11. Attempt a classification of Map Projections and write the merits and demerits of any
Two of the following map projections:
a. Bonne's b. Mercator's c. Mollweides

MAP PROJECTION:

A map projection is a systematic representation of the parallels of latitude and the meridians of longitude of the spherical surface of the earth on a plane surface. In other words, it is a method of representing the parallels and the meridians of the earth on a plane surface. The network of the parallels and the meridians so formed is called a **graticule.**

On our earth resembles a sphere. Therefore, a globe being spherical in shape represents the earth truly. Thus a globe is a true representation of the earth. In other words, a globe is true map of the earth. Since a map represents a flat surface and a globe a spherical surface, the shape of the network of the parallels and the meridians on a map is always different from that on a globe. There are a number of methods of transferring the parallels and the meridians of a globe on a plane surface, i.e., constructing map projections. The shape of the network of the parallels and meridians drawn by one method differs from that by the other methods. Therefore, there is a great variety of graticules. A variety in the graticules is necessary to meet various specific purposes.

Earth relationships such as shapes, areas of countries and direction of one place from the other, are not maintained on map. A map projection showing the area of a globe correctly will not maintain the shapes and directions of the areas truly. Thus it is not possible to construct a map projection showing the globe truly and there is always some distortion in the shape of the graticules. Being unable to acquire all the qualities of a globe, a map projection can't be used as a complete substitute for a globe.

CLASSIFICATION OF MAP PROJECTIONS:

There are two ways of classifying map projections. The first is based on the principle involved in their mode of development and the second is based on the group or family to which they belong.

1. **CLASSIFICATION BASED ON THE MODE OF THEIR DEVELOPMENT:**

Under this scheme we have flowing map projections:

I. Perspective map projections
II. Non-perspective map projections
III. Conventional map projections

I. PERSPECTIVE MAP PROJECTIONS:

The word perspective in the usual sense means the art of representing solid objects on a flat surface in such a way as to give the same impression of relative distance, size, etc., as the objects themselves do when viewed from a certain point. Thus in a perspective map projection the parallels and the meridians of the globe are represented on a surface geometrically from a point. There are three types of surfaces on which parallels and meridians of the globe are transferred and they are

1. A cylinder in which the globe is placed
2. A come which is placed on a globe in such a way that its apex is vertically above the north or South Pole
3. A plane which is placed tangentially to the globe at the north and South Pole.

The cylinder and the cone being developable surfaces are unrolled into flat surfaces. The projection developed on a cylinder is called a cylindrical perspective projection, that developed on a cone is called a conical perspective projection and that developed on a plane is called a zenithal perspective projection.

There are three positions of the view point. They are

- The centre of the globe
- A point on the globe antipodal to the surface on which the projection is drawn
- Infinity

Anyone of these three positions is selected for the viewpoint. The position of the viewpoint and the nature of the surface are selected with a view to developing a particular property in the projection. In actual practice we draw rays from the view point on to the surface

In pure form very few perspective map projections are useful. To make them useful they have been greatly modified.

TYPES OF PERSPECTIVE PROJECTIONS:

Following are the perceptive projections:

ZENITHAL PERSPECTIVE PROJECTION:

- **i.** Gnomonic projection
- **ii.** Stereographic projection
- **iii.** Orthographic projection

i. GNOMONIC PROJECTION:

This is the projection in which the surface is plane placed tangentially at a pole of the globe and the ‘viewpoint’ at the centre of the globe.

ii. STEREOGRAPHIC PROJECTION:

In this projection the surface is plane placed tangentially at a pole of the globe and the viewpoint at the other pole of the globe

iii. ORTHOGRAPHIC PROJECTION:

In this projection the surface is a plane placed tangentially at a pole of the globe and the viewpoint at infinity.

II. NON PERSPECTIVE MAP-PROJECTIONS:

The perspective projections being of limited use have been modified to develop useful properties. Being modified to a great extent they remain no longer geometrical and are, therefore, known as non-perspective projections. They are so modified as to acquire any one or more of the following useful properties:

1. Equal area
2. Orthomorphic
3. General-purpose.

The non-perspective map projections since meet a number of requirements are far more useful and, therefore, more important than the perceptive map projections.

