

# WORKSHOP CALCULATION & SCIENCE

(NSQF)

2<sup>nd</sup> YEAR

(As per Revised Syllabus July 2022)

**Technician Mechatronics**



Directorate General of Training

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



**NATIONAL INSTRUCTIONAL  
MEDIA INSTITUTE, CHENNAI**

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

**Workshop Calculation & Science**  
**Technician Mechatronics - 2<sup>nd</sup> Year NSQF**  
**As per Revised Syllabus July 2022**

**Developed & Published by**



**National Instructional Media Institute**

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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 Mechatronics 2<sup>nd</sup> 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 Mechatronics 2<sup>nd</sup> 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 Mechatronics 2<sup>nd</sup> 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 Mechatronics 2<sup>nd</sup> Year** as per NSQF Revised 2022.

### MEDIA DEVELOPMENT COMMITTEE MEMBERS

- |                                     |   |   |
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| Shri. G. Sathiamoorthy              | - | Jr. Training Officer - SG (Retd.)<br>Govt. I.T.I, Trichy, DET - Tamilnadu.          |
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### NIMI CO-ORDINATORS

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

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

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

## INTRODUCTION

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

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

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

### Time allotment - 2<sup>nd</sup> Year : 16 Hrs

Time allotment for each title of exercises has been given below. **Workshop Calculation & Science - Technician Mechatronics 2<sup>nd</sup> Year NSQF Revised Syllabus 2022.**

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

## 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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Exercise No.	Title of the Exercise	Page No.
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## SYLLABUS

**2<sup>nd</sup> Year**

### Workshop Calculation & Science - Technician Mechatronics Revised syllabus July 2022 under CTS

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





Algebra - Addition, subtraction, multiplication & division

Introduction

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

Positive and negative numbers

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

**Example**  $+x, -y$ .

+8 or simply 8 positive number.

–8 negative number.

Addition and subtraction

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

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

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

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

Multiplication of positive and negative numbers

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

**Ex.**

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

Division

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

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

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

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

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

Example

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

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

Parentheses and grouping symbols

( ) Brackets

{ } Braces

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

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

Parentheses

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

### Algebraic symbols and simple equations

#### Algebraic symbol

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

#### Factor

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

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

#### Algebraic terms

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

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

The sign must precede the term.

#### Kinds of terms:

##### 1 Like terms

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

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

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

##### 2 Unlike terms

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

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

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

#### Examples :

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

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

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

#### 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

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

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

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

4.  $x + 10 = 12$ ,

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

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

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

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

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

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

## Transposition of the terms of the equations

= equals to

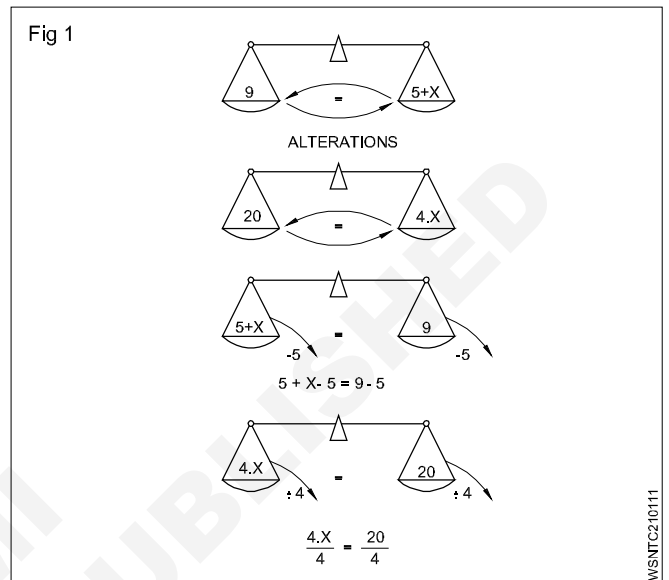
+ plus

- minus

x multiply

÷ divided by

## Concept of equality (Fig 1)



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

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

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

$$x = 4.$$

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

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

$$x = 80,$$

$$5x = 25.$$

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

$$x = 5.$$

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

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

a plus quantity becomes minus quantity.

a minus quantity becomes a plus quantity

a multiplication becomes a division

a division becomes a multiplication.

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

### Example

• Solve for x if  $4x = 3(35 - x)$

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

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

$$7x = 105$$

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

## Assignment

### Add

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

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

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

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

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

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

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

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

9  $x - z + y + z$

10  $15a + 13a - 37a$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

### Subtract

1  $38xy - 25xy$

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

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

### Add and Subtract

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

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

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

### Multiplication

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

2  $3ax - 9b$

3  $2ab \times -7pq$

### Division

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

2  $-3ax \div -6x$

3  $15xy \div -5$

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

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

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

Algebra - Theory of indices, Algebraic formula, related problems

Calculations involving powers

Power : Concept

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

a is the base, n is the exponent.

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

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

Powers with a positive base have a positive result.

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

The sign

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

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

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

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

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

Addition and subtraction of powers

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

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

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

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

Multiplication

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

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

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

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

$$8 \times 4 = 32.$$

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

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

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

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

Division

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

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

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

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

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

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

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

Only like powers can be added or subtracted.

Examples

(The exponent 1 is usually not written.)

$$a^1 = a$$

$$2^1 = 2$$

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

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

$$a^0 = 1$$

$$2^0 = 1$$

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

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

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

Powers are involved by multiplying the exponents.

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

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

Powers can be transposed without affecting the result.

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

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

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

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

$$8 \times 8 = 64$$

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

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

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

### 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

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

$$\begin{matrix} (-) & (+) \\ & = -32x^7 \end{matrix}$$

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

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

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

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

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

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

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

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

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

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

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

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

$$= 24a^5$$

### 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

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### 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**

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**Introduction**

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

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

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

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

The following essential details are required for preparing an estimate.

Drawings like plan, elevation and sections of important parts.

Detailed specifications about workmanship & properties of materials, etc.

Standard schedule of rates of the current year.

