - $25x$y

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   5yz$x$ x (-5ab)

2   3ax -9b

3   2ab x -7pq

Division

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

2   -3ax ÷ -6x

3   $15x$y ÷ -5

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

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

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

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.

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

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.

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

$(2^2)^3 = 2^{2.3} = 2^6$

Powers can be transposed without affecting the result.

$$\left(a^n\right)^m = \left(a^m\right)^n$$

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

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

$4 \times 4 \times 4 = 64$

$8 \times 8 = 64$

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

5

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

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

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

  $[a^m]^n = a^{m.n}$

- 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

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

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

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

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

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

   $3x^2 + 2y^2$

   $2x^2 - 3y^2$

   _____

   $x^2 + 5y^2$

   _____

Multiplication

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

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

   $\qquad\qquad\qquad = -32x^7$

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

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

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

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

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

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

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

   $= 40x^7y^4$

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

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

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

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

   $= 24a^5$

Division

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

2 $\dfrac{15y^{15}}{15y^5} = y^{10}$

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

   $= 9c^3d$

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

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

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

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

   $= 5a^{15}a^8 = 5a^{23}$

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

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

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

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

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

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

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

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

$= 5b^2$

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 $x + y = 9$

$x - y = 1$

$2x = 10$

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

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 $x^4 + y^4$**

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

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

$x^2 + y^2 = 169$

$(x^2 + y^2)^2 = (169)^2$ (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 $8\,xy\,(x^2 + y^2)$

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

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

Solve the equations

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

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

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

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

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

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

(-)   (-)   (+)   (-)

$4xy = 2$

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

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

$= 4 \times 4 = 16$

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

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

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

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

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

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

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

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

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

$\left(x - \dfrac{1}{x}\right)^3 = x^3 - \dfrac{1}{x^3} - 3\,(x)\left(\dfrac{1}{x}\right).\left(x - \dfrac{1}{x}\right)$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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 $\dfrac{8a^4}{12a^{-7}}$

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

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

Estimation and Costing - Simple estimation of the requirement of material etc., as applicable to the trade - Rectify the faults in the microwave oven

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: Rectify the faults in the microwave oven (Fig 1)

Tools/Instruments - Service persons owns

- Tool kit   - 1 Set
- Screwdriver with insulated handle   - 1 No
- Pliers with insulated handles   - 1 No

- Heavy duty insulated working gloves   - 1 No

Requirement

- User manual

Fig 1
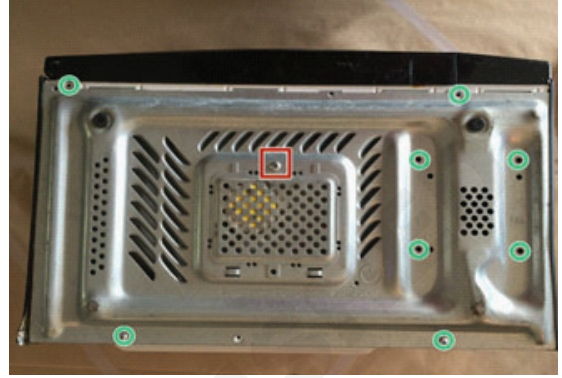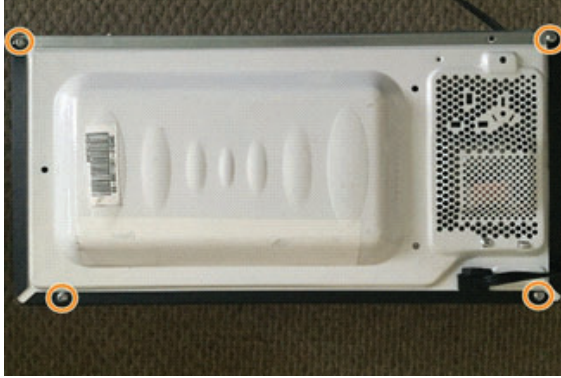
1   Check that the microwave is unplugged.