TYPES OF NON- PERSPECTIVE PROJECTIONS:

Following are the non-perspective projections:

1. CYLINDRICAL NON- PERSPECTIVE MAP PROJECTIONS:

i. Simple cylindrical projection
ii. Cylindrical equal-area projection.
iii. Mercator’s or cylindrical orthomorphic projection

i. SIMPLE CYLINDRICAL MAP PROJECTION

This is a very simple projection in which both the parallels and the meridians are represented by straight lines at right angles to one another and are drawn at their true distance apart. They thus form a series of square.

In this projection the distances along the meridians and the equator are correct but those along the parallels are more and more exaggerated towards the poles, which are extended to be of the same length as the equator.

ii. CYLINDRICAL EQUAL-AREA MAP-PROJECTION

The cylindrical equal-area projection is a real projection in the geometrical sense. In it the planes of the parallels are imagines to be extended to meet the circumscribing cylinder which touches the globe along the equator, and so when the cylinder is infolded, the representations of the parallels are straight lines which are parallel to the equator, and are close together towards the poles. The meridians are also straight lines at right angles to the parallels and are spaced at equal distances, as in the simple cylindrical.

iii. MERCATOR'S OR CULINDRICAL ORTHOMORPHIC MAP PROJECTION

This projection named after its inventor, was devised by **Gerardus Mercator**, a Dutch, in **1569** and used by him for a world map. It is based upon a mathematical formula.

The meridians on the simple cylindrical projection and the cylindrical equal-area projection don not converge towards the poles. They are equi-distant throughout these projections, i.e., the distances between the meridians increases towards the poles in these projections

2. CONICAL MAP PROJECTIONS:

i. SIMPLE CONICAL WITH ONE STANDARD PARALLEL:

In this projection the cone touches the globe along a chosen parallel called the standard parallel, which passes through the middle of the area. The meridians are all straight lines converging to a point, the vertex of the cone, which is beyond the North Pole above the top of the map. They are at their true distances apart along the standard parallel. The parallels are all equidistant circular arcs drawn with the vertex of the cone as the center. The distance between any two parallels represents the true distance between them on the globe.

ii. SIMPLE CONICAL PROJECTION WITH TWO-STANDARD PARALLEL.

This projection is a slight modification of the simple conical with one standard parallel. In this, instead of one, take two standard parallels, one towards the middle of the upper half and the other towards the middle of the lower half of the map. Like the simple conic with one standard parallel, all the parallels are at their true distances apart and are represented buy concentric circular arcs whose radii from the meridians. Thus all the meridians are correct to scale.

iii. BONNE'S PROJECTION:

It is a modified conical projection with one standard parallel. It was invented by Rigobert Bonne **(1727-1795).** A French cartographer.

In construction it is very similar to the simple conical projection with one standard parallel. The central meridian is drawn straight and is divided truly, and through the points off division the parallels are drawn as concentric circles as in the simple conical, but the meridians are not straight lines joining the vertex of the cone to the points of division of the standard parallel. Instead of this al the parallels are made of the exact lengths of the corresponding parallels on the globe, and divided truly like the standard parallel. Then the meridians are formed by drawing curves through the corresponding points on each parallel.

iv. POLYCONIC PROJECTION:

In this projection each parallel is constructed in the same way as the chosen standard parallel in the simple conic. The meridians are drawn as in Bonne's. The parallels are, therefore, circular arcs, true distances part along the central meridian, but diverging from one another on either side of the central meridian, as each is drawn from a different centre. The central meridian s a straight line divided truly, while the other meridians are curves, the curvature being slight near the central meridian but increasing rapidly after the first 30 degrees of longitude.

v. INTERNATIONAL PROJECTION:

This projection is very useful modification of the Polyconic, and is employed in one-in-a-million international map of the world, according to the decisions of the international map committee (1909). The map consist of 2,222 sheets, each covering 6 degree of longitude and 4 degree of latitude below the 60^{th} parallel, and 12 degree of longitude and 4 degree of latitude above it up to the 88^{th} parallel, the two sheets of the polar areas are circular, each being 4 degree in diameter.

