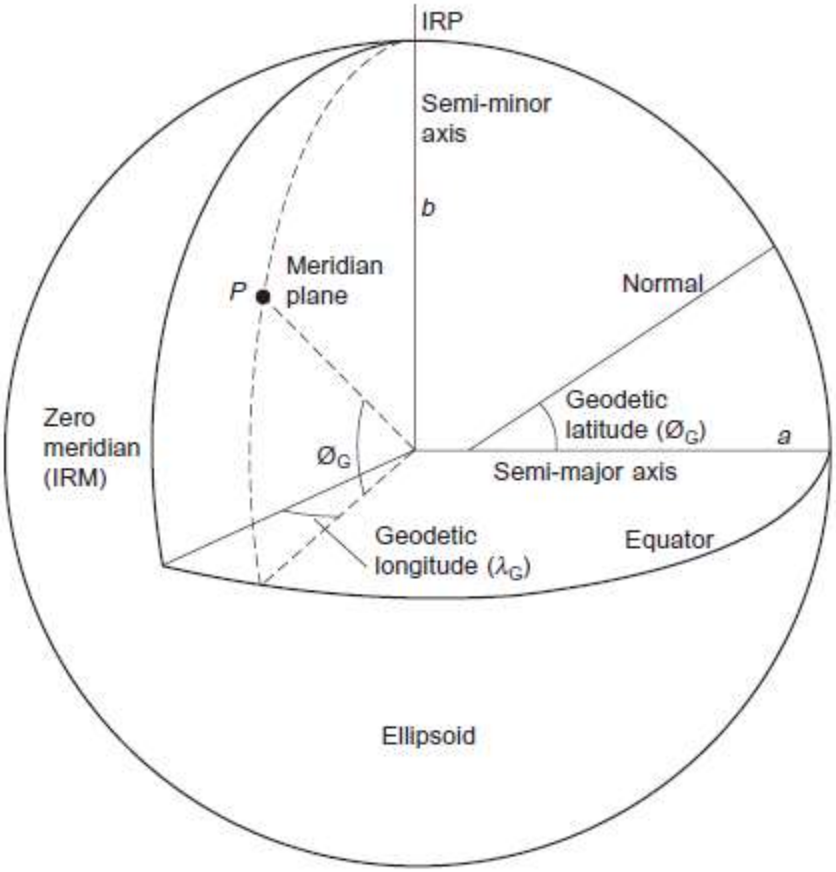
Geodetic Position

- ***Geodetic coordinates***

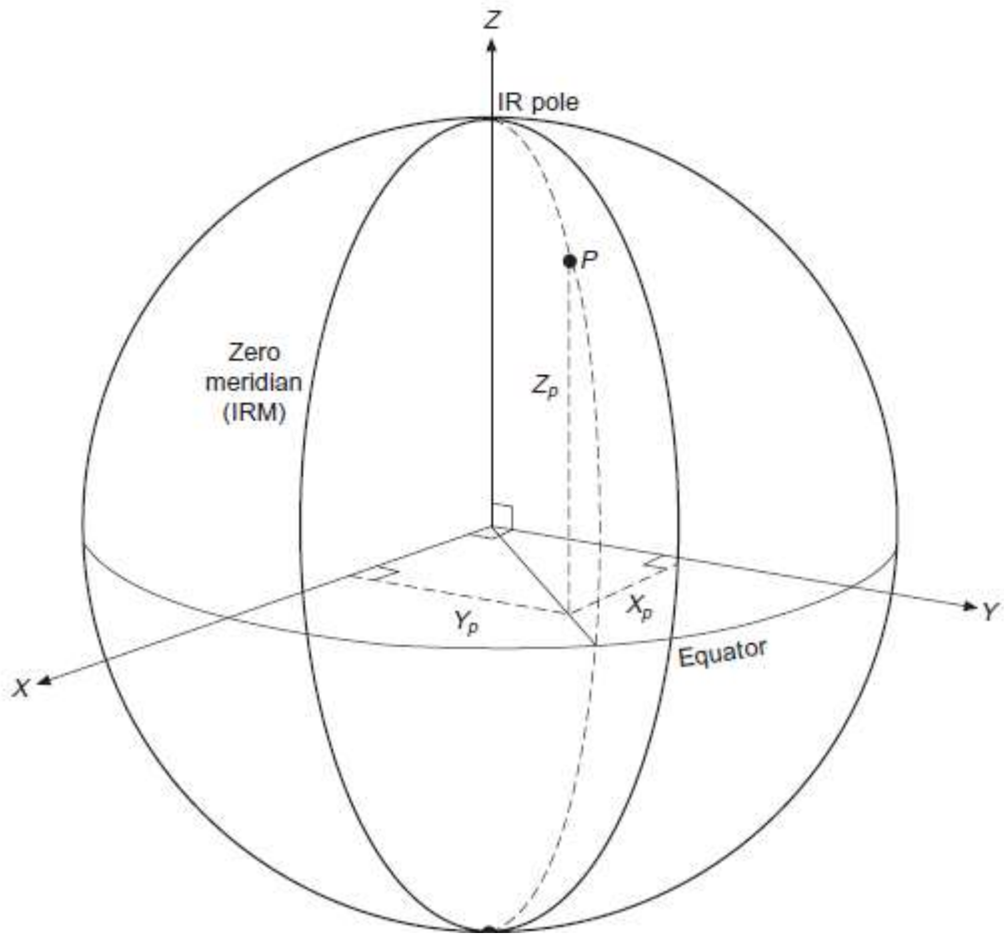
Considering a point (*P*) *at* height ***h***, measured along the normal through (***P***), above the ellipsoid, the ellipsoidal latitude and longitude will be ϕ_G and λ_G, as shown in Figure below. Thus the ellipsoidal latitude is the angle describing the inclination of the normal to the ellipsoidal equatorial plane. The ellipsoidal longitude is the angle in the equatorial plane between the International Reference Meridian (IRM) and the geodetic meridian plane through the point in question (*P*). The height ***h*** of P above the ellipsoid is called the ellipsoidal height. As the ellipsoid has a conceptually smooth surface no two points will have the same coordinates, as in the previous system. Also, the ellipsoidal coordinates can be used to compute azimuth and ellipsoidal distance. These are the coordinates used in classical geodesy to describe position on an ellipsoid of reference.