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

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

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

**Purpose of Estimating and Costing**

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

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

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

**Estimation Methods**

Estimate involves the following operations

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

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

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

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

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

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

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

**There are two types of costings**

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

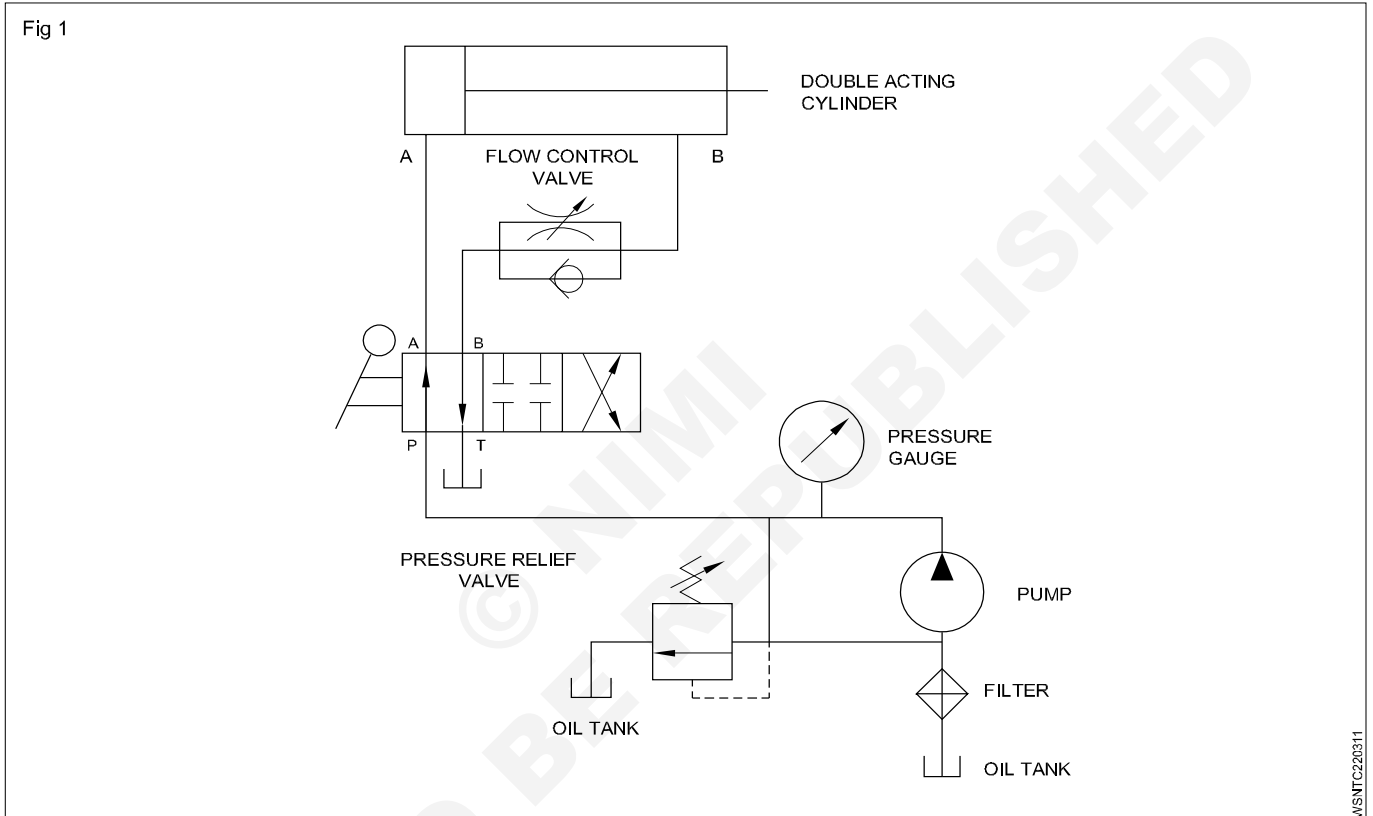
**Cumulative Costing** - this type of costing looks at the total cost for all phases of work, but it can be difficult to ensure that estimates are accurate.

**Exercise:**

**1 Estimate the items required for installation of a speed control circuit, Meter in flow control circuit and calculate the cost of items required for work (Fig 1)**

**Tools/Instruments/Equipments - Service persons owns**

1 Pressure relief valve	- 1 No.	6 Pipes	- 8 m
2 Compressor	- 1 No.	7 Filter	- 1 No.
3 Junction box	- 1 No.	8 Oil Tank	- 1 No.
4 Manually operated 2x3 DC valve single acting cylinder	- 1 No.	9 Pump	- 1 No.
5 Double acting cylinder	- 1 No.	10 Pressure Gauge	- 1 No.



