PRACTICAL MATHEMATICS: PART I, INSTRUCTION PAPER

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PRACTICAL MATHEMATICS

PART I

INSTRUCTION PAPER

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PRACTICAL MATHEMATICS

PART I

INTRODUCTION

No one who is at all acquainted with the demands of the Engineering profession will deny the need of a good foundation in elementary mathematics any more than he will deny the need of a solid underpinning on which to rest the walls of a big business block.

The simplest problems of the contractor and workman, such as the number of feet of lumber required for a house, the number of cubic yards of excavation for a ditch or cellar, the proper understanding of plans and specifications, and the laying off of measurements according to these plans, all require a knowledge of this important subject. The size of a concrete retaining wall, the dimensions of a girder for a steel structure, the amount of iron in the field of a dynamo, or the capacity of the cylinders of an engine, is certainly not left to the arbitrary judgment of a foreman but is carefully worked out by mathematics and by a knowledge of the properties of the materials used.

Mathematics might be likened to a kit of tools which the workman carries; the master workman carries more than the apprentice and the more tools each man has in his kit and knows how to use, the more things he can do and the greater is his earning power. Each mathematical process is a tool to be used as the occasion demands. Some of them are used in every problem which comes up, others less frequently, but the more advanced the work the greater the number of tools required.

It is with this keen demand in mind, therefore, that we are requiring of each student at the outset of his course this work or its equivalent in Practical Mathematics. We want him to fill his kit with enough tools to meet the steady demands of the work ahead of him, and we feel sure that, once provided with this equipment, his progress will be assured.

In the preparation of this work the authors have intentionally lost sight of the material usually found in the school books on this subject, and have kept in mind only the particular parts which are of special importance to the engineering student. Not only the topics discussed but all of the problems have been made exceptionally practical, and the aim has been at all times to give the student the satisfaction of knowing that whatever he is learning will be of use in his work and will also count for his advancement.

DEFINITIONS AND MATHEMATICAL SIGNS

1. Definitions. *Mathematics* is the science which treats of quantity, and its fundamental branches are Arithmetic, Algebra, and Geometry.

Quantity is anything which can be increased, diminished, or measured; for example: numbers, lines, space, motion, time, volume, and weight.

A *unit* is a single thing, or *one.*

A *number* is a unit or a collection of units and is either *concrete* or *abstract.*

A *concrete* number is one whose units refer to particular things, as, for example 5 rivets, 7 bolts.

An *abstract* number does not refer to any particular thing. For example, 5, 23, etc., used without designating any particular objects, are abstract numbers.

2. Mathematical Signs. For the sake of brevity, signs are used in mathematics to indicate processes. Those signs most used in Arithmetic are $+$, $-$, $\times$, $\div$, $=$, ( ) and, $\overline{\qquad}$

The sign $+$ is read "plus" and is the sign of addition. It shows that the quantities between which it is placed are to be added together. If 2 and 2 are to be added it is expressed, thus: $2 + 2$ are four.

The sign $-$ is read "minus" and is the sign of subtraction. It means that the quantity which follows this sign is to be subtracted or taken away from the quantity which precedes it, thus: $6 - 4$ are 2.

The sign $\times$ is read "times" and is the sign of multiplication. It means that the quantity which precedes this sign is to be multiplied by the quantity which follows it, thus: 2×5 are 10.

The sign ÷ is read "divided by" and is the sign of division. It means that the quantity which precedes this sign is to be divided by the quantity which follows it, thus: $4 \div 2$ are 2.

The sign = is read "equals" or "is equal to" and is the sign of equality. It means that the expressions between which it is placed are identical in value, thus: $4 + 3 = 10 - 3$. This sign is very often misused. Great care should be taken at all times to make sure that the quantities connected by it are *equal*. For example, it would be absurd to say that $5 + 9 = 14 \div 2 = 7$, because $5 + 9$ does not equal 7.

The *parenthesis* ( ) and *vinculum* $\overline{\quad\quad}$ are used to show that two or more quantities are to be treated as one; or in other words, that the operations indicated within the parenthesis or under the vinculum are to be carried out first, thus:

$$(20 - 5) + 3 - \overline{2 + 3} = (15) + 3 - (5) = 13.$$

NOTATION

3. *Notation* is the art of writing numbers in words, in figures, and in letters.