2   Remove the glass plate.

3   Remove all the screws on the outer casing.

4   The LEFT side of the oven has a single black screw that needs to be removed.

5   On the RIGHT side there are two identical black screws; remove these as well.

6   On the back side of the oven's screw on each corner; remove all four.

7   Remove the four on the top and bottom of the casing, and four more on the right side which are holding the transformer to the inside of the case.

8   Leave the last screw, which is located in the raised rectangle in the middle of the bottom panel.

9   Lift the vented metal plate from the back side at an angle until the clips on the front side by the oven door are no longer holding the plate.

10   Set bottom plate aside and the oven's contents are accessible.

11   Unplug the two power wires for the motor with a yellow sticker on it.

12   Disconnect single screw on motor, pull motor off while microwave mounting, and set aside.

13   Bend the right side of sheet metal around side tabs on front. To do so, apply medium force until the sheet metal is out of its bracket grooves.

14   Carefully bend the sheet metal down flat onto the work surface to allow complete access to internal electronics.

15   The high-voltage capacitor is located on the upper left corner of the side view.

16   Move the loose plastic harness, which is holding the red wires in place, out of the way.

17   Disconnect the two plugs with red wires from the capacitor.

18   Remove the screw for the metal bracket holding the capacitor in place, and remove the bracket.

19   Disconnect the three plugs in the front of the fan.

20   Disconnect the two power plugs on the circuit board on the bottom of the fan system.

21   Remove the two screws securing the ground wires, and put the fan system aside

22   The transformer is labeled "Danger High Voltage" in red letters, and will be already disconnected from the oven's bottom grate which was removed in steps 4 and 5.

23   Two red wire connectors go to the magnetron, which is directly below the transformer. Unplug these and set the transformer aside

24   The magnetron is the heart of the microwave oven, since it ultimately converts voltage to microwaves.

25   Disconnect the red wire connector protruding from the bottom of the magnetron.

26   Remove 4 screws holding the magnetron to the food compartment. Set the magnetron aside.

27   The PCB for the keyboard and the LED display has two screws hidden between on-board components. The board also has several connectors that cannot be removed reliably without the functionality of the oven, so it is recommended to leave the board connected unless it must be replaced.

Cost of Relay	=	Rs. 700
Cost of Front panel	=	Rs. 500
Total cost	**=**	**Rs.1200**

Estimation and Costing - Simple estimation of the requirement of material etc., as applicable to the trade - Faults and rectification in DMP
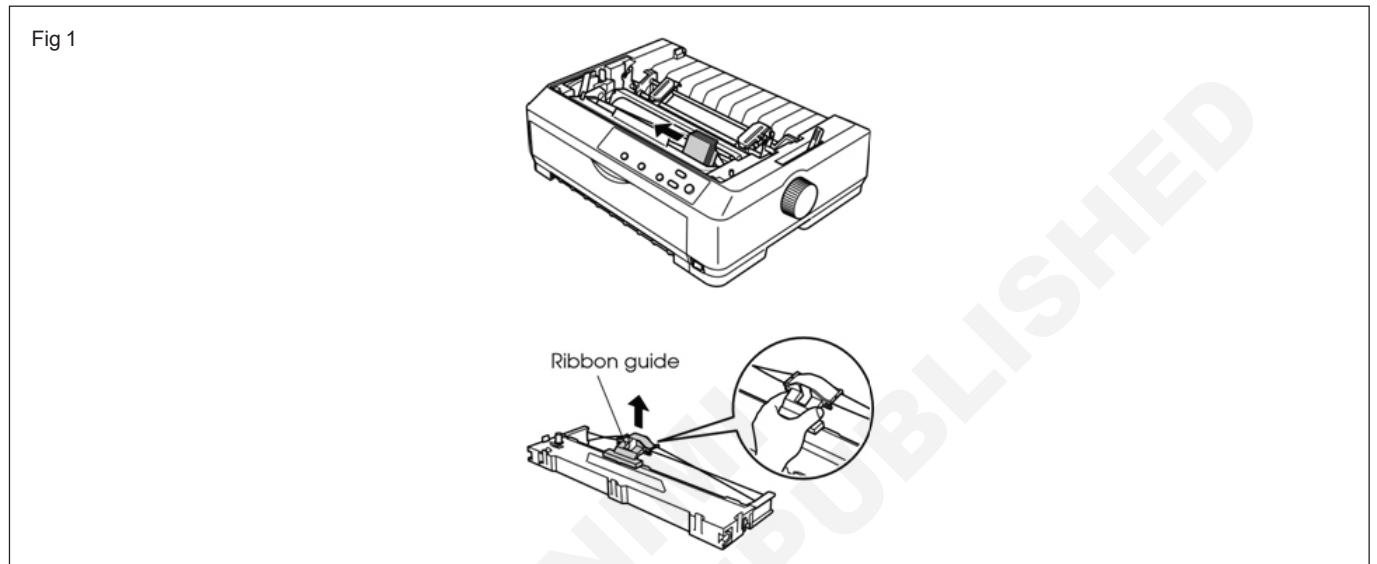
Faults and rectification in DMP (Fig 1)