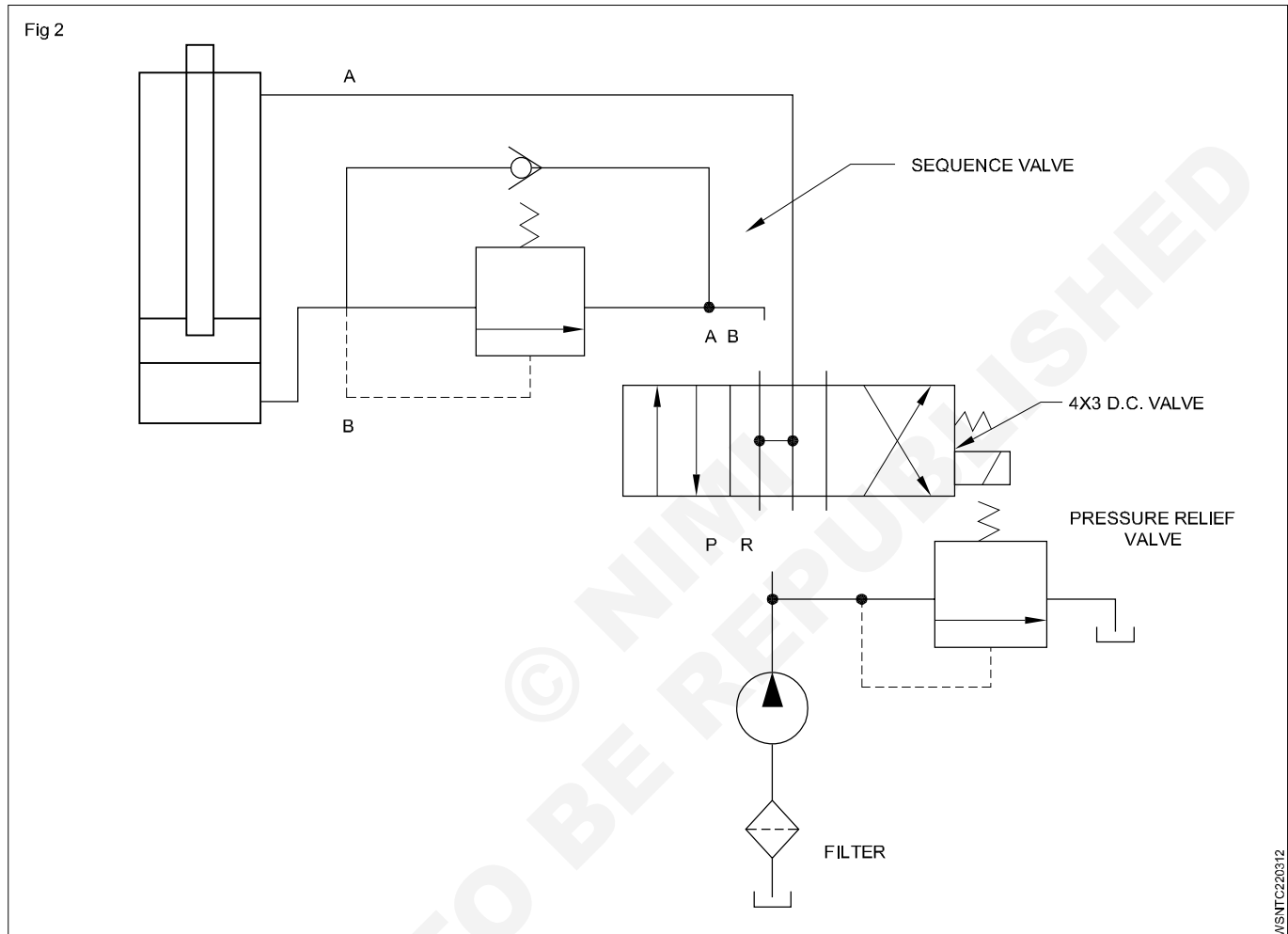
**Estimation of Items**

1 Pressure relief valve	=	Rs. 9,000
2 Filter	=	Rs. 8,000
3 Compressor	=	Rs. 8,950
4 Junction Box	=	Rs. 300
5 Manually operated 2x3 DC valve Single acting cylinder	=	Rs. 1,800
6 Double acting cylinder	=	Rs. 2,000
7 Pipes	=	Rs. 1,020
8 Oil tank	=	Rs. 4,000
9 Pressure Gauge	=	Rs. 2,400
10 Pump	=	Rs. 7,290
<b>Total items cost</b>	<b>=</b>	<b>Rs. 44,760</b>

2 Estimate the components required for installation of Make simple pressure counter balance circuit in hydraulics, calculate the cost of items required for work. (Fig 2)

**Tools/Instruments/Equipments - Service persons owns**

1 Hydraulic cylinder	- 1 No.	5 Oil tank	- 1 No.
2 Direction control valve	- 1 No.	6 Counter balance valve	- 1 No.
3 Pump	- 1 No.	7 Filter	- 1 No.
4 Pressure relief valve	- 1 No.	8 Pipe	- 8 m.



