Name: Andrew Brown	**Lab Time:** T 12:00
People Worked With: Cailin Moore	**Websites Used: none**
Time spent on zyBooks (hrs):1	**Time spent on lab (hrs):2**
Submission Instructions	
Turn all work in to Lab 10 on Gradescope (PDF) and Canvas (.zip file), even if it is not complete yet. If you are not finished, complete the assignment outside of lab and re-submit to Lab 10 on Gradescope and Canvas. All labs are typically due at the same time on Monday every week, but check Canvas if in doubt.	

Learning objectives:

- Making and plotting surfaces
- Plotting in 3D

New MATLAB commands

These are highlighted in **bold** in the instructions below.

- `surf( xs, ys, zs, 'FaceColor', [0.5, 0.5, 0.5], 'EdgeColor', 'none')` – Make a surface. FaceColor and EdgeColor are optional. Color is red, green, blue from 0 to 1
- `camlight left; lighting phong;` - add light and nice shading
- `alpha(0.2);` - make the surface transparent. Parameter is 0-1 from less to more transparent
- `sign(x)` – returns 1 if x is positive, -1 if x is negative, 0 if x is zero

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Lab Problems

Files to download to your Lab 10 Folder

- *DataFiles.zip*
- *unzip them to get srfX.txt etc*

Getting Started

Anything for experimentation goes here with bullet points

- Do this
  - [X, Y, Z] = sphere();
  - surf(X,Y,Z);
  - axis equal
- Look at picture than do
  - [X, Y, Z] = cylinder();
  - surf(X,Y,Z);
  - axis equal
  -
- Then do
  - [X, Y, Z] = cylinder([1 0.2 1]);
  - surf(X,Y,Z)
  - axis equal
  -
- And look at picture
- Make sure you can read in the data files from DataFiles.zip
  - X = dlmread('srfX.txt')
    - same for Y and Z
  - surf(X,Y,Z)
  - axis equal
  -

Problem 1

Make a surface of revolution and plot/draw it

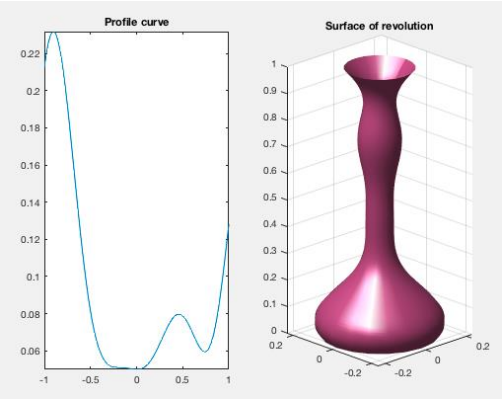
Deliverables:

1. Script that does the surface creation and plotting
2. Figure showing the profile curve and the surface

Step by Step Instructions:

- Create a function for the profile curve. If you don't want to the surface to "pinch" in the middle then make sure your function is always positive.
    - The t values can be anything (zero to one, -1 to 1, 0 to 2 pi, etc)
    - Plot the function
        - You can create values and plot, or use fplot – whatever you want
- Now create the surface of revolution
    - [X,Y,Z] = cylinder(ys)
        - ys has to be an array of values, not a function
            - i.e., if you made an anonymous function, evaluate it to get an array
        - ys = YourFunction(t values)
        - Make sure you use the same t value range you used in the profile curve picture
    - Plot using surf(). Set the color and the camera and the light.

Self-check: You do not have to replicate this picture; just do something "interesting"



