ENGINEERING APTITUDE

(QUANTITATIVE APTITUDE AND ANALYTICAL ABILITY)

(For ESE GATE & PSUs Exam)

(CE, ME, PI, CH, EC, EE, IN, CS, IT)

Salient Features :

- **More than 170 topics covered**
- **530+ theoretical examples for in-depth understanding**
- **390+ chapterwise practice questions with detailed solutions**
- **930+ previous years questions with detalied solutions**
  UPSC (37 yrs), GATE (16 yrs) & ESE (8 yrs)

Office : F-126, (Lower Basement), Katwaria Sarai, New Delhi-110016 • **Phone :** 011-26522064
Mobile : 8130909220, 9711853908 • **E-mail:** info.publications@iesmaster.org, info@iesmaster.org
Web : iesmasterpublications.com, iesmaster.org

IES MASTER PUBLICATION

F-126, (Lower Basement), Katwaria Sarai, New Delhi-110016

Phone : 011-26522064, **Mobile :** 8130909220, 9711853908

E-mail : info.publications@iesmaster.org

Web : iesmasterpublications.com

First Edition : 2017

Second Edition : 2018

Third Edition : 2019

Fourth Edition : 2020

Fifth Edition : 2021

Sixth Edition : 2022

Seventh Edition : 2023

Eighth Edition : 2024

Typeset at : IES Master Publication, New Delhi-110016

PREFACE

Union Public Services Commission (UPSC) in its quest for best engineering minds looks for the very basic pride of an engineer, which it tests through quantitative and analytical abilities of candidates. The profession itself calls for putting candidates in situations, both human and technical, where things are tied into hundred knots. As an engineer one is expected to think critically, detect systematic themes while analysing data, and achieve thoroughness with accuracy in deriving solutions under challenging circumstances.

To test these qualities in an ESE, GATE & other Engineering Exam aspirant, in the year 2017, UPSC introduced Engineering Aptitude as a part of the syllabus for the common paper of ESE in 2017. Also, Engineering Apptitude is having good weightage in GATE & other engineering exams, and thus, it is important for GATE & others exams too. With an objective to develop these abilities, IES Master has come up with the revised and updated **Eighth edition** of the book Engineering Aptitude that acquaints an ESE aspirant to thousands of problems under various sub-heads such as probability, polynomials, speed-time, work-time, clock and calendar, as well as geometry and measurements that they might come across during their professional career. Covering more than **170 topics under 25 chapters in 5 units**, this book is an effort by IES Master to offer the complete theory of ESE syllabus along with previous years questions from **UPSC (last 37 years), GATE (last 16 years), and ESE (last 8 years) to the ESE aspirants**.

As you flip through the pages of this book, it captures your imagination with subtleness, and exposes you to more than **1,860^{+} problems**, enough to give your pen the required strength to take on any competitive exams including ESE, GATE and PSUs.

Having gone through the clarity and conciseness offered in this revised edition, we hope that as your fingers follow your command, the brain will engineer solutions no matter how difficult the challenge is.

IES Master Publication

New Delhi

CONTENTS

UNIT 1 : QUANTITATIVE APTITUDE

UNIT 2 : ANALYTICAL REASONING

UNIT 3 : CRITICAL REASONING

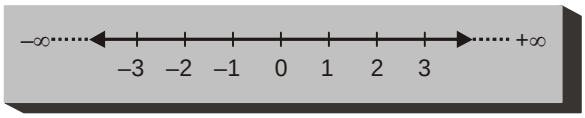
UNIT 4 : MODERN MATHS

UNIT 5 : DATA INTERPRETATION

1.1 NUMBER SYSTEM

NUMBER LINE

Number line is a line on which all the positive and negative numbers can be represent in a sequence. It stretches from negative infinity to positive infinity.



DEFINITION OF VARIOUS TYPES OF NUMBERS

Natural Numbers

Counting Numbers 1, 2, 3, 4, ... are called Natural Numbers. The symbolic representation is N, i.e.,

N = {1, 2, 3, 4, 5, ...}.

Whole Numbers

All the natural numbers together with '0' are called Whole Numbers and the symbolic representation is W, i.e., W = {0, 1, 2, 3, 4, ...}

Integers

An integer is a number that can be written without a fractional component, it is represented by 'Z'.
Integers are further classified into positive integers (2, 4, 5 etc.), zero (0) and negative integers (–2, –5 etc.).

Rational Numbers

A number which can be expressed in the form of $\frac{p}{q}$ where, p and q are integers and $q \neq 0$, is called a rational number.