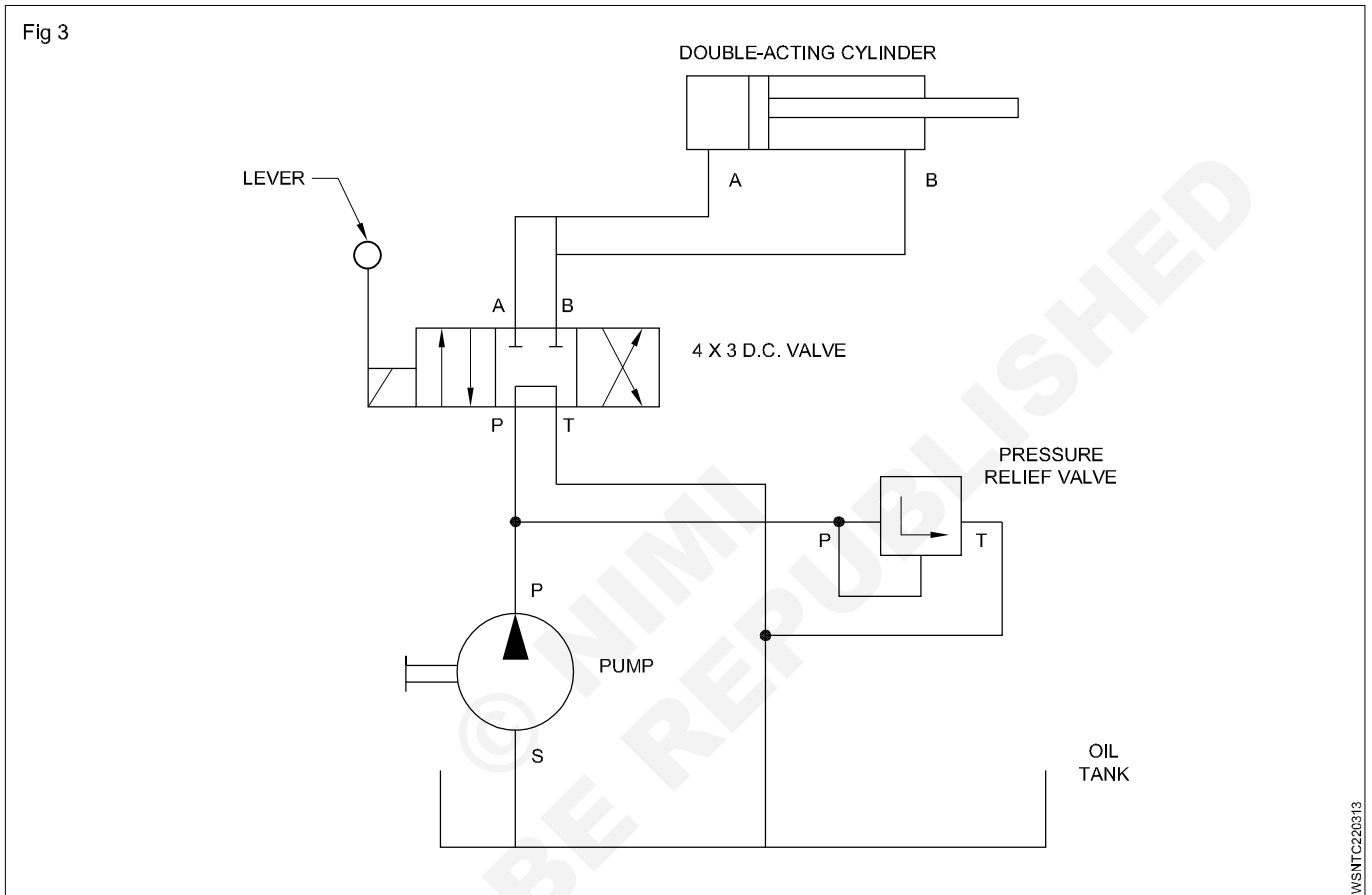
**Estimation of Items**

1 Hydraulic cylinder	=	Rs. 2,020
2 Direction control valve	=	Rs. 5,800
3 Pump	=	Rs. 7,290
4 Pressure relief valve	=	Rs. 9,000
5 Oil tank	=	Rs. 4,000
6 Counter balance valve	=	Rs. 2,020
7 Filter	=	Rs. 8,000
8 Pipe	=	Rs. 1,020
<b>Total items cost</b>	<b>=</b>	<b>Rs. 39,150</b>

**3 Estimate the list of components for installation of Working of hydraulic circuit for double acting cylinder and a hydraulic meter to calculate the cost of items required for the work. (Fig 3)**

**Tools/Instruments/Equipments - Service persons owns**

1 Oil tank	- 1 No.	5 Double acting cylinder	- 1 No.
2 Filter	- 1 No.	6 Hydraulic Motor	- 1 No.
3 Pump	- 1 No.	7 Pipe	- 8 m.
4 Manually operated 4x3 DC valve	- 1 No.	8 Lever	- 1 No.



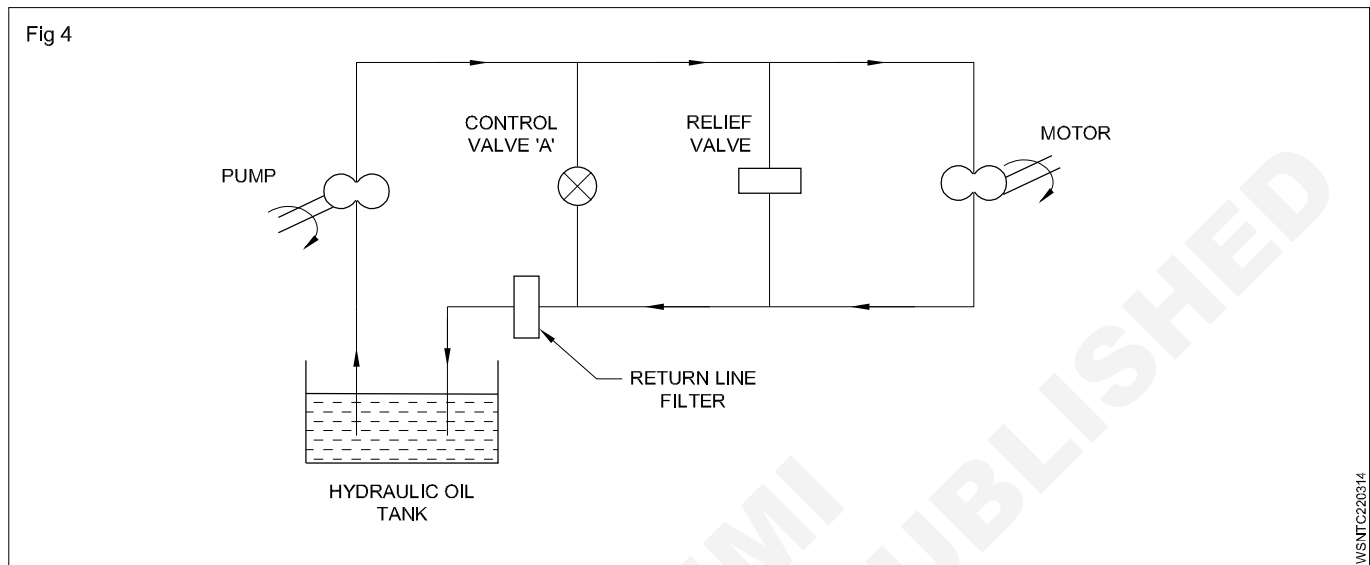
**Estimation of Items**

1 Oil tank	=	Rs. 4,000
2 Filter	=	Rs. 8,000
3 Pump	=	Rs. 7,290
4 Manually operated 4x3 DC valve	=	Rs. 5,500
5 Double acting cylinder	=	Rs. 1,800
6 Hydraulic Motor	=	Rs. 2,200
7 Pipe	=	Rs. 1,500
8 Lever	=	Rs. 3,100
<b>Total items cost</b>	<b>=</b>	<b>Rs. 33,390</b>

4 Estimate the components required for replacing a pump Making basic hydraulic system for transmission of force by pressurized hydraulic fluid and calculate the cost of items required for the work. (Fig 4)

**Tools/Instruments/Equipments - Service persons owns**

1 Pump	- 1 No.	5 Hydraulic oil tank	- 1 No.
2 Control valve	- 1 No.	6 Filter	- 1 No.
3 Relief valve	- 1 No.	7 Pipe	- 8 m.
4 Motor	- 1 No.		