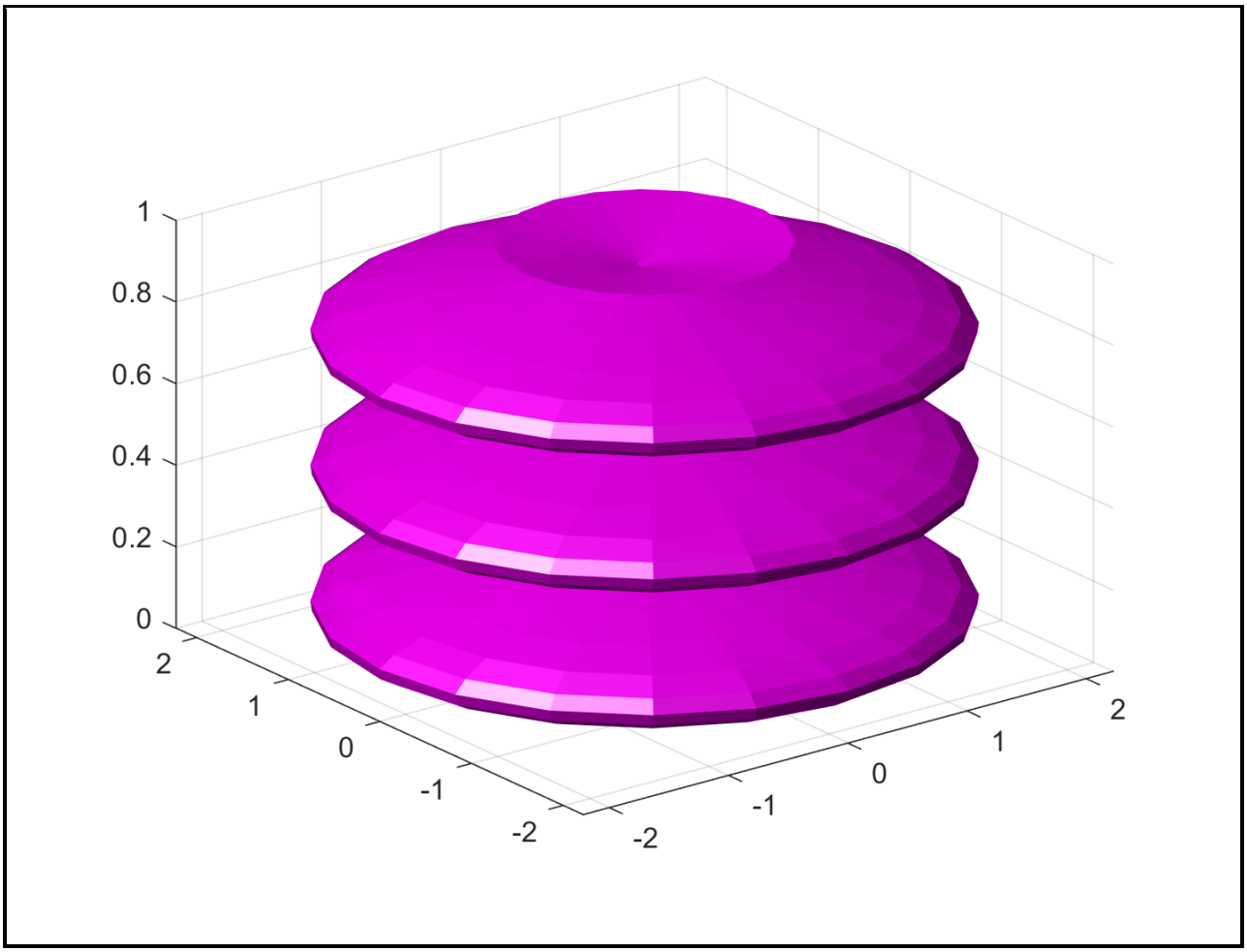
Grading Criteria:
[20 pts] [Create function/profile curve]
[20 pts] [Plot of curve]
[30 pts] [Create surface of revolution]
[30 pts] [Plot of surface]

Answer script here:

```
% Andrew Brown Lab 10 Script 1

clc
clear
close all

%Practice plotting surfces

%Create t-values
t=linspace(0,3*pi,40);

%Create fucntion to plot
myFunc = @(t) abs(2*sin(t)+cos(t));

%pass t values through the function
ys=myFunc(t);

%plot the fucntion
fplot(myFunc)

%get the vales into cylidrical coordinates
[x,y,z]=cylinder(ys);

%plot the suface with cylindrical coordinates
surf(x,y,z,'FaceColor','m','EdgeColor','none')
camlight left %lighint from the left side
lighting flat
% alpha(0.6);
```

Function scripts here (if any):

Plot here:


1
0.8
0.6
0.4
0.2
0
2
1
0
-1
-2
-2
-1
0
1
2

Problem 2

Read in surface data and plot surfaces with a centerline.

