

# Numerical Analysis Project

## MATH 5600

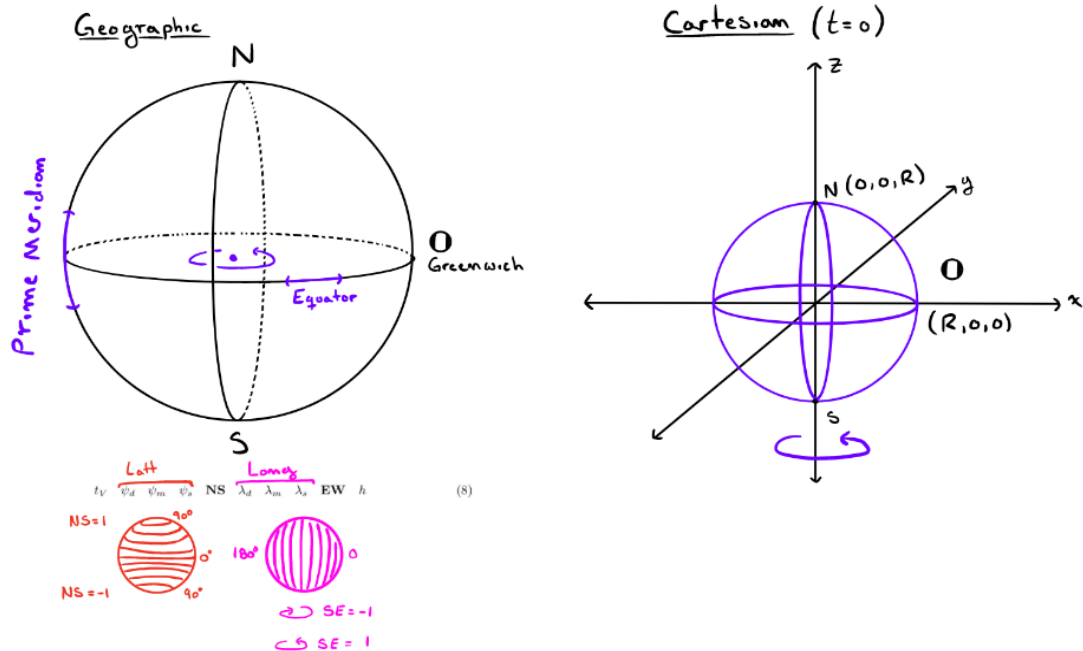
### Homework 1

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## Models of the Earth with Respect to Coordinate Systems

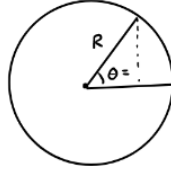
In our work through the term project, we utilize two coordinate systems: Geographical and Cartesian. Geographical coordinates are used to identify a location on the Earth in terms of Longitude and Latitude. In relationship with Cartesian coordinates, Geographic coordinates rotate around the z-axis with respect to time. At time = 0, the x-axis intersects the globe at the Equator and Prime Meridian. The y-axis therefore perpendicular to the xz-plane.



**Exercise 1:** Find a formula that describes the trajectory of the point **O** in Cartesian coordinates as a function of time.

From Physics, we know that distance is equal to the rate of an object multiplied by the time traveled. We can apply this to trajectory with the equation  $\theta = \omega \cdot t$ , where  $\omega$  is angular

velocity. Angular velocity is the distance around the globe divided by one sidereal day. Thus we obtain the angle  $\theta = \frac{2\pi}{s} \cdot t$ . The formula that describes the trajectory of the point **O** as a function of time in Cartesian coordinates is:



$$\mathbf{O}_{car}(t) = \begin{bmatrix} R \cos\left(\frac{2\pi}{s} \cdot t\right) \\ R \sin\left(\frac{2\pi}{s} \cdot t\right) \\ 0 \end{bmatrix}$$

**Exercise 2:** Write a program that converts angles from degrees, minutes, and seconds to radians, and vice versa.

```

1  import math
2  pi = math.pi
3
4  def deg_to_rad(deg, min, sec):
5      rad = (deg + min / 60 + sec / 3600) / 180 * pi
6      return rad
7
8  # Need to find a way to separate the whole number.
9  def rad_to_deg(rad):
10     dummy = rad * 180 / pi
11     deg = floor(dummy) # Just use the whole number
12     min = floor((dummy - floor(dummy)) * 60) # Multiply the decimals by 60
13     sec = floor(((dummy - floor(dummy)) * 60 - min) * 60)
14     return deg, min, sec
15

```

**Exercise 3:** Find a formula that converts position as given in (8) at time  $t = 0$  into Cartesian coordinates. It is important to note the parameters for the following variables:  
 $t_V = 0$   $\psi_d, \psi_m, \psi_s \in \left[0, \frac{\pi}{2}\right]$