Tools/Instruments - Service persons owns

• Tool kit	- 1 Set
• DMP	- 1 No.
• Digital multimeter	- 1 No.

Requirements

• User manual

• A4 size paper

Fig 1

1   Unplug the main power cable

2   Pick one of the labelled DMP from the given lot and identify the model number and company.

3   Repeat the steps 1 of 2 for remaining labelled DMP

4   Make sure the printer is turned off and unplugged. Then open the printer cover and pull it up to remove it.

5   Remove the paper tension unit by pressing the tabs on each side and pulling it up.

6   Use your hand to slide the print head to the middle of the printer.

7   Remove the new ribbon cartridge from the package.

8   Hold the ribbon cartridge by its handle and insert it into the printer at an angle, then press down on both sides of the cartridge to fit the plastic hooks into the printer slots. You should hear it click into place.

9   Slide the ribbon guide into the print head until it clicks in place. Be careful not to twist or crease the ribbon.

10   Turn the ribbon-tightening knob to help feed the ribbon into place.

11   Reinstall the paper tension unit by lowering it onto the printer's mounting pegs. Then press down on both ends until it clicks into place.

12   To replace the printer cover, insert the front tabs into the slots on the printer and lower the cover into place. Then push it down until it clicks.

13   Make sure the top part of the cover is folded forward. Then attach the paper guide.

1	Cost of printer head	= Rs.500
2	Cost of Ribbon guide	= Rs.100
	Total cost	**= Rs.600**

Estimation and Costing - Simple estimation of the requirement of material etc., as applicable to the trade - Install CCTV cameras to DVR, record and replay

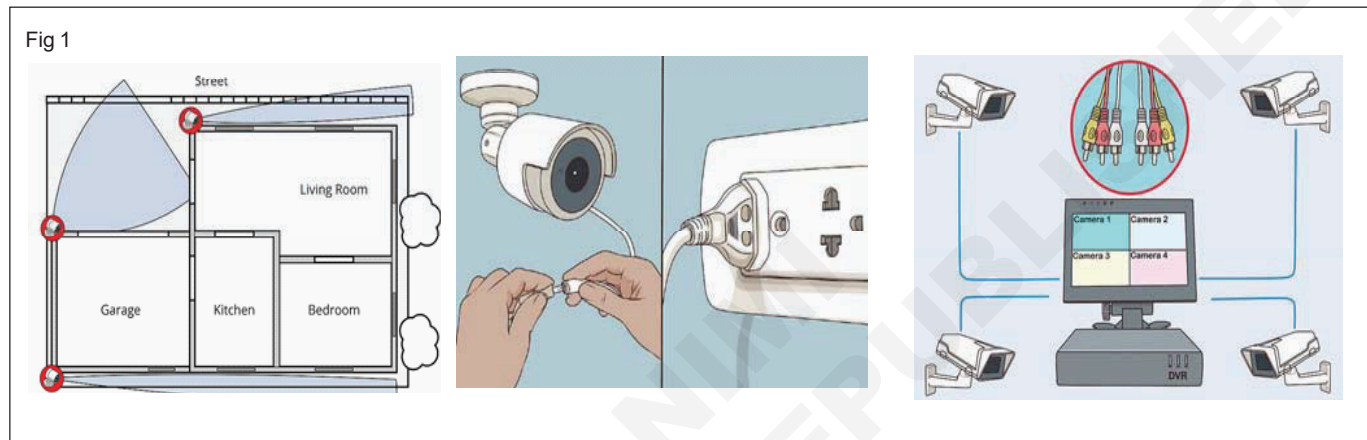### Install CCTV cameras to DVR, record and replay (Fig 1)

