Course: General Mathematics and Statistics (6401)
Semester: Spring, 2021
ASSIGNMENT No. 2

Q.1 Write down how to construct different types of triangles (at least 4) along with their diagrams.

In Geometry, a **triangle is the most important shape**, defined as a closed two-dimensional diagram containing 3 sides, 3 angles, and 3 vertices. In simple words, a triangle is a polygon with 3 sides. The word triangle is taken from the Latin word 'triangulus,' which means three-cornered.

During ancient times, astronomers had created a method called triangulation to determine the distances of the distant stars. They measure the distance from two different locations, then measure the angle created by shift or parallax, formed by the observer's movement between the two locations. Then they used to apply the law of sines for calculating the required distance.

The Egyptians created the pyramids around 2900 B.C. Its shape is actually that of a 3D pyramid, which has triangular faces. It is a perfectly engineered model that its lengths and angles on all sides are the same. Miletus (624 BC – 547 BC), a Greek mathematician, adopted Egypt's geometry and was brought to Greece.

Aristarchus (310 BC – 250 BC), a Greek mathematician, used the above method to find the distance between the Earth and the Moon. Eratosthenes (276 BC – 195 BC), again, used the same method to determine the distance around the surface of Earth (called circumference).

This article will **discuss the meaning of a triangle**, the **different types of triangles** and their properties, and their real-life applications.

A triangle is a two-dimensional closed figure with 3 sides. It is a polygon with three corners, three vertices, and three angles joined together that forms a closed diagram. We use the symbol Δ to denote a triangle.

Different Types of Triangles

The types of triangles are classified based on:

- The lengths of their sides
- Interior angles

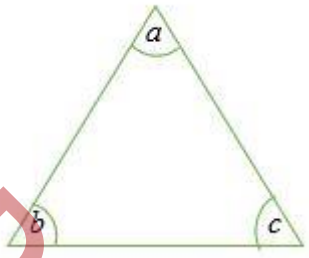
Classification of triangles according to the measure of interior angles

According to the measure of interior angles, we can classify triangles into three categories:

1. Acute-angled
2. Obtuse-angled
3. Right-angled

Acute triangle

An acute angle triangle is a triangle in which all three interior angles are less than 90 degrees.



Each one of the angles a, b and c is less than 90 degrees.

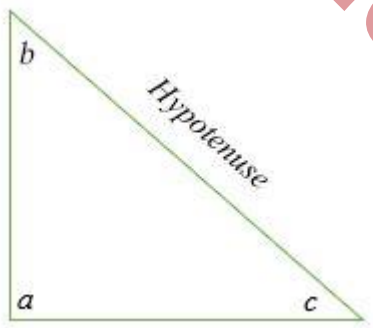
Obtuse triangle

An obtuse triangle is a triangle in which one of the interior angles is more than 90 degrees.

Angle a is more obtuse, while angles b and c are acute.

Right Triangle

A right triangle is a triangle in which one of the angles is exactly 90 degrees. The hypotenuse is the side of a right triangle with the longest length.



In the illustration above, angle a = 90 degrees while angles b and c are acute angles.

Classification of triangles according to the length of their sides

We can classify triangles into 3 types based on the lengths of their sides:

1. Scalene
2. Isosceles
3. Equilateral

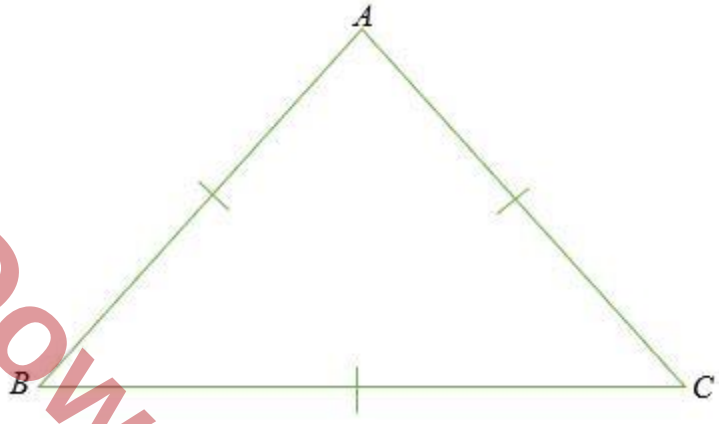
Isosceles triangle

An isosceles triangle is a triangle in which two sides and two angles are equal. Equal lengths of a triangle are shown by making an arc on each side.