3. ZENITHAL NON-PERSPECTIVE MAP PROJECTIONS:

i. Zenithal equidistant projection.
ii. Zenithal equal-area projection.

i. ZENITHAL EQUIDISTAND PROJECTION:

This is a very common projection for polar areas and is very easy to draw. In the polar scale, of the net represents the pole and the parallels are drawn from it as concentric circles, at correct distances apart. The meridians are represented by straight lines drawn from the center at the required interval.

ii. ZENITHAL EQUAL-AREA PROJECTION

In the polar-zenithal equal area projection, like the zenithal equidistant, the meridians are radiating straight lines and the parallels are concentric circles, but the distance between the parallel circles are reduced in the same proportion as the scale along the parallels is too large. The parallels are thus closer together away from the centre.

III. CONEVNTIONAL PROJECTIONS:

These projections do not fall into the systems of cylindrical, conical and zenithal projections. In these projections, the parallels and the meridians are drawn arbitrarily so as to make the graticule of a projection more useful for specific purposes. They are drawn generally for showing the whole world.

TYPES OF CONVENTIONAL PROJECTIONS:

Following are the conventional projections:

i. THE SANSON FLAMSTEED OR SINUSOIDAL PROJECTION:

This is a particular case of Bonne's projection where equator is taken as the standard parallel. Therefore, all its properties are also similar. The equator and the central meridians are straight lines at right angles to each other and divided truly. The parallels are also straight lines parallel to the equator and are divided truly for the meridians intervals. The meridians are curves drawn through the corresponding points on the several parallels.

ii. MOLLWEIDE'S MAP PROJECTION:

This projection is invented by Karl B. Mollweide in 1805. It is also known as homolographic projection. "Homolographic" is a word often used to mean "equal-area", a property that this projection possesses. One hemisphere is outlined by a circle; the other hemisphere is divided into two parts and added with an elliptical outline to either side of the circle. All other meridians, except the straight central meridian, are halves of ellipses. The equator is twice as long as the central meridian, which is also true on a globe.

iii. RECENTRED OR THE INTERRUPTED HOMOLOGRAPHIC PROJECTION:

Both the Mollweide's and Sanson-Flamsteed's projections can be interrupted to avoid distortion—the chief drawback of these projections. Breaks can be made in those parts which are not material, e.g. in the case of continents, the breaks could occur at the pecans. The idea is to show only the best part of the projection with each land mass having its own central meridians; hence the word "recentred" means.
In other words, they may be regarded as Mollweide's or Sanson-Flamsteed's projection with several centered meridians.

iv. GLOBULAR:

This is a purely conventional or arbitrary projection which has no special properties except that it is very easy to make. It is often used in atlases for the map of the world in hemispheres.

A circle is drawn to represent each hemisphere, its horizontal diameter representing one-half of the equator and the vertical diameter the central meridian. The meridians are arcs of circles, concave to the central meridian, and spaced at equal intervals along the equator, while the parallels are arcs of circles convex to the equator and spaced at equal intervals along the central and the bounding meridians.

2. CLASSIFICATION BASED ON THE FAMILY OF THE PROJECTIONS:

They are

- **i.** Cylindrical map projections
- **ii.** Conical map projections
- **iii.** Zenithal map projections
- **iv.** Conventional map projections

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CYLINDRICAL MAP PROJECTION:

In these projections, the parallels and the meridians of the globe are transferred to a cylinder which is a developable surface.

This class of projections is most suitable for maps of the equatorial regions, and so the more useful of them are (non-perspective) equatorial, that is where the cylinder touches the equator. Some of them are also used for maps of the world on a single she

CONICAL MAP PROJECTIONS:

The parallel and the meridians of a globe are transferred to a cone placed on the globe in such a way that its vertex is above one of the poles and it touches the globe along a parallel. The parallel along which the cone touches the globe is called a standard parallel. The cone is unrolled into a flat surface. The conical projection is formed.