Tools/Instruments - Service persons owns

• Tool kit	- 1 Set	• Plier	- 1 No
• Digital multimeter	- 1 No	• Drill machine	- 1 No
• CCTV	- 1 No	**Requirements**	
• Monitor	- 1 No	• User manual	
• DVR	- 1 No	• RJ45 cable/connector	
• Striper	- 1 No	• Co-axial cable / connectors	

Fig 1

Connection of CCTV camera to DVR

1. Make a diagram of your surveillance needs
2. Take the right package of CCTV.
3. Take the cameras individually.
4. Mount your camera to the wall.
5. Attach your camera to a power source
6. Attach a wired camera to your DVR
7. Link wireless cameras to your computer.
8. Attach the monitor to the DVR
9. Attach each video cable to a separate DVR port.
10. Set up a recording device and monitor
11. Test your equipment before installing

1	Cost of CCTV camera - 3 Nos.	= Rs. 7500
2	Cost of Hard disk - 1 TB	= Rs. 2500
3	Cost of DVR	= Rs. 3000
4	Cost of CCTV Cable	= Rs. 1000
5	Cost of Monitor	= Rs. 5000
	Total cost	= **Rs.19000**

Estimation and Costing - Simple estimation of the requirement of material etc., as applicable to the trade - Interconnect printer to computer & perform printer test & cleaning of an ink cartridge

Interconnect printer to computer & perform printer test & cleaning of an ink cartridge (Fig 1)
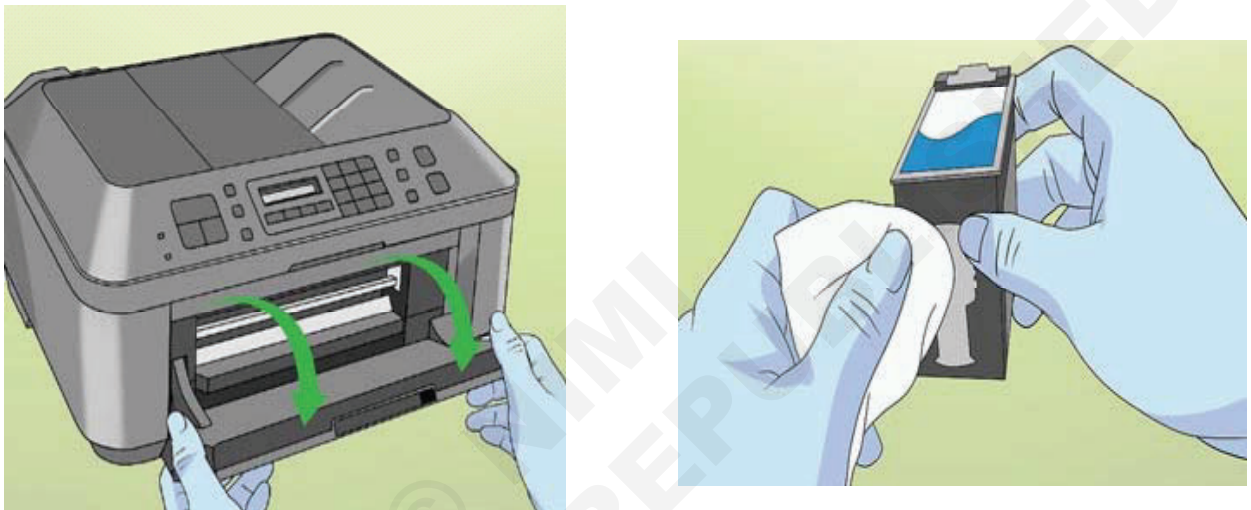
Tools/Instruments - Service persons owns

- Digital multimeter   -1 No
- Inkjet printer   -1 No

Requirement

- User manual

Fig 1

Interconnect printer to computer and testing

1 Install test chart (test chart name:*********) to PC

2 Open test chart and select "File" menu.

3 Select "Print".

4 Select "Fax" from "Printer Name".

5 Input "Receiver Name" and "Fax Number", and click "Next" button.

6 Click "Next" button.

7 Check and click "Next" button.

8 Click "Finish" button to send fax data from PC to "R" unit

9 Confirm if telephone rings correctly during calling tone of "R" unit rings.

10 Confirm if dial tone of telephone is lost during "R" unit receives fax data without calling tone.

Cleaning of an ink cartridge.