For example : *Any integer number is a rational number since, it can be written as the ratio of two integer numbers, one the integer number itself and another number is 1.*

Other examples of rational number are $\frac{2}{3}, -\frac{3}{7}, \ldots$ etc.

Note : *A decimal represents a rational number if and only if it has a finite number of digits. But recurring decimals are exceptions as they are also assumed as Rational Numbers, i.e., all recurring decimals are rational numbers.*

Irrational Numbers

A real number, which is not rational, is called **irrational number**. An irrational number has non-terminating and non-recurring decimal part.

Between any two numbers, there are infinite numbers of irrational numbers.

Examples of irrational numbers are : $\sqrt{3}, \sqrt{5}, \sqrt[3]{7}, \sqrt[4]{11}$

Numbers π and e are also irrational number because both have non-terminating and non-recurring decimal part.

π = 3.14159265358979… and e = 2.71828182859045… where, e is called Euler's number.

Note : *Any terminating* ***or*** *recurring decimal is a rational number. Any non-terminating* ***and*** *non-recurring decimal is an irrational number.*

Example 1

Which one of the following is not a rational number?

(a) $\frac{3}{8}$ (b) $-\frac{111}{23}$ (c) $\sqrt{2}$ (d) None of these

Sol. (c)

The number is option (a) and (b) are rational numbers, as they are the ratio of two integers. The number $\sqrt{2}$ is non-recurring, so it is not a rational number.

Real Numbers

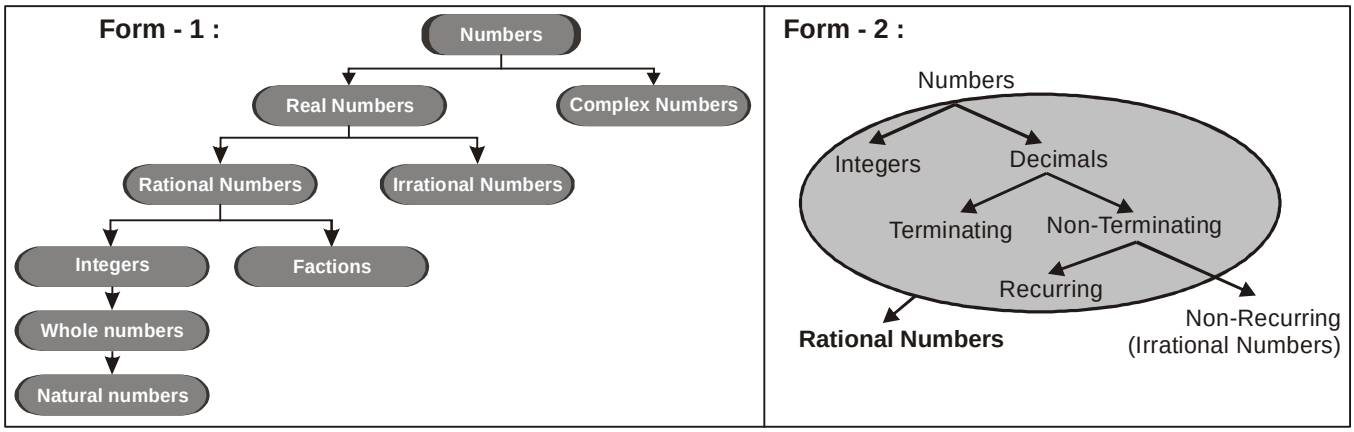
The real numbers include all the measuring numbers. The symbol for the real number is R. **All the numbers which can be represented on the number line are called real numbers.**

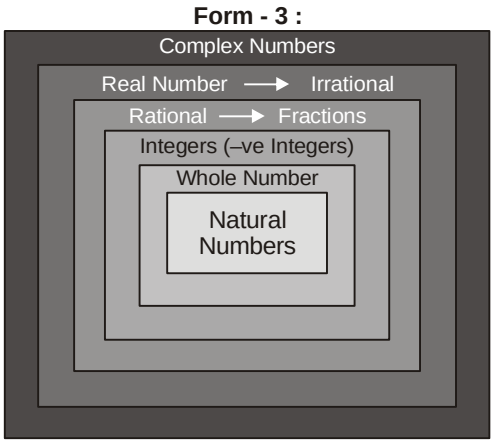
Complex Numbers

All the numbers that can be represented in a + ib form where a & b are real numbers and i = $\sqrt{-1}$ are called Complex Numbers.

$$C = \{a + ib; a, b \in R \ \& \ i^2 = -1\}$$

VARIOUS FORMS OF NUMBER TREE





1.4 PROFIT AND LOSS

Cost Price

The cost price of an article (or an item) is the price at which that article has been purchased, it is abbreviated as cost price (CP).