ZENITHAL MAP PROJECTION:

These are the projections made on a plane touching the globe at any suitable point. The plane is usually made to touch one of the poles or some point on the equator and in oblique cases a point intermediate between the equator and the poles.
It is most suitable for showing polar areas.

The zenithal or azimuthal, group of projections includes all types that are centered about a point and have a radial symmetry.

i. MERCATOR'S PROJECTION:

This projection named after its inventor, was devised by **Gerardus Mercator**, a Dutch, in **1569** and used by him for a world map. It is based upon a mathematical formula.

The meridians on the simple cylindrical projection and the cylindrical equal-area projection don not converge towards the poles. They are equi-distant throughout these projections, i.e., the distances between the meridians increases towards the poles in these projections. Mercator's devised a mathematical formula by virtue of which he placed the parallels increasingly father apart towards the poles thereby increasing the lengths of the meridians but taking care that the increase in the lengths of the meridians was in the same proportion in which the lengths of the parallels increased. By doing so he got a true orthomorphic projection. The projection is, therefore, also called the cylindrical orthomorphic projection.

In this projection, as in simple cylindrical projection, the parallels and the meridians are represented by straight lines at right angles to one another, and the meridians are spaced at equal distances. But to preserve the shapes of areas, the distance along the meridians (i.e., between the parallels) are elongated. In various latitudes in proportion to the stretching of the parallels, all of which are represented by exaggerated lengths, all being equal to the equator. In other words, at any latitude the meridians are stretched towards the poles to the same extent as they are done east and west to become parallel to one another. The scale along the meridians is increased in the same proportion as it is done along the parallels, so that it is the same north and south as it is east and west.

MERITS:

1. The Mercator's chart is true conformal projection. Any small island or country is shown in its true shape.

2. The really important, unique features of an equatorial Mercator projection is that a straight line drawn anywhere on the map, in any direction desired, is a line of constant compass bearing. Such a line is known to navigators as a rhumb-line, or loxodrome. If this line is followed, the ship's (or plane's) compass will show that the course is always at constant angle with respect to geographic north. Once the proper compass bearing is determined, the ship is kept on the same bearing throughout the voyage, if the rhumb line is to be followed. The mariner gets his direction by the rhumb-line but tries to remain as near the great circle as possible to follow the shortest route. Lines indicating the great circles are marked on the maps (drawn on this projection) with the help Of Gnomonic projection. He breaks up the great circle into a number of sections and joins the points of divisions (on the great circles) by lines which serve as various legs of the rhumb-line. The mariner follows the first leg until he reaches the great circle. He then changes his bearing to follow the next leg of the rhumb-line. Thus, he goes on changing his bearings till he reaches his destination.

3. The equatorial Mercator is the only one of all known projections on which all rhumb lines are true straight lines, and vice versa. A protector can be used with reference to any meridian on the map, and the compass bearing of any straight line can be measured off directly.

4. It provides an excellent grid for equatorial regions.

5. Certain forms of geographical information are best shown on the Mercator's projection.

6. Because of its accurate depiction of the compass direction of lines, the Mercator net is preferred for maps of direction flow of oceans currents and winds, or lines of equal value of air pressure and air temperature.

7. This projection is commonly used for navigational purposes both on the sea and the air. The distance along a rhumb-line between any two points is greater than the distance along the great circle between the same two points, on the earth. A rhumb-line on this projection is a straight line but a great circle running more or less in the east-west direction is a curved line. A great circle bends towards the poles—northwards in the northern hemisphere and southwards in the southern hemisphere. A rhumb-line and a great circle, however, run together as a straight line along the equator and the meridians on this projection.

DEMERITS:

1. The scale along the parallels and the meridians increases rapidly towards the poles. There being a great exaggeration of scale along the parallels and the meridians in high latitudes for this reason, the polar areas cannot be shown satisfactorily on this projection.

2. Poles cannot be shown on this projection because the exaggeration in the scales along the **90º parallel** and the meridians touching them is infinite.