1   Put on a pair of latex gloves before you touch the printer.

2   Unplug the printer before opening it

3   Open up your printer to take the cartridges out.

4   Remove the cartridges gently one-by-one.

5   Wipe the outside of the cartridges with a paper towel.

6   Clean the print head with a wet cotton swab

7   Scrub the colored circuitry strip with a different wet cotton swab.

8   Get rid of excess water on the ink cartridges and let them dry.

9   Snap the cartridges back into their holders

10   Close the printer and plug it back in

11   Test out your printer by printing a document.

1	Printer test & cleaning charge	=	Rs. 800
2	Ink cartridge - 3 colours	=	Rs.2250
	Total cost	**=**	**Rs.3050**

Estimation and Costing - Problems on estimation and costing - Rectify and service the washing machine

Rectify and service the washing machine (Fig 1)

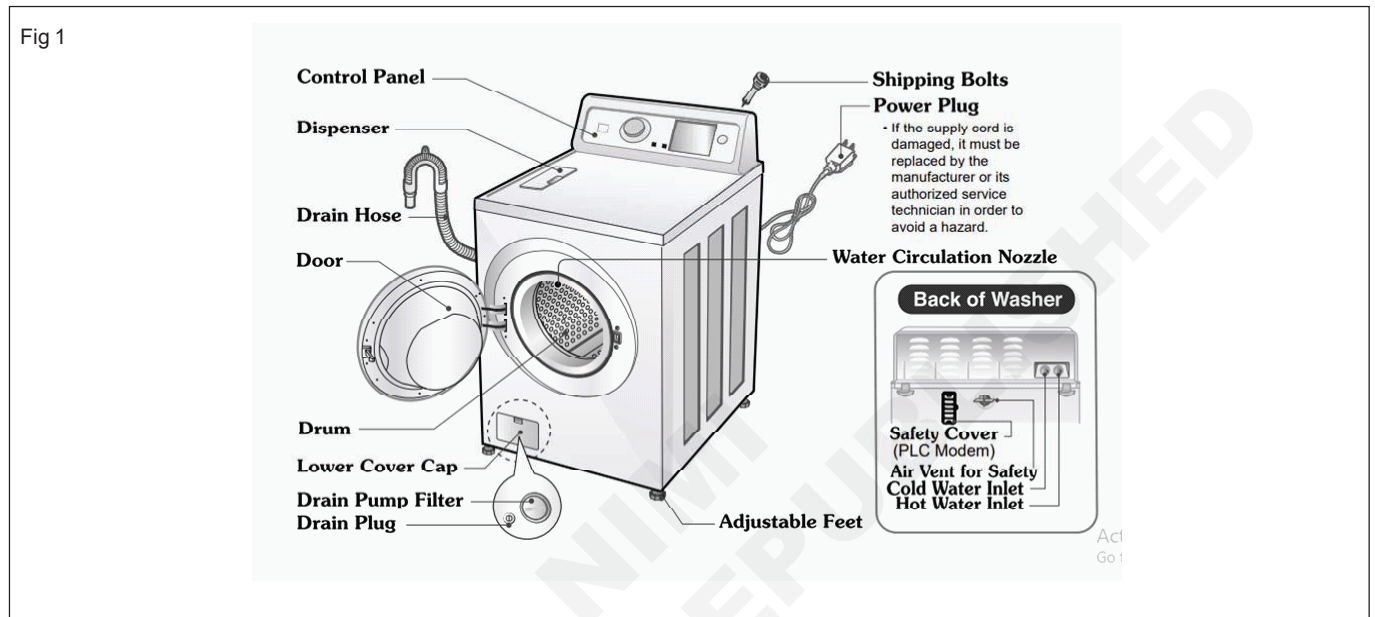**Tools/Instruments - Service persons owns**