In the diagram above, the length of side AB = AC and ∠ ABC =∠ ACB.

Equilateral triangle

An equilateral triangle has all three sides equal, and all three interior angles equal, too. In this case, each interior angle of an equilateral triangle is 60 degrees. An equilateral triangle is sometimes referred to as an equiangular triangle because all three angles are equal.

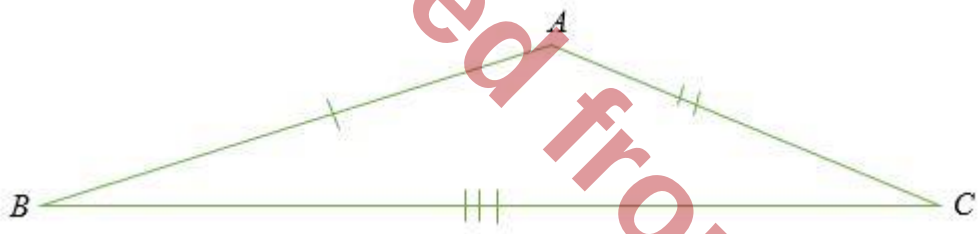


In an equilateral triangle, the sides AB = BC = AC and ∠ ABC =∠ ACB = ∠ BAC

Note that the angles of an equilateral triangle do not depend on the lengths of the sides.

Scalene Triangle

A scalene triangle is a triangle in which all the sides have different measures and all the interior angles are also different.



Q.2 Prove the following identities:

a) $\frac{1-\sin\theta}{\cos\theta} = \frac{\cos\theta}{1+\sin\theta}$

multiply the LHS , top and bottom by $(1+\sin x)$

$$\frac{(1-\sin x)(1+\sin x)}{\cos x(1+\sin x)}$$

$$= \frac{1-\sin^2 x}{\cos x(1+\sin x)}$$

but $\sin^2 x + \cos^x = 1$

$$\therefore = \frac{\cos^2 x}{\cos x(1+\sin x)}$$

$$= \frac{\cancel{\cos x}\,(\cos x)}{\cancel{\cos x}\,(1+\sin x)}$$

as required.

b) $(\sin^2\theta + \cos^2\theta)^5 = 1$

$\sin^2(t) + \cos^2(t) = 1$

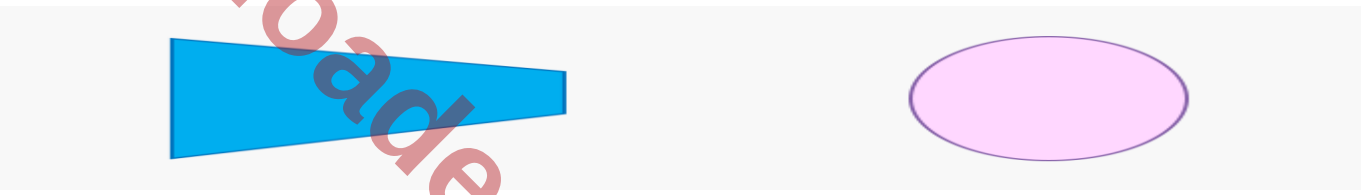
Hense LHS

(1)^5 = 1

LHS = RHS

Q.3 What is perimeter? How to find perimeter of different geometrical shapes? Explain with examples and diagrams.

In geometry, perimeter can be defined as the path or the boundary that surrounds a shape. It can also be defined as the length of the outline of a shape.



The word perimeter has been derived from the Greek word 'peri' meaning around, and 'metron' which means measure. Perimeter is the total length of the sides of a two-dimensional shape. We often find the perimeter when putting up Christmas lights around the house or fencing the backyard garden. Other examples may include finding the total length of the boundary of the soccer field or the length of the crochet or ribbon required to cover the border of a table mat.