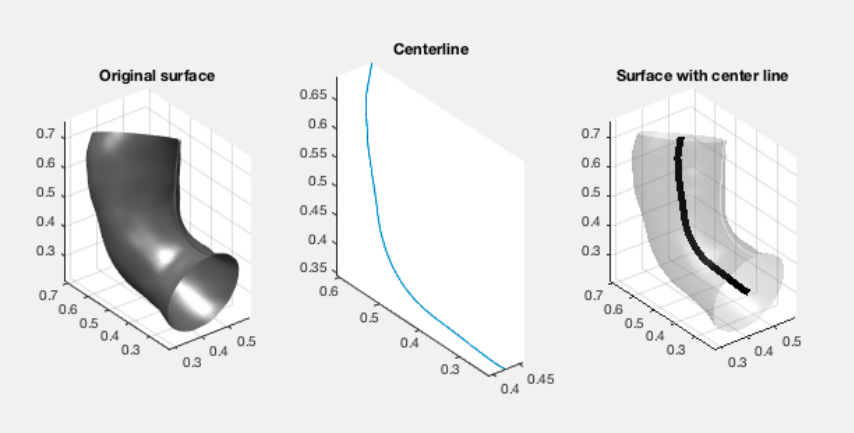
Deliverables:

3. Script to read in data and plot it
    a. Find the axis
    b. Plot it, too
4. Plot of surfaces with centerline

Step by Step Instructions:

- Read in the 3 surface files, srfX, srfY, and srfZ
    - These are each 80X50 2d arrays with the X, Y, and Z coordinates of the surface
    - See getting started
- Plot these using surf
    - Set the color to be whatever you want (I used gray)
    - Turn the edges off `('EdgeColor', 'none')`
    - See above for turning on camera light and doing
- Calculate the mid-line of the surface (i.e., the black line that runs down the middle)
    - This is the average of each circle of points
        - One point for each circle
    - A cylinder is a sheet of paper (the grid) ''wrapped" around so the opposite edges touch
        - Try this with a piece of paper – make a telescope out of it
        - Sketch a grid on the paper – see how one row (or column) of the grid makes one circle?
    - Use mean to find the average of each circle
        - eg `xC = mean( xs )`
    - Use plot3 to plot the result (middle picture below)
        - If you're stuck, grab a TA
- Now plot the surface AND the mid-line
    - Plot the mid-line first
    - Then plot the surface transparent
    - Then make the surface transparent using `alpha(0.2)`

Self-check:



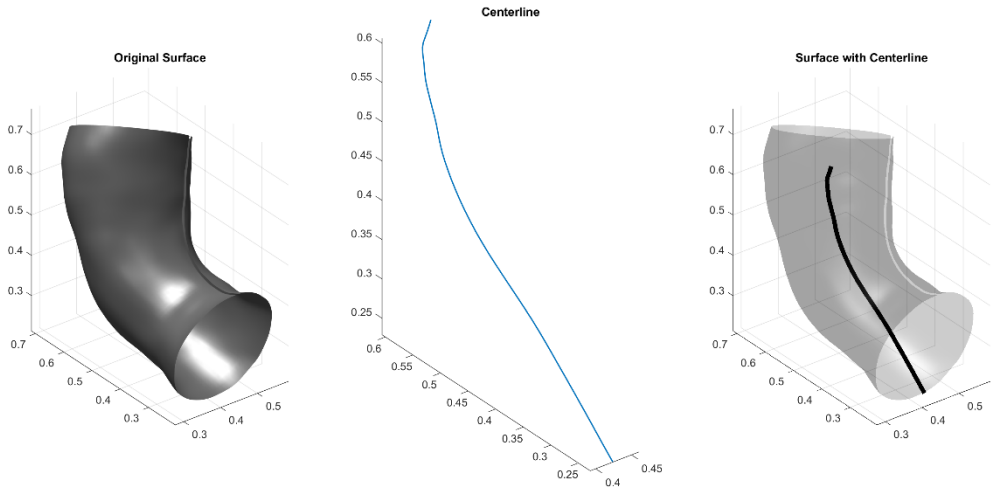
Grading Criteria:
[20 pts] [Reading data in]
[20 pts] [Plotting surface]
[20 pts] [Calculate mean/mid-line]
[20 pts] [Plot mid-line]
[20 pts] [Plot mid-line with transparent surface]