- Tool kit   - 1 Set
- Screwdriver with insulated handle   - 1 No
- Pliers with insulated handles   - 1 No

- Heavy duty insulated working gloves   - 1 No

Requirement

- User manual

Fig 1

1   Be sure to unplug the washer and disconnect the water hoses.
2   Look at the back of the washer for the screws that you will need to remove.
3   Remove the screws that connect the assembly to the washer.
4   Remove the end caps of the control panel.
5   Remove the two screws that you will see.
6   Carefully, lift the control panel away from the body of the washer.
7   Lay the panel carefully back.
8   Take this opportunity to clean the area.
9   Remove the spring clip if you need to get in further for your repair.
10   Make your repairs.
11   Unscrew the front panel.
12   Handle a machine without a removable front panel
13   Remove the outer retaining band.
14   Fold the door seal into the washing machine.
15   Remove the retaining spring or band.
16   Note the position of the drain holes.
17   Pull off the seal.

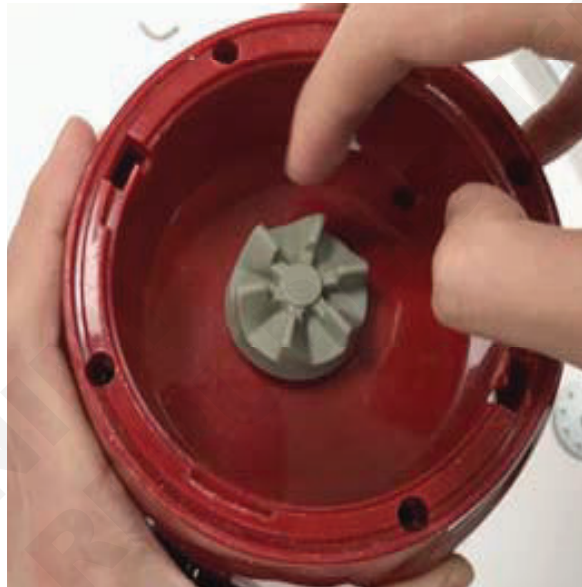|			
1	Cost of circuit control panel	=	Rs.5000
2	Cost of Door seal	=	Rs.1000
3	Service charge	=	Rs. 800
	Total cost	**=**	**Rs.6800**

Estimation and Costing - Problems on estimation and costing - Faults rectification of mixer/grinder

Faults rectification of Mixer/Grinder (Fig 1)

Tools/Instruments - Service persons owns

• Tool kit	- 1 Set
• Screwdriver with insulated handle	- 1 No
• Pliers with insulated handles	- 1 No
• Heavy duty insulated working gloves	- 1 No

• Digital multimeter   - 1 No

Requirement

• User manual

Fig 1

1   Take off lid by twisting anti-clockwise.

2   Remove the glass jar from the blender base by again twisting anti-clockwise.

3   The blender blade is attached to a base component at the bottom of the blender jar.

4   To remove the blade, simply twist the attachment according to the direction written, in this case, turning anti-clockwise.

5   The blade could be easily taken out from the jar, if difficulties occur at this stage, simply adjust the blade's angle when removing.

6   Remove four screws from the base of the blender.

7   Take out the ventilation opening from the base. Keep screws aside.

8   The clutch is attached to the bottom of the blender. This can be twisted out directly with hand.

9   The disk attached inside the clutch can be pulled out after the clutch is removed from the blender bottom.

10   This little component is used to stabilize wires. It can be taken out after cutting the wires.

11   Lift out the major electronic part of the blender

12   Cut off two pieces of wires, then take out the mini light bulb.

13   This is how the blender base should look like at the moment.

14   Unscrew the two screws from both sides of the clasp to detach all component, this includes the motor of the blender.