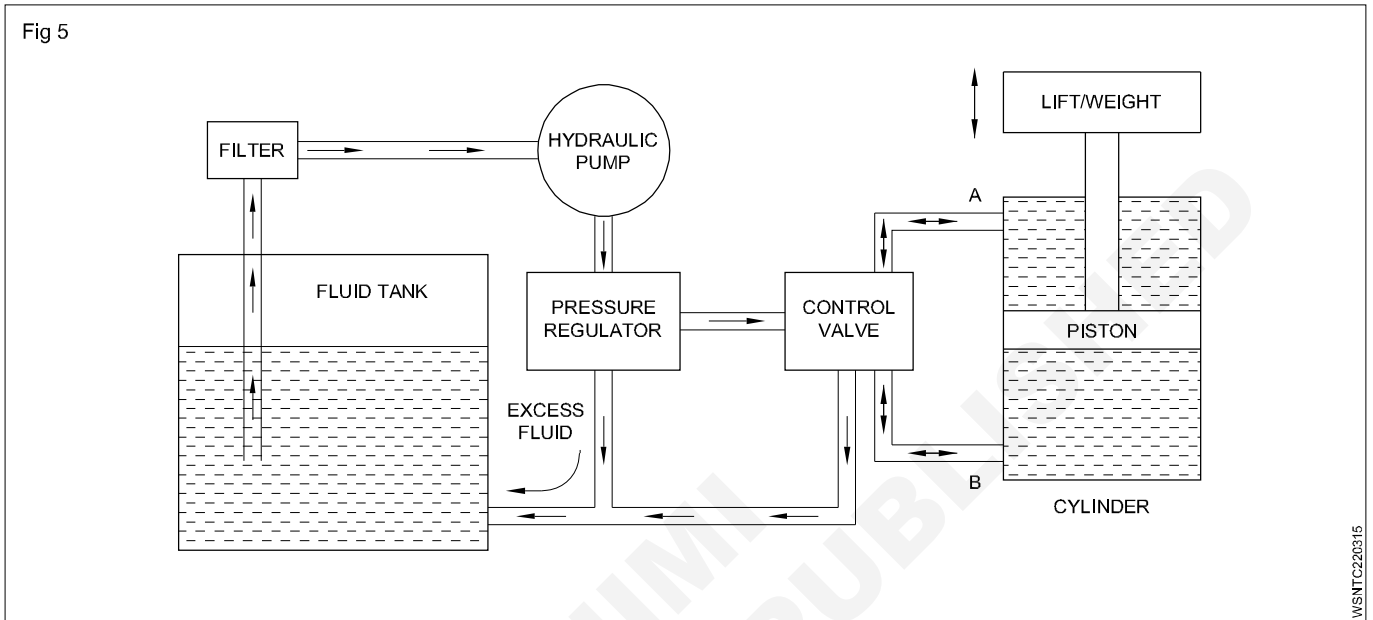
**Estimation of Items**

1 Pump	=	Rs. 7,290
2 Control valve	=	Rs. 5,500
3 Relief valve	=	Rs. 9,000
4 Motor	=	Rs. 2,180
5 Oil tank	=	Rs. 4,000
6 Filter	=	Rs. 8,000
7 Pipe	=	Rs. 1,020
<b>Total items cost</b>	=	<b>Rs. 36,990</b>

**5 Estimate the components required for installation of Make basic hydraulic systems, also calculate the cost of items required for the work. (Fig 5)**

**Tools/Instruments/Equipments - Service persons owns**

1 Oil tank	- 1 No.	5 Double acting control valve	- 1 No.
2 Pressure relief valve	- 1 No.	6 Pressure gauge	- 1 No.
3 Direction control valve	- 1 No.	7 Filter	- 1 No.
4 Flow control valve	- 1 No.	8 Pipes	- 10 m.



**Estimation of Items**

1 Oil tank	= Rs. 4,000
2 Pressure relief valve	= Rs. 9,000
3 Direction control valve	= Rs. 7,000
4 Hydraulic pump	= Rs. 7,290
5 Flow control valve	= Rs. 1,500
6 Double acting control valve	= Rs. 4,000
7 Pressure gauge	= Rs. 2,400
8 Filter	= Rs. 8,000
9 Pipe	= Rs. 1,050
10 Actuators	= Rs. 3,200
<b>Total items cost</b>	<b>= <u>Rs. 47,440</u></b>

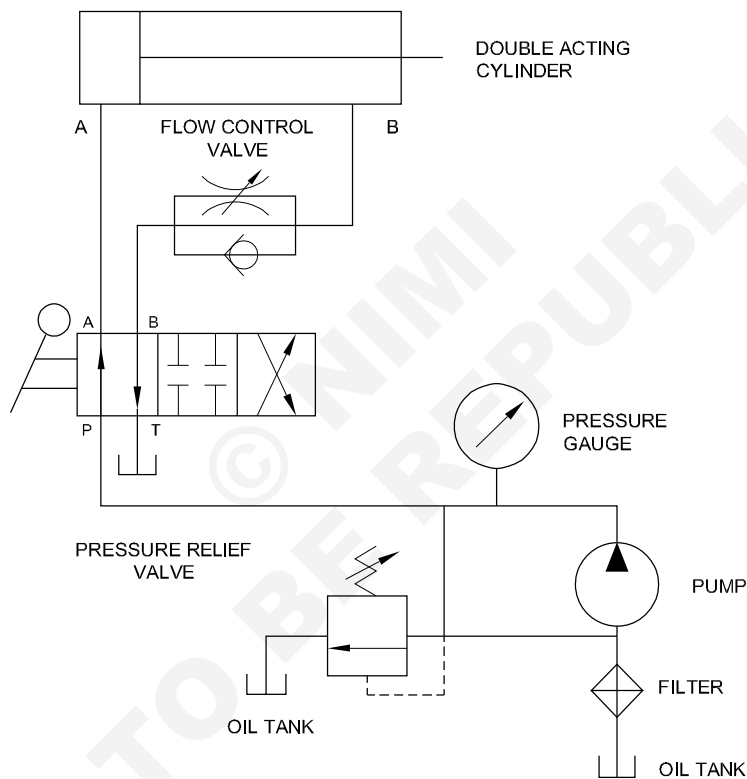
**Estimation and Costing - Problems on estimation and costing**

Estimate the items required for installation of a speed control circuit, Meter in flow control circuit and calculate the total cost required for the work. (Fig 1)

**Tools/Instruments/Equipments - Service persons owns**

1 Pressure relief valve	- 1 No.	6 Pipes	- 8 m
2 Compressor	- 1 No.	7 Filter	- 1 No.
3 Junction box	- 1 No.	8 Oil Tank	- 1 No.
4 Manually operated 2x3 DC valve single acting cylinder	- 1 No.	9 Pump	- 1 No.
5 Double acting cylinder	- 1 No.	10 Pressure Gauge	- 1 No.

Fig 1



- 1 Check the leakages if any.
- 2 Operate the DCV slowly to prevent damage.
- 3 Start the pump only when you have checked the connection of hose.
- 4 Connect all the hose pipes as given in the circuit.
- 5 Start the pump and adjust the flow of oil using flow control valve.
- 6 Actuate the cylinder using direction control valve.