Polygon name :	Polygon Picture/Image :	Perimeter Formula :
Equilateral Triangle		P = 3 x a
Scalene Triangle		P = a + b + c
Square		P = 4 x a
Rectangle		P = 2 (a + b)
Quadrilateral		P = a + b + c + d
Regular Pentagon		P = 5 x a
Regular Hexagon		P = 6 x a
Regular Octagon		P = 8 x a
Regular N-gon	A regular n-gon with each side a units long	P = n x a , where ***n*** is the number of sides and ***a*** is the lenght of the sides.

Perimeter Formulas for different geometrical figures:

Geometric Shape	Perimeter Formula	Metrics
Parallelogram	2(Base + Height)	
Triangle	a + b + c	a, b and c being the side lengths
Rectangle	2(Length + Width)	
Square	4a	a =Length of a side
Trapezoid	a +b+c+d	a, b, c, d being the sides of the trapezoid
Kite	2a + 2b	a = Length of the first pair of equal sides b = Length of the second pair of equal sides
Rhombus	4 x a	a = Length of a side
Hexagon	6 x a	a = Length of a side

Q.4 What are the different ways of graphical representation of frequency distribution? Draw figures and state what type of graph is effective for what sort of data?

The frequency (**f**) of a particular observation is the number of times the observation occurs in the data. The distribution of a variable is the pattern of frequencies of the observation. Frequency distributions are portrayed as frequency tables, histograms, or polygons.

Frequency distributions can show either the actual number of observations falling in each range or the percentage of observations. In the latter instance, the distribution is called a relative frequency distribution.

Frequency distribution tables can be used for both categorical and numeric variables. Continuous variables should only be used with class intervals, which will be explained shortly.

A frequency distribution shows us a summarized grouping of data divided into mutually exclusive classes and the number of occurrences in a class. It is a way of showing unorganized data notably to show results of an election, income of people for a certain region, sales of a product within a certain period, student loan amounts of graduates, etc. Some of the graphs that can be used with frequency distributions are histograms, line charts, bar charts and pie charts. Frequency distributions are used for both qualitative and quantitative data.

1. Decide the number of classes. Too many classes or too few classes might not reveal the basic shape of the data set, also it will be difficult to interpret such frequency distribution.
2. Calculate the range of the data (Range = Max – Min) by finding the minimum and maximum data values. Range will be used to determine the class interval or class width.

Generally the class interval or class width is the same for all classes. The classes all taken together must cover at least the distance from the lowest value (minimum) in the data to the highest (maximum) value. Equal class intervals are preferred in frequency distribution, while unequal class intervals (for example logarithmic intervals) may be necessary in certain situations to produce a good spread of observations between the classes and avoid a large number of empty, or almost empty classes.

1. Decide the individual class limits and select a suitable starting point of the first class which is arbitrary; it may be less than or equal to the minimum value. Usually it is started before the minimum value in such a way that the midpoint (the average of lower and upper class limits of the first class) is properly placed.
2. Take an observation and mark a vertical bar (|) for a class it belongs. A running tally is kept till the last observation.
3. Find the frequencies, relative frequency, cumulative frequency etc. as required.

Managing and operating on frequency tabulated data is much simpler than operation on raw data. There are simple algorithms to calculate median, mean, standard deviation etc. from these tables.

Statistical hypothesis testing is founded on the assessment of differences and similarities between frequency distributions. This assessment involves measures of central tendency or averages, such as the mean and median, and measures of variability or statistical dispersion, such as the standard deviation or variance.

A frequency distribution is said to be skewed when its mean and median are significantly different, or more generally when it is asymmetric. The kurtosis of a frequency distribution is a measure of the proportion of extreme values (outliers), which appear at either end of the histogram. If the distribution is more outlier-prone than the normal distribution it is said to be leptokurtic; if less outlier-prone it is said to be platykurtic.

Letter frequency distributions are also used in frequency analysis to crack ciphers, and are used to compare the relative frequencies of letters in different languages and other languages are often used like Greek, Latin, etc.

#1 Line Graphs

The most common, simplest, and classic type of chart graph is the line graph. This is the perfect solution for showing multiple series of closely related series of data. Since line graphs are very light-weight (they only consist of lines, as opposed to more complex chart types, as shown further below), they are great for a minimalistic look.

#2 Bar Graphs

Bars (or columns) are the best types of graphs for presenting a single data series. Bar charts have a much heavier weight to them than line graphs do, so they really emphasize a point and stand out on the page.