15   Insert wisdom.

16   To take out the back of the blender speed dial, unscrew two screws that are located opposite each other.

17   After taking out the back of the speed dial, the dial will fall out itself.

18   There are three individual pieces that make up the speed dial: the ring, the metal and plastic casting.

19   The final disassembly, with all the blender parts and screws, will look like this.

MIxer

1	Cost of Shaft replace	=	Rs. 80
2	Cost of Blade	=	Rs.100
3	Service charge	=	Rs.100
	Total cost	**=**	**Rs.280**

Grinder

1	Cost of Belt replace	=	Rs.150
2	Cost of Bearing	=	Rs.300
3	Service charge	=	Rs.200
	Total cost	**=**	**Rs.650**

Estimation and Costing - Problems on estimation and costing - Vacuum cleaners service and defective parts replacement

Vacuum cleaners service and defective parts replacement (Fig 1)

Tools/Instruments - Service persons owns

• Tool kit	- 1 Set	• Heavy duty insulated working gloves	- 1 No
• Screwdriver with insulated handle	- 1 No	**Requirement**	
• Pliers with insulated handles	- 1 No	• User manual	

Fig 1
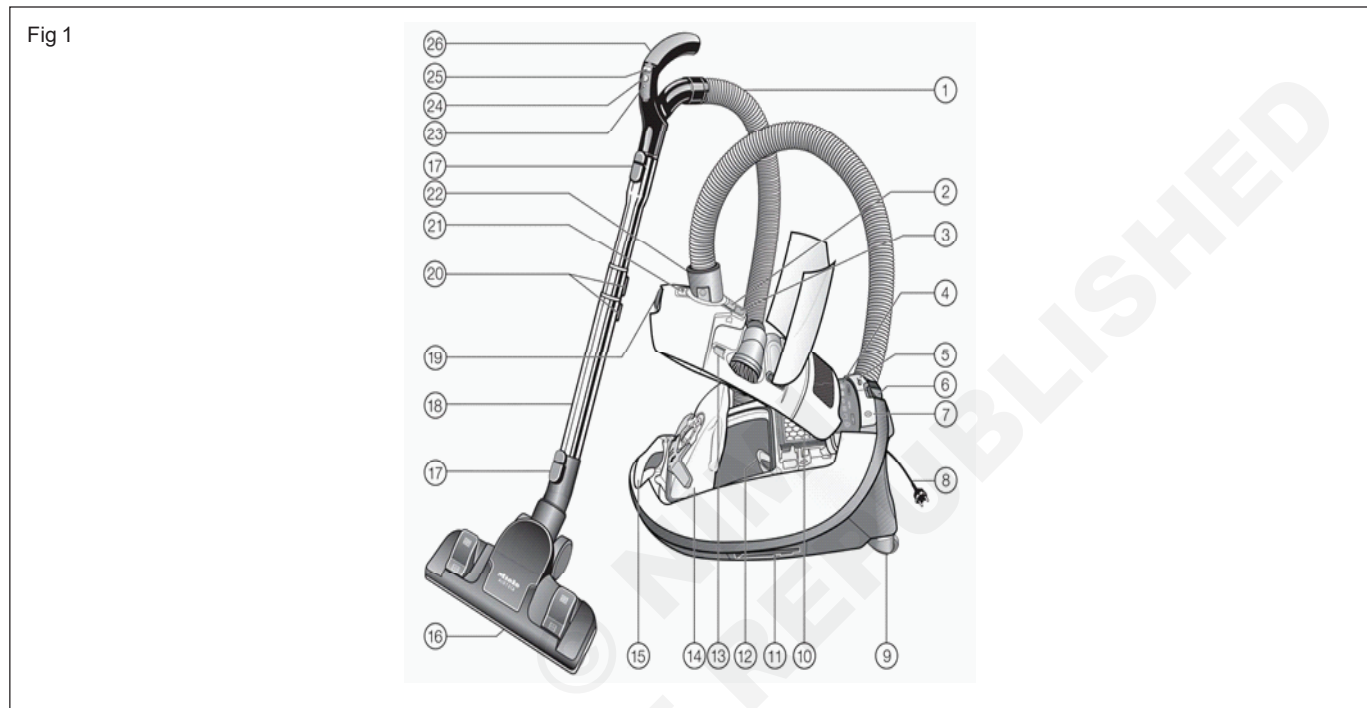
1   Detach the BUTTON with a flat head screw driver.