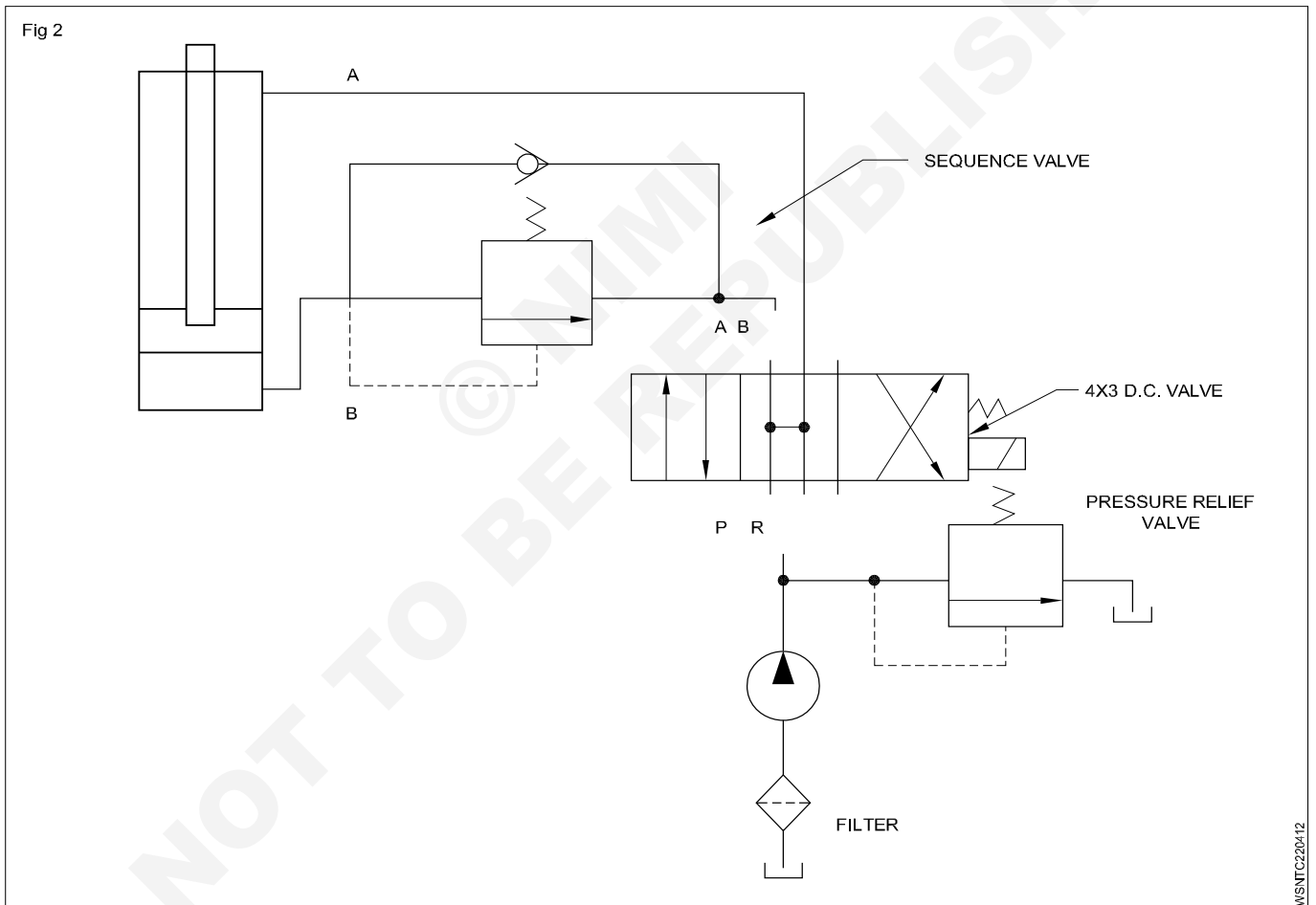
### Calculation

- 1 Total items cost = Rs.44,760
- 2 Labour charge = Rs.1500
- Total cost = Material cost + Labour charge  
= Rs.44,760 + Rs.1,500  
**= Rs.46,260**

2 Estimate the components required for installation of Make simple pressure counter balance circuit in hydraulics, calculate the total cost required for the work. (Fig 2)

### Tools/Instruments/Equipments - Service persons owns

- |                           |         |                         |         |
|---------------------------|---------|-------------------------|---------|
| 1 Hydraulic cylinder      | - 1 No. | 5 Oil tank              | - 1 No. |
| 2 Direction control valve | - 1 No. | 6 Counter balance valve | - 1 No. |
| 3 Pump                    | - 1 No. | 7 Filter                | - 1 No. |
| 4 Pressure relief valve   | - 1 No. | 8 Pipe                  | - 8 m.  |