There are two methods of notation in common use; the *Roman* and the *Arabic*.

4. Roman Notation. In the *Roman notation*, 7 capital letters are used, as follows:

I is used to express one.
V " " " five.
X " " " ten.
L " " " fifty.
C " " " one hundred.
D " " " five hundred.
M " " " one thousand.

All other numbers are expressed by repetitions or by combinations of these seven letters according to the following rules:

By repeating a letter the value denoted by the letter is doubled; thus: XX means twenty; CC means two hundred.

By placing a letter denoting a less value before a letter denoting a greater, their difference of value is represented; thus: IV denotes four or one less than five; XL denotes forty or ten less than fifty.

By placing a letter denoting a less value after a letter denoting a greater value, their sum is represented; thus: VII denotes seven or two more than five. XV denotes fifteen or five more than ten.

A line ‾‾ *placed over a letter increases the value denoted by the letter a thousand times;* thus: $\overline{X}$ means ten thousand. $\overline{IV}$ means four thousand.

The use of the Roman notation is now confined mainly to the writings of dates, and the numbering of chapters in books, and the hours on the dials of clocks.

Table I shows some of the combinations of the 7 letters used.

TABLE I
Roman Notation

I	one	LXXX	eighty
II	two	XC	ninety
III	three	C	one hundred
IV	four	CC	two hundred
V	five	CCC	three hundred
VI	six	D	five hundred
VII	seven	DC	six hundred
VIII	eight	DCC	seven hundred
IX	nine	CM	nine hundred
X	ten	M	one thousand
XX	twenty	MD	fifteen hundred
XXX	thirty	MM	two thousand
XL	forty	$\overline{X}$	ten thousand
L	fifty	$\overline{M}$	one million
LX	sixty	MCMX	1910
LXX	seventy		

5. Arabic Notation. The *Arabic notation* employs ten characters or figures in expressing numbers. They are

1,	2,	3,	4,	5,	6,	7,	8,	9,	0
one	two	three	four	five	six	seven	eight	nine	cipher

The first nine are sometimes called *digits;* the cipher is also called *naught* or *zero* because it expresses *nothing* or the absence of a number.

The digits (1, 2, 3, 4, 5, 6, 7, 8, 9) have been termed *significant figures* because each has of itself a definite value, always representing so many units or *ones* as its name indicates. However, the value of the units represented by a figure depends upon the particular position which that figure occupies with regard to other figures. This position is called its *place* or *order.*

For example, if three figures are written together to represent a number, as 444, each of these figures, without regard to its place, expresses four units, but when considered as part of the number these fours differ in value. The 4 in the first place to the right represents *4 units;* the 4 in the second place, represents *4 tens* or 4 units each ten times the size or value of a unit of the first place; and the 4 in the third place, represents *4 hundreds,* or 4 units each one hundred times the size or value of a unit of the first place. It is readily seen that the value of any figure is increased ten-fold by removing it one place to the left.

hundreds	tens	units	
		4	= 4 units
	4	0	= 4 tens
4	0	0	= 4 hundreds
4	4	4	= total

The cipher becomes significant when connected with other figures by filling a place that otherwise would be vacant, as in 10 (ten) it gives a ten-fold value to the 1. In 130 (one hundred thirty) it gives a ten-fold value to the 13. A cipher between two or more figures produces the same effect. In 405 the cipher which fills the intervening place between 4 and 5 causes the 4 to represent four *hundreds,* not four tens.

hundreds	tens	units	
		5	= 5 units
	0	0	= 0 tens
4	0	0	= 4 hundreds
4	0	5	= total

The following general principles should be firmly fixed in the mind:

All numbers are expressed by the nine digits and zero.

Zero has no value; it is used to fill vacant places only.

A figure has different values according to the place it occupies.

The base of the system of notation is ten; ten units of any order making one unit of the next higher order.

NUMERATION

6. *Numeration* is the art of reading numbers when expressed by letters or figures.

This is accomplished by first enumerating the *orders* from right to left, as shown in Table II, and then reading these orders in the reverse direction in groups of three, called *periods.* The first three orders, *Units, Tens, Hundreds,* constitute the *first* or *unit period.* The second three orders form the *second* or *thousand period;* the third three orders, the *third* or *million period;* and so on.