2   Loosen the three screws and detach PANEL-CONTROL.

3   Loosen the one screw and detach the INDICATOR assembly.

4   Loosen the four screws and grasp both sides of the body control.

5   Lift it upwards

6   Separate the wire assembly from the PCB board assembly.

7   Loosen the two screws and separate cover motor from the body.

8   Separate motor and wire harness motor.

9   Disassemble the guard cord with a flat head driver. (Insert it into the gap and push the hook to the opposite side.)

10   Separate the cord reel from the main body.

11   Hold the cover reel, and wind the power cord to the left 4~5 times.

12   After winding, assemble the cord reel to the body.

|				
1	Cost of ON/OFF power cord		=	Rs. 100
2	Cost of Display panel		=	Rs. 500
3	Cost of Swivel casters		=	Rs. 600
4	Cost of Lock release button		=	Rs. 50
5	Service charge		=	Rs. 400
	Total cost		**=**	**Rs.1650**

Estimation and Costing - Problems on estimation and costing - Faults and rectification of induction cook-top

Faults and rectification of Induction Cook-Top (Fig 1)

Tools/Instruments - Service persons owns

- Tool kit — 1 Set
- Screwdriver with insulated handle — 1 No
- Pliers with insulated handles — 1 No
- Heavy duty insulated working gloves — 1 No

- Digital multimeter — 1 No
- Hex wrench — 1 No

Requirement

- User manual

Fig 1
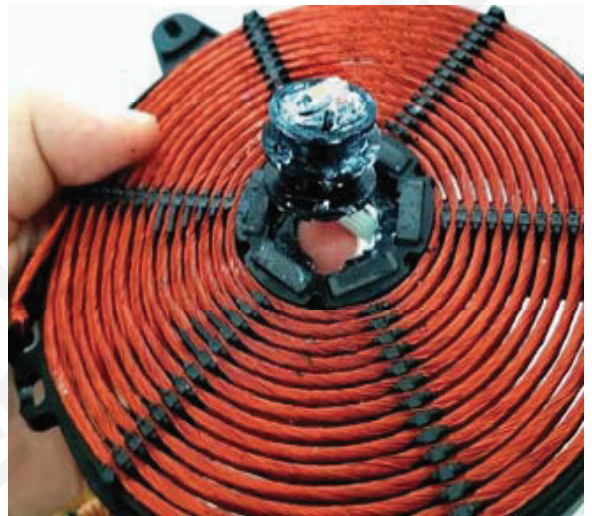
1   Unplug the main power cable

2   Use a Phillips head screwdriver to undo the 6 screws found on the fringe of the back face.

3   Carefully flip the cooker so that the ceramic panel faces the top, then lift the panel to remove it from the case.

4   Once open, you can locate the User Interface PCB (Printed Circuit Board).

5   To remove the user PCB, use the screwdriver to remove the base. Unclip the white wires that attach to the Main PCB before lifting the board out.

6   Next locate the copper induction coil, which uses alternating current to create a magnetic field. Thus, creating heat by inducing a current.

7   Then gently pop all the chords out of the fasteners on the PCB. Once both the Induction coil and the Main PCB have been unscrewed, remove both.

8   The aluminum heat sink, as we identified in previous exercise is a passive cooling device meaning it involves no electronics. The ribs provide surface area to allow air flow from the fan to help cool the inner components

9   To remove, flip the Main PCB upside down and use a screwdriver to remove the screws around the heat sink. Then lift from PCB

10   In the centre of the coil there are two sensors, a temperature sensor and an electromagnetic wave sensor.

11   Attached to the ceramic glass plate via the thermal paste.

12   Carefully push the sensors rubber casing out of the induction coil.

13   Going back to the base locate the ABS fan, which cools the electrical components.

14   Remove each screw and their respective washers before lifting the fan from the base.

15   Finally, where the induction coil was, there is a circular aluminium shield attached to the base. The shield prevents energy from the induction coil escaping downward.

16   To remove simply use the screwdriver to undo the screw located at the centre.

17   Lift the shield to remove it from the base.

Service charge for Faults and rectification = Rs.1100