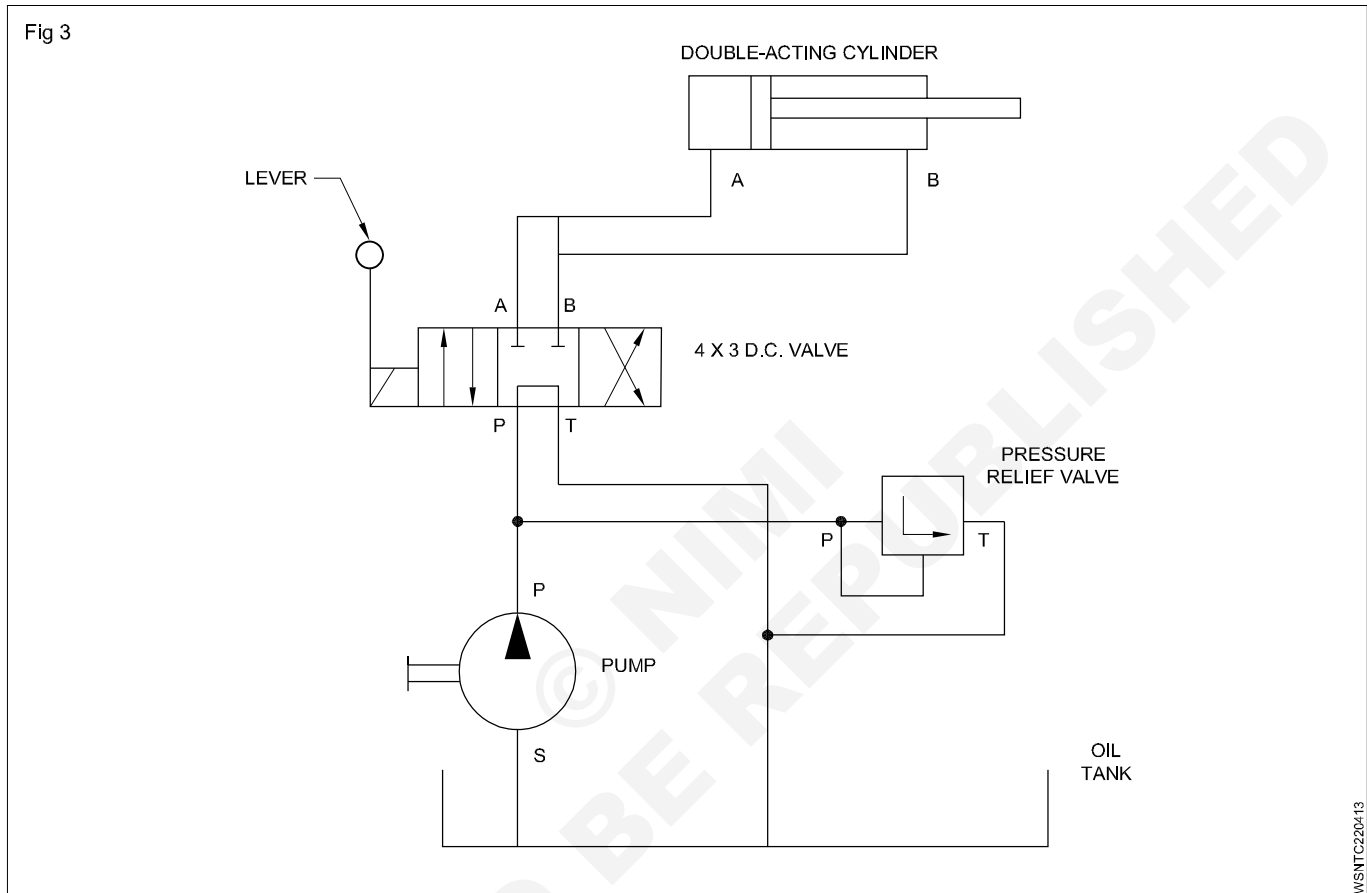
### Calculation

- 1 Total item cost = Rs.39,150
- 2 Labour charge = Rs.1,500
- Total cost = Material cost + Labour charge  
= Rs.39,150 + Rs.1,500  
**= Rs.40,650**

**3 Estimate the list of components for installation of Working of hydraulic circuit for double acting cylinder and a hydraulic meter to calculate the total cost required for the work. (Fig 3)**

**Tools/Instruments/Equipments - Service persons owns**

1 Oil tank	- 1 No.	5 Double acting cylinder	- 1 No.
2 Filter	- 1 No.	6 Hydraulic Motor	- 1 No.
3 Pump	- 1 No.	7 Pipe	- 8 m.
4 Manually operated 4x3 DC valve	- 1 No.	8 Lever	- 1 No.