#3 Combo Chart

The above two types of graphs can be combined to create a combo chart with bars and lines. This is very useful when presenting two data series that have a very different scale and might be expressed in different units. The most common example is dollars on one axis and percentage on the other axis.

#4 Scatterplot

The scatterplot is excellent for showing the relationship between two data series and determining their correlation. The scatterplot is great for showing what a distribution of data points looks like and for drawing a line of best fit for regression analysis.

#5 Waterfall Chart

In Excel 2016, Microsoft finally introduced a waterfall chart feature. In all older versions of Excel, analysts had to create a custom workaround using stacked column charts. If you are in a version of Excel prior to 2016, then please see our free guide and waterfall chart template. The waterfall chart is excellent for variance analysis and explaining how an "actual" result was different than a "budget" or how something has changed relative to an original data point.

#6 Pie Graph

Pie charts have a bad reputation and are known for being messy and hard to read. However, if you're trying to illustrate the percentage breakdown of a small number of data points, then they can be very effective. For example, the percentage of people who prefer bananas, pineapples, and grapes.

#7 Histogram

Histograms are a type of graph that shows the distribution of a dataset. They graph the percentage or the number of instances of different categories. For example, to show the distribution of age categories (0-10, 11-20, 21-30, etc.), we can clearly see which categories are the biggest and how many people fall into each.

#8 Gauge Chart

The gauge chart is perfect for graphing a single data point and showing where that result fits on a scale from "bad" to "good". Gauges are an advanced type of graph, as Excel doesn't have a standard template for making them. To build one you have to combine a pie and a doughnut. Learn how in our data visualization course.

#9 Area Graph

An area chart is a solid area and can be effective when showing stacked, cumulative data series – for example, showing the cumulative sales revenue from different products. This allows the reader to easily visualize the "area" (or weight) of each series relative to each other.

#10 Spider chart / radar graph

A spider or radar graph is a very useful type of graph for showing qualitative data or the overall "score" or comparison of multiple series. For example, a spider/radar can be easily used to compare three different types of phones based on five criteria (speed, screen size, camera quality, memory, apps).

Q.5 What is standard deviation? How is it used to interpret data? What is use of standard deviation in physics? Write down its advantages and disadvantages.

Standard deviation is the measure of dispersion of a set of data from its mean. It measures the absolute variability of a distribution; the higher the dispersion or variability, the greater is the standard deviation and greater will be the magnitude of the deviation of the value from their mean. The concept of Standard Deviation

was introduced by Karl Pearson in 1893. It is by far the most important and widely used measure of dispersion. Its significance lies in the fact that it is free from those defects which afflicted earlier methods and satisfies most of the properties of a good measure of dispersion. Standard Deviation is also known as root-mean square deviation as it is the square root of means of the squared deviations from the arithmetic mean. In financial terms, standard deviation is used -to measure risks involved in an investment instrument. Standard deviation provides investors a mathematical basis for decisions to be made regarding their investment in financial market. Standard Deviation is a common term used in deals involving stocks, mutual funds, ETFs and others. Standard Deviation is also known as volatility. It gives a sense of how dispersed the data in a sample is from the mean. In case of individual observations, Standard Deviation can be computed in any of the two ways:

1. Take the deviation of the items from the actual mean
2. Take the deviation of the item from the assumed mean

In case of a discrete series, any of the following methods can be used to calculate Standard Deviation:

1. Actual mean method
2. Assumed mean method
3. Step deviation method

Just like Range gave us the simple measure of spread by telling us the Min and Max values of data, we have another measure called standard deviation (or an equivalent measure called variance) to measure spread. Standard Deviation essentially

- Measures the spread (Differences of individual data points) from the mean
- Squares the differences (So that positives and negatives all become positive)
- Takes the average of these squared differences
- Excel makes your life easier. Just use the function, **StdevP** or **VarP** and show it the data. It does all the number crunching on its own!

The following are the advantages and disadvantages of standard deviation:

Advantages:

- The value of standard deviation is always fixed, and it is rigidly defined.
- Mathematical operations and statistical analysis both are possible with the use of standard deviation.

Disadvantages:

- The open end frequency distribution can be calculated using standard deviation.
- The extreme values in the series affect the standard deviation.