Mathematica Project for MA 2733-02

Due: Tuesday, December 3, 2024, in class

You may work in **groups (with other students in YOUR class) or by yourself** for this project. No more than 5 people can be in a group. Turn in only one printed copy of the project to be graded. You will also submit one copy of the code file on Canvas. All students who decide to work in groups will receive the same grade. ***Use Mathematica* to complete the problems.** When you have finished the problems, print out your finished *Mathematica* Notebook as a pdf. Please make sure that everything in your Notebook is labeled clearly as to what problem is answered by which section of code. The best way to do this is to clearly number or type each problem as text into your Notebook in the appropriate places.

You may work on your own computer, or you can access *Mathematica* (and save and print your Notebooks) in any MSU computer lab. The Allen 414 computer lab is open from 5pm – 7pm Wednesday and Thursday. Lab assistants will be available in the lab for help on Wednesday and Thursday from 5pm – 7pm. Their responsibility is to help with coding *Mathematica*, not working the mathematics. Be sure to bring a portable storage device if you want to save your Notebook for future work. (Or you can email your Notebook to yourself)

Missing any of the items below will result in a reduction of points on the project grade.

Your finished project should consist of the following:

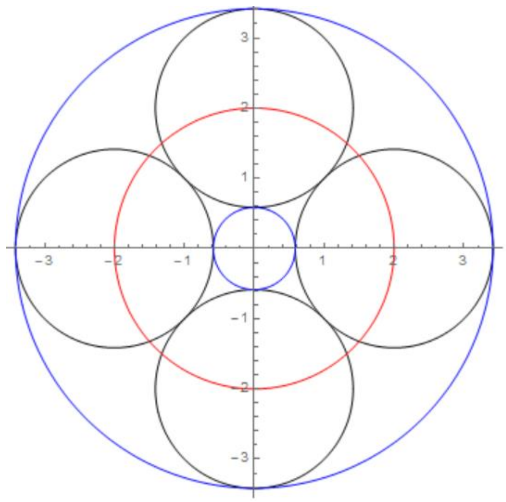
1. A **printed** copy of your *Mathematica* Notebook with each problem **clearly labeled**. To print, it may help to save as a PDF first and then print that.
2. Each student's name who worked on the project (with NetIDs) should be at the top of the first page.
3. **Staple** all pages together **in order** in the upper left corner.

Once completed, print the *Mathematica* file with **input/output** statements included, and upload your *Mathematica* Notebook file (.nb) into Canvas under the appropriate submission link.

Remember that you can stop by during my office hours or make an appointment to get advice or assistance on your *Mathematica* Project.

Every problem is worth equal weight.

1. Use Mathematica to recreate the following picture. Make sure that you are using the command ParametricPlot and not the command Circle. (Hint: This can be done in all black ink and you will need to use $PlotRange \to \{\{x_{min}, x_{max}\}, \{y_{min}, y_{max}\}\}$ to get entire graph).



2. Find the equation of the tangent line for the following function. Then plot the original function and the tangent on the same graph. Use the Solve function to find the tangent line.

$$x = t^2 - t \qquad y = t^2 + t + 1 \qquad t = 1$$

3. Use Mathematica to graph the following curve. Choose the parameter interval to ensure you get the entire graph

$$r = \cos^2\left(\frac{\theta}{64}\right)$$

4. Use Mathematica to graph the following curves. Then find the exact area that lies inside the first curve and outside the second curve. (You will need to figure out your own parameters. You will need to use the Solve function in Mathematica to help find the parameters)

$$r = 3\cos\theta \qquad r = 2 - \sin\theta$$

5. (Using ContourPlot3D):
   a. Use Mathematica to sketch and name the surface $-x^2 + y^2 - z^2 = 1$
   b. Use Mathematica to sketch the surface $(3x^2 + 3z^2 + 25y^2 - 1)^3 + 4x^2z^3 + \frac{6}{25}y^2z^3 = 0$

6. If $\boldsymbol{r}(t) = \left\langle \frac{t}{t^2+1}, \sqrt{t-3}, 2\cos\left(\frac{t}{2}\right) \right\rangle$, find $\boldsymbol{r}'(t), \boldsymbol{T}(t), \boldsymbol{r}''(t), and\ \boldsymbol{r}'(t) \times \boldsymbol{r}''(t)$.

7. Graph the curve with the following vector function and find the total length of the curve to four decimal places.

$$\boldsymbol{r}(t) = \langle t^4, t^2, t^3 \rangle, \qquad 0 \le t \le 2$$

8. Graph the curve with parametric equations $x = \sin t\,, y = \cos t\,, z = \cos(3t)$ and find the curvature at the point $(1, 0, 0)$.

9. Find the vectors $\boldsymbol{T}, \boldsymbol{N}, \boldsymbol{B}$ at the given point. (Hint: $\boldsymbol{B} = \boldsymbol{T} \times \boldsymbol{N}$)

$$\boldsymbol{r}(t) = \langle t^2, \ln t\,, 2t \rangle, \quad (1, 0, 2)$$

10. Find the Taylor Polynomial $T_{10}(x)$ for the function $f(x) = \cos(x^2)$ centered at the number $a = 0$. Graph $f(x)$ and $T_{10}(x)$ on the same xy-plane between $-\frac{3\pi}{4} \leq x \leq \frac{3\pi}{4}$. Use the Taylor Polynomial to find the y-value when $x = \frac{\pi}{4}$ and compare that with the actual y-value for $f(x)$ when $x = \frac{\pi}{4}$.