Selling Price

The selling price of an article is the price at which that article has been sold. It is abbreviated as selling price (SP).

Marked Price

The price that is indicated or marked on the product is called marked price. Marked price is also defined as the price which is given in the price list. So, marked price is also known as the **list price**.

GAIN

If the selling price (SP) of an article is more than the cost price (CP) then, the difference of these two is called as profit or gain.

$\therefore$ Profit or Gain = SP – CP & Percentage profit $= \frac{SP - CP}{CP} \times 100 = \frac{Profit}{CP} \times 100$

LOSS

If the cost price of an article is greater than the selling price then the difference of these two is called as loss.

Loss = CP – SP & Percentage loss $= \frac{CP - SP}{CP} \times 100 = \frac{Loss}{CP} \times 100$

Note : *1. If the selling price (SP) and percentage gain is given then, Cost price, CP* $= \left[\frac{100}{100 + \%\,Gain}\right] \times SP$

2. If the selling price and percentage loss is given then, Cost price, CP $= \left[\frac{100}{100 - \%\,Loss}\right] \times SP$

CONCEPT OF MULTIPLYING FACTOR RELATED TO PROFIT AND LOSS

Sometimes this traditional formula of computing Profit & Loss percentage is not very easy to calculate. So rather than using that formula, we can use the concept of multiplying factor (f) related to profit percentage.

If f is the multiplying factor for profit & loss percentage, then

[CP × f = SP]

For example*, Amit sells his watch for Rs. 200 for a profit of 20%. At what price did Amit purchased it.*

Sol. Approach 1 : Let x is the CP of the watch, then

$$x + \frac{20x}{100} = 200 \quad \Rightarrow \quad x = 166.66$$

Approach 2 : Since, 20% = $\frac{1}{5}$, so multiplying factor for profit (f) = $1+\frac{1}{5} = \frac{6}{5}$

Hence, CP × f = SP $\Rightarrow$ $CP \times \frac{6}{5} = 200$ $\Rightarrow$ CP = 166.66

Example 1

Two lots of onions with equal quantity, one costing ` 10 per kg and the other costing ` 15 per kg, are mixed together and whole lot is sold at ` 15 per kg. What is the profit or loss?

(a) 10% loss (b) 10% profit (c) 20% profit (d) 20% loss

Sol. (c)

Method-I: Let the weight of each onion lot is x kg.

Then, the total cost price of both the lots = 10 × x + 15 × x = 25x

When both the lots are mixed then, selling price of both the lots = 15 × 2x = 30x

As selling price is more than the cost price so, there will a profit.

$$\therefore \quad \% \text{ profit} = \frac{SP - CP}{CP} \times 100 = \frac{30x - 25x}{25x} \times 100 = 20\%$$

Method-II : As discussed in method I, total CP = 25x & total SP = 30x

and we know that CP × f = SP where f = multiplying factor for % increase or % decrease.

so, (25x) × f = 30x $\Rightarrow$ $f = \frac{30}{25} = \frac{6}{5} = 1+\frac{1}{5}$ $\because \frac{1}{5} \approx 20\%$ so profit % = 20%

Example 2

A merchant earns a profit of 20% by selling a basket containing 80 apples which cost is ` 240 but he gives one-fourth of it to his friend at cost price and sells the remaining apples. In order to earn the same profit, at what price must he sell each apple?

(a) ` 3.00 (b) ` 3.60 (c) ` 3.80 (d) ` 4.80

Sol. (c)

Method-I: The cost price of each apple = $\frac{240}{80} = ` 3$

As merchant gives 25% (i.e. one fourth) apples to his friend so, the selling price of these 25% apples

$$= 80 \times \frac{25}{100} \times 3 = ` 60$$

To get 20% profit, the selling price of all apples would be = 120% of 240 = ` 288

Hence, the selling price of remaining three-fourth (or 75%) apples must be = 288 – 60 = ` 228

$$\therefore \quad \text{Price of each apples} = \frac{228}{\frac{3}{4} \times 80} = ` 3.8$$

Method-II: Total apples = 80, Number of apples given by him to his friend = $\left(\frac{1}{4}\right)^{th}$ of total applies = $\frac{1}{4} \times 80 = 20$ Apples