3. Because of infinite stretching towards the poles, this map fails completely to show how the land areas of North America, Asia and Europe are grouped around the polar area. In the mind of inexperienced user, it may enhance a false sense of isolation between inhabitants of these lands.

4. The Mercator's projection is orthomorphic. it preserves shapes for small areas. As the scale changes from latitude to latitude the shapes of bigger areas are distorted

ii. BONNE'S PROJECTION:

It is a modified conical projection with one standard parallel. It was invented by Rigobert Bonne **(1727-1795).** A French cartographer.

In construction it is very similar to the simple conical projection with one standard parallel. The central meridian is drawn straight and is divided truly, and through the points off division the parallels are drawn as concentric circles as in the simple conical, but the meridians are not straight lines joining the vertex of the cone to the points of division of the standard parallel. Instead of this al the parallels are made of the exact lengths of the corresponding parallels on the globe, and divided truly like the standard parallel. Then the meridians are formed by drawing curves through the corresponding points on each parallel.

MERITS:

1. All the parallels are correctly divided for spacing the meridians. The scale along all the parallels is, thus, correct.

2. The central meridian is a straight line and it is correctly divided for spacing the parallels. The scale along the central meridian is, thus, correct.

3. The scale along the parallels is correct and the distance (perpendiculars) between them is also correct. Evidently, the area between any two parallels on this projection is equal to the area between the same two parallels on the globe. As all the parallels are correct to scale and the perpendicular distance between them is also correct it is, therefore, an area-equal projection.

4. The rectangle, enclosed by any two parallels and meridians on the globe, is represented in the projection by a parallelogram which is on equal base and of equal height to scale.

5. This projection is most common in atlases

6. Since it is an equal-area projection and since shapes are maintained satisfactorily for small areas, this projection is commonly used for showing maps of European countries such as Spain, France, and Germany. Etc. it can be used for drawing general-purpose maps.

7. Large areas such a North America and Australia are also shown on this projection in some atlases.

8. This projection is also used by small countries of middle latitude for making topographical sheets.

DEMERITS:

The shapes away from the central meridians are distorted, the distortion increasing away from the central meridians. The shapes in the margins of the projection showing a large area such as Asia are much distorted. Therefore, this projection maintains shapes satisfactorily along with its equal-area property if areas are small and compact and have not large longitudinal extent. Hence, the projection is not orthomorphic and the shapes are not well preserved. This projection is ill adapted for countries having great extent in longitude.

iii. MOLLWEIDES HOMOLOGRAPHIC PROJECTION:

This projection is invented by Karl B. Mollweide in 1805. It is also known as homolographic projection. “Homolographic” is a word often used to mean “equal-area”, a property that this projection possesses. One hemisphere is outlined by a circle; the other hemisphere is divided into two parts and added with an elliptical outline to either side of the circle. All other meridians, except the straight central meridian, are halves of ellipses. The equator is twice as long as the central meridian, which is also true on a globe. Parallels are straight, horizontal lines, becoming more closely spaced towards the poles. The spacing of parallels, so adjusted as to give the map equal-area properties, is obtained by an individual method.

In this projection all the meridians are ellipses excepting the central and the 90^{th} meridian which are the special cases when the ellipse respectively becomes a straight line and a circle. The parallels are all straight lines parallel to the equator, but are not spaced at equal intervals. The distance between the parallels gradually decreases as the latitude increases.

MERITS:

1. Its equal area property makes it valuable for showing the global areal distribution of geographical or political entities.

2. It makes a good base for maps of Africa and South America, either of which can be included in the central area of relatively little distortion.

3. Interrupted and titled forms have proved valuable as world maps.

4. It can be centered on any desired meridians as to reduce distortion for a particular area.

DEMERITS:

1. As the projection is equal-area. The scales, both along parallels and the meridians, are incorrect, and the distortion increase away from the central meridian.

2. Severe distortion in the Polar Regions has hindered its wider use. Even on the central meridian, small tracts of country are stretched vertically and contracted horizontally near the equator, and stretched horizontally and contracted vertically near the poles.

3. There are only two points on the central meridian where the map is orthomorphic.