Answer script here:

```
% Andrew Brown Lab 10 Script 2

clc
clear
close all

% Practice with surf

%Read in the given data
x=dlmread('srfX.txt');
y=dlmread('srfY.txt');
z=dlmread('srfZ.txt');

%plot the surface with the given surf data
subplot(1,3,1)
surf(x,y,z,'Facecolor',[0.5,0.5,0.5],'Edgecolor','none')
camlight left %left lighting
lighting phong %phong lighting
axis equal
title('Original Surface')

%plot the average of the circles of the given data
subplot(1,3,2)
xs=mean(x); %avg of x vals
ys=mean(y); %avg of y vals
zs=mean(y); %avg of z vals
plot3(xs,ys,zs,'Linewidth',1.2) %plot a 3D line
axis equal
title('Centerline')

%plot both the line and the surface (transparent)
subplot(1,3,3)
```

```
surf(x,y,z,'Facecolor','k','Edgecolor','none') %plot surface
alpha(0.2) %make surface transparent
hold on
plot3(xs,ys,zs,'k','Linewidth',4) %plot line
camlight left %left lgihting
lighting phong %phong lghting
axis equal
title('Surface with Centerline')
```

Plot here:



Problem 3

Do a 3D surface function. You can make a sphere, cylinder, cone - or a sheet. You may not call sphere/cylinder for this problem.

Extra credit:

Do a super quadric instead: https://en.wikipedia.org/wiki/Superquadrics

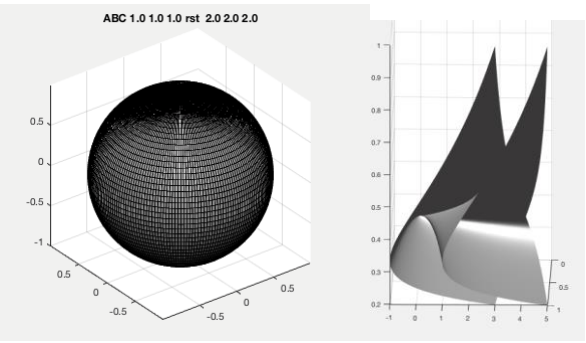
Deliverables:

5. Function to map s,t to x,y,z (in a function file)
6. Script to create grid of points, call surface, and plot surface
7. Picture of your surface

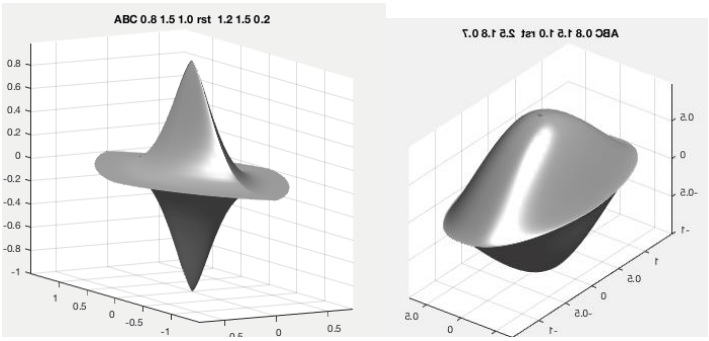
Step by Step Instructions:

- Create a function file that takes in u,v and returns X,Y,Z
  - Sphere/cylinder/cone: Use the equation (google it)
  - Sheet: I did the equation below; but you can make up your own
    - $X = u^2$
    - $Y = v^2 + u$
    - $Z = 1/(uv + 3)$
- Use `meshgrid` to create your U,V 2D array of u,v values
  - Sphere/cylinder/cone: usually has one of u,v going from -pi to pi, the other going from -pi/2 to pi/2 (or sometimes 0 to pi). Make sure the grid is the right-way round
    - If you get half a sphere or a double sphere you may need to swap u and v
  - Sheet: I did -1 to 1 for u, -2 to 2 for v
- Call your function with your U and V 2D arrays
- Plot using surf
- Extra credit:
  - This would be a really good time to use a struct to carry around the parameters for your superquadric…
  - You will need two auxiliary functions, f and g, in addition to the main function
    - You will need the function `sign(x)` to write f and g
  - If A = B = C = 1,and r = s = t = 2 then you get a sphere. See comment above about u and v in `meshgrid` above if you are, eg, getting half a surface
  - Title your plot with your ABC and rst values

