

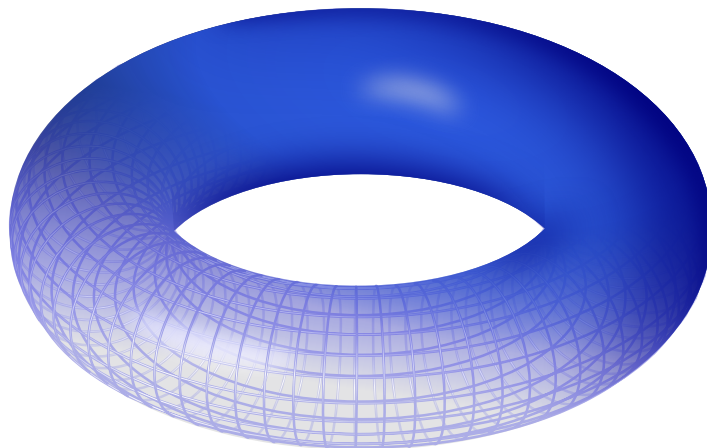
# Exercise: Plotting Torus

In this lesson, you will be plotting a torus.

## WE'LL COVER THE FOLLOWING ^

- Task
- Problem statement

In geometry, a **torus** is a surface of revolution generated by revolving a circle in three-dimensional space about an axis that is coplanar with the circle.

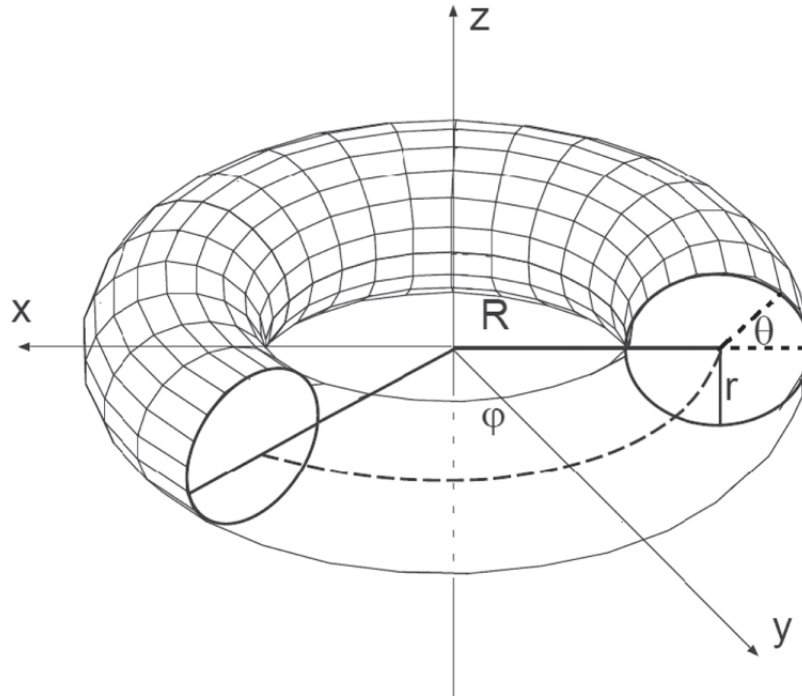


A torus is defined by the following equation:

$$x(\theta, \phi) = (R + r\cos\theta)\cos\phi$$

$$y(\theta, \phi) = (R + r\cos\theta)\sin\phi$$

$$z(\theta, \phi) = r\sin\theta$$



Courtesy: <https://answers.unity.com/storage/temp/114690-parametrization-of-a-torus-by-coordinates-left-the.png>

If you see the diagram above,

- $\theta$  and  $\phi$  are angles which make a full circle so their values start and end at the same point:
  - $\theta$  is the angle inside the cross-section of the tube and is in the  $x - z$  plane.
  - $\phi$  is the angle from one point on the torus to another point through the center and it lies in the  $x - y$  plane.
- $R$  is the distance from the center of the tube to the center of the torus,
- $r$  is the radius of the tube.



The ratio  $R : r$  is usually  $3 : 1$  or  $2 : 1$ .

## Task #

In this exercise, you will plot tori with a different viewing axis and colormaps using surface plots.

## Problem statement #

Define a function `torus()` with arguments `r`, `R` and `angle`.

`torus()` should return 3 arrays: `x`, `y` and `z`.

Plot **two** 3-D surface plots on the same figure with different axes. Set the values of arguments as you seem fit.

Set appropriate axis limits based on the dimensions of your torus.

### Properties of First Plot

1. colormap = `cool`
2. elevation angle = 36
3. azimuthal angle = 26

### Properties of Second Plot

1. colormap = `rainbow`
2. elevation angle = 15
3. azimuthal angle = 45



Use all the important modules needed.

A basic structure of the code is given below.

```
# importing modules
import matplotlib.pyplot as plt

# defining function
def torus(r, R, theta, phi):
    # write your function here
    pass

# initializing values of arrays
# write your code here

# initializing figure
# write your code here

# plotting commands for first plot
```



```
# write your code here

# plotting commands for second plot
# write your code here

# plot saving command
plt.savefig('output/torus.png')
```



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The solution to this exercise will be discussed in the next lesson.