- **Cartesian coordinates**

As shown in Figure below, if the International Earth Rotation Service (IERS) spin axis is regarded as the ***Z***-axis, the ***X***-axis is in the direction of the zero meridian (IRM) and the ***Y***-axis is perpendicular to both, a conventional three-dimensional coordinate system is formed.

Cartesian coordinates are used in satellite position fixing. Where the various systems have parallel axes but different origins, translation from one to the other will be related by simple translation parameters in X, Y and Z, i.e. Δ_X, Δ_Y and Δ_Z.



- **Plane rectangular coordinates**

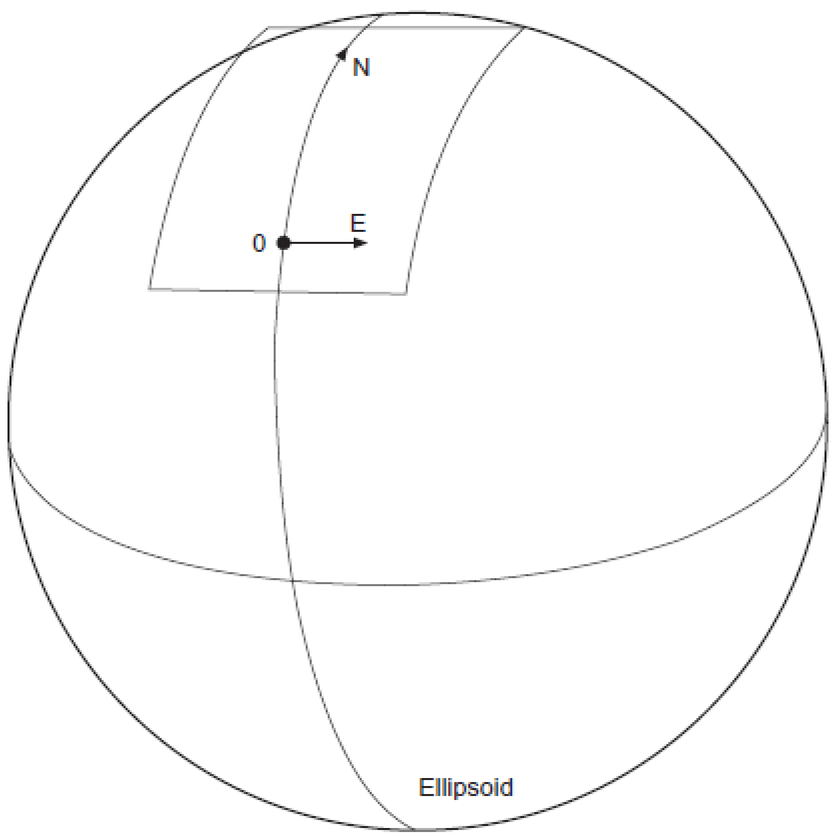
The geodetic surveys required to establish the ellipsoidal or cartesian coordinates of points over a large area require very high precision, not only in the capture of the field data but also in their processing. The mathematical models involved must of necessity be complete and hence are quite involved. To avoid this the area of interest on the ellipsoid of reference, if of limited extent, may be regarded as a plane surface or curvature catered for by the mathematical projection of ellipsoidal position onto a plane surface. These coordinates in the UK are termed eastings (***E***) and northings (***N***) and are obtained from

$$E = f_E\ (\phi_G, \lambda_G)\ (ellipsoid\ parameters)$$

$$N = f_N\ (\phi_G, \lambda_G)\ (ellipsoid\ parameters)$$

The result is the definition of position by plane coordinates (***E, N***) which can be utilized using plane trigonometry.

Figure below illustrates the concept involved and shows the plane tangential to the ellipsoid at the local origin ***O***.



- **Height**

In outlining the coordinate systems in general use, the elevation or height of a point has been defined as 'orthometric', 'ellipsoidal' or by the ***Z*** ordinate. With the increasing use of satellites in engineering surveys, it is important to understand the different categories.

Orthometric height (***H***) in general terms, it is referred to as height above MSL.

Ellipsoidal height is rarely used in engineering surveys for most practical purposes. However, satellite systems define position and height in ***X***, ***Y*** and ***Z*** coordinates, which for use in local systems are first transformed to ϕ_G, λ_G and ***h*** using. The value of ***h*** is the ellipsoidal height, which, as it is not related to gravity, is of no practical use, particularly when dealing with the direction of water flow. It is therefore necessary to transform ***h*** to ***H***, the relationship of which is shown in Figure below.