Self-check: *`Sphere or sheet`*



Example extra credit



Grading Criteria:
[40 pts] [*Function file taking in u,v and returning X,Y,Z (must work for arrays)]*
[40 pts] [*Setting up meshgrid correctly]*
[20 pts] [*Plotting]*
[+50EC] [Superquadric]

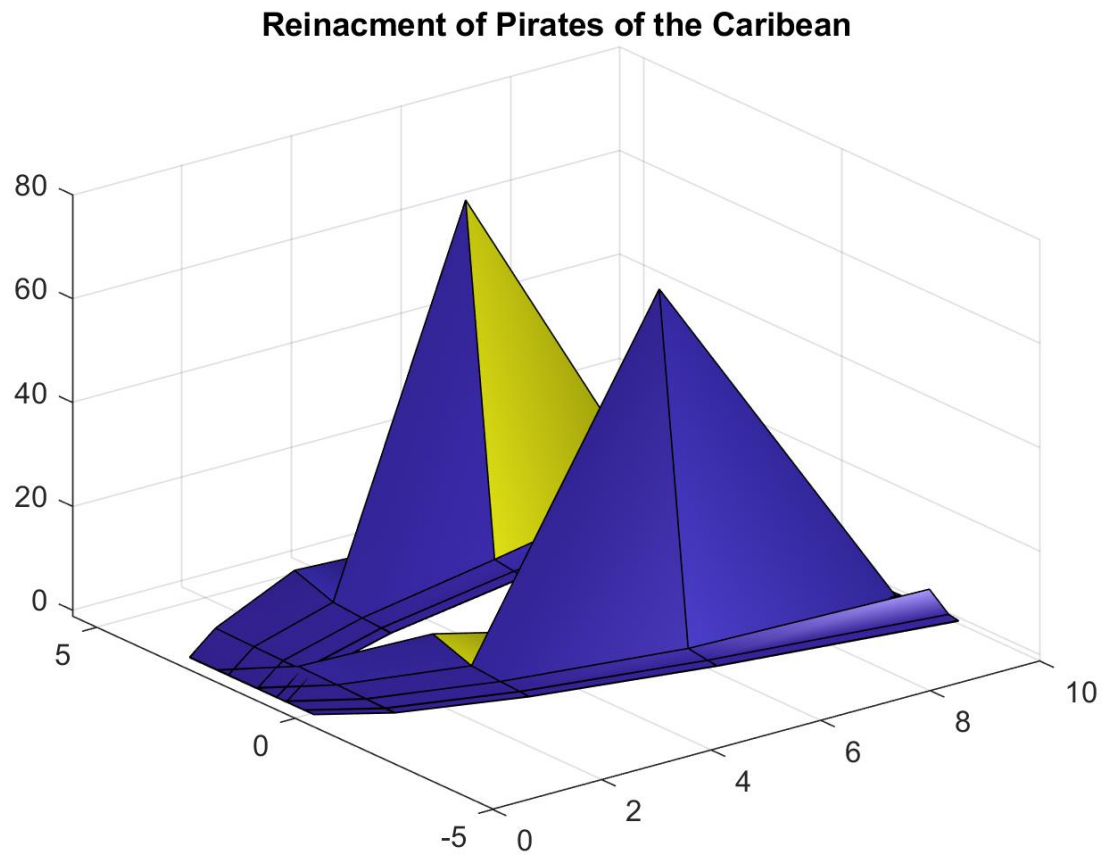
Answer script here:

```
%Andrew Brown Lab 10 Script 3

clc
clear
close all

%Practice with Super quadrics

u=linspace(-pi,pi,10); %Define u vals
v=linspace(-pi/2,pi/2,10); %define v vals

[U,V]=meshgrid(u,v); %mate v and u matrices

%Put matrices through function
[x,y,z] = Quadric(U,V);

%Plot the super quadric
surf(x,y,z)
title('Reinacment of Pirates of the Caribean')
camlight right
lighting phong
```

Function scripts here:

```
function [x,y,z] = Quadric(u,v)
%QUADRIC creates super quadric values
x=u.^2;
y=v.^(2)+u;
z=1./((u.*v)+3);
end
```

Plot here:



zyBooks Challenge Exercises

Do the challenge activities for the following in Week 10

1. *10.3.1: Logic array: Identifying qualifying times*
2. *10.3.2: Extracting data: Heart rate (pulse)*