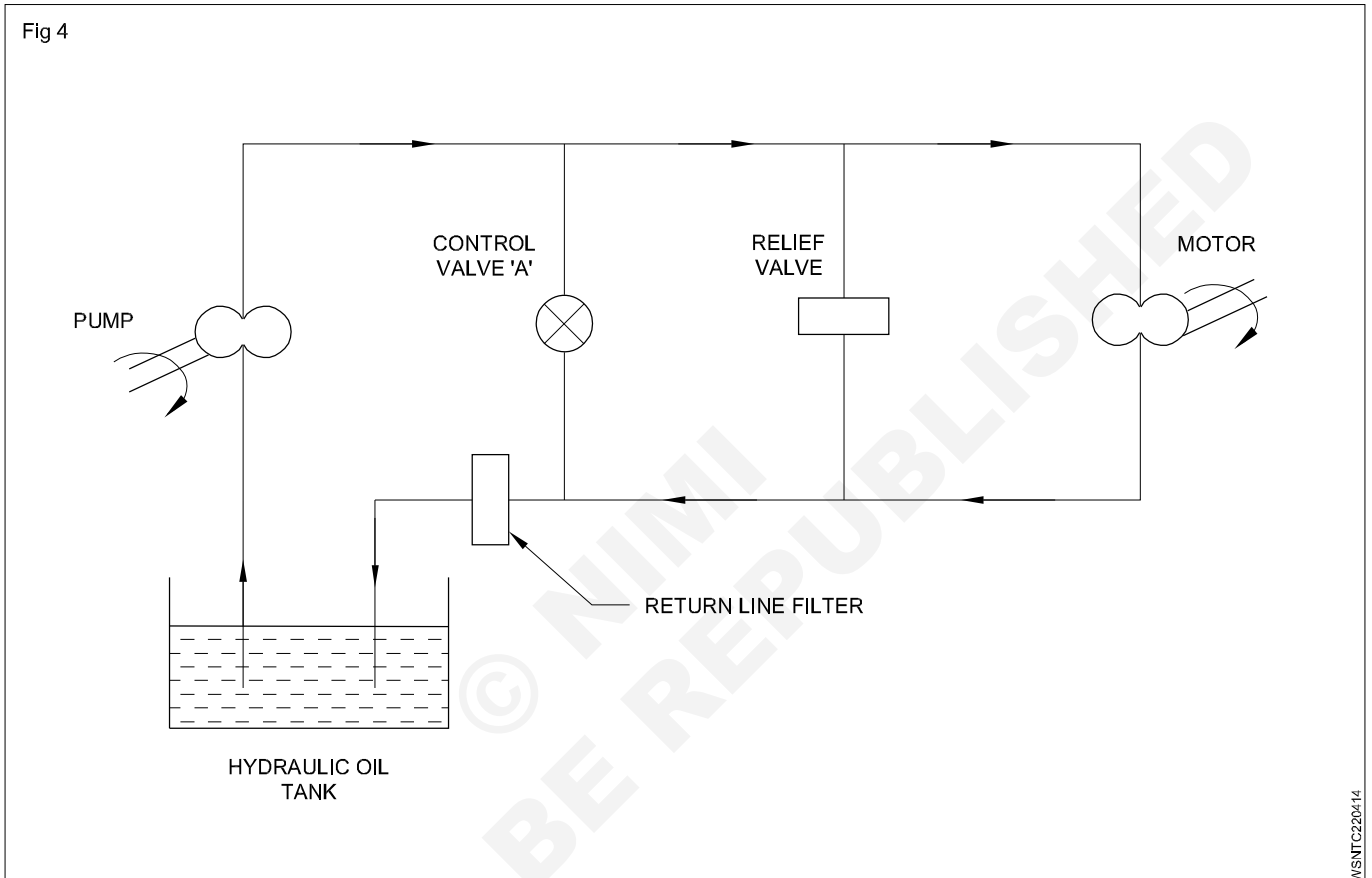
**Calculation**

1 Total items cost	=	Rs.33,390
2 Labour charge	=	Rs.1,000
Total cost	=	Material cost + Labour charge
	=	Rs.33,390 + Rs.1,000
	=	<b>Rs.34,390</b>

4 Estimate the components required for replacing a pump Making basic hydraulic system for transmission of force by pressurized hydraulic fluid, calculate the total cost required for the work. (Fig 4)

**Tools/Instruments/Equipments - Service persons owns**

1 Pump	- 1 No.	5 Hydraulic oil tank	- 1 No.
2 Control valve	- 1 No.	6 Filter	- 1 No.
3 Relief valve	- 1 No.	7 Pipe	- 8 m.
4 Motor	- 1 No.		



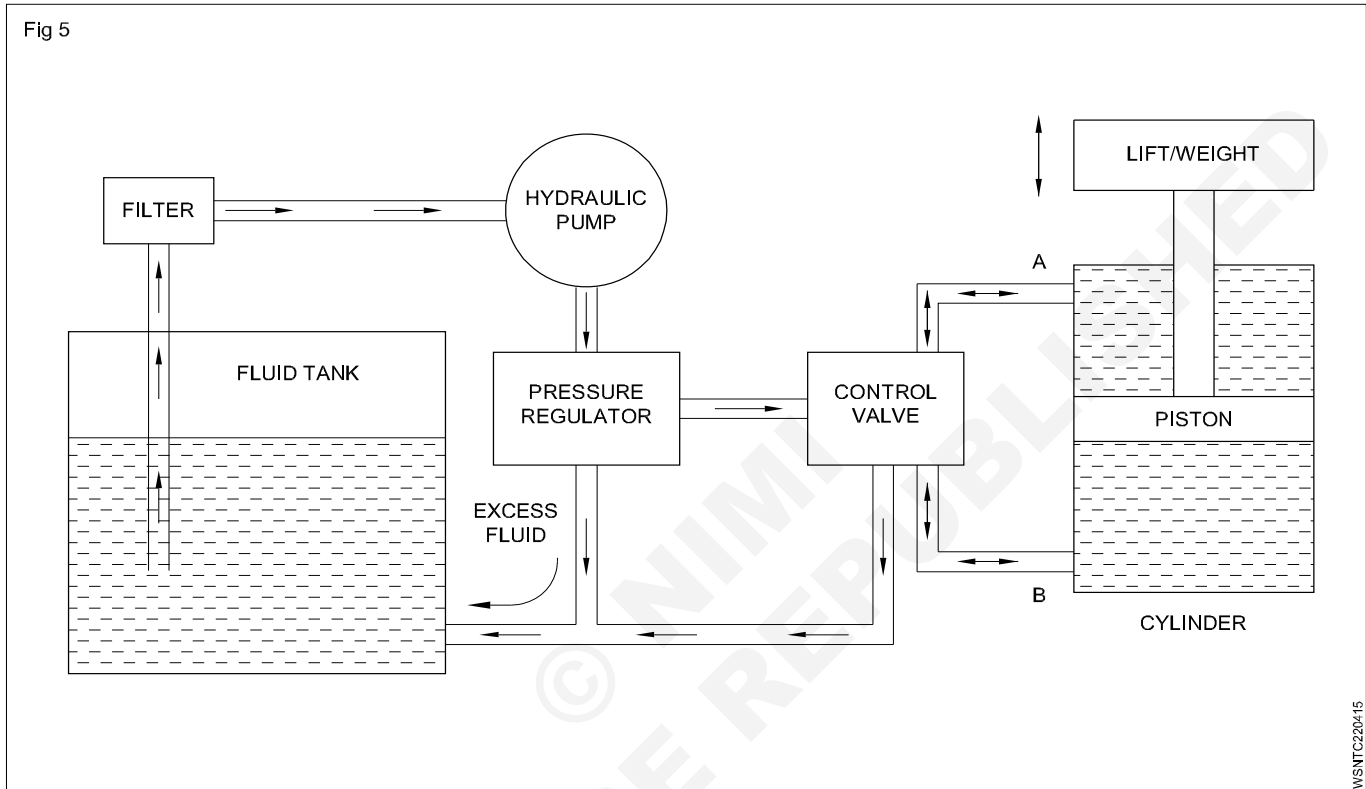
**Calculation**

1	Total items cost	=	Rs.36,990
2	Labour charge	=	Rs.1,500
	Total cost	=	Material cost + Labour charge
		=	Rs.36,990 + Rs.1,500
		=	<b>Rs.38,490</b>

5 Estimate the components required for installation of Make basic hydraulic systems, also calculate the total cost required for the work. (Fig 5)

**Tools/Instruments/Equipments - Service persons owns**

- |                           |         |                               |         |
|---------------------------|---------|-------------------------------|---------|
| 1 Oil tank                | - 1 No. | 5 Double acting control valve | - 1 No. |
| 2 Pressure relief valve   | - 1 No. | 6 Pressure gauge              | - 1 No. |
| 3 Direction control valve | - 1 No. | 7 Filter                      | - 1 No. |
| 4 Flow control valve      | - 1 No. | 8 Pipes                       | - 10 m. |



**Calculation**

- |                    |   |                               |
|--------------------|---|-------------------------------|
| 1 Total items cost | = | Rs.47,440                     |
| 2 Labour charge    | = | Rs.1,500                      |
| Total cost         | = | Material cost + Labour charge |
|                    | = | Rs.47,440 + 1,500             |
|                    | = | <b>Rs.48,940</b>              |