Mathematics 1110H – Calculus I: Limits, Derivatives, and Integrals
Trent University, Summer 2023 (S61)

Plotting with SageMath
Due* just before midnight on Friday, 12 May.

Before tackling this assignment, please read *Getting Started with* `sage.trentu.ca`, if you haven't already, as well as take a peek at the file `1110H-lab-20230503.pdf`, both of which you can find in the Labs folder in the Course Content section on Blackboard. Skimming and later referring to as necessary to Sections 1.4, 3.3, 3.4, and 3.6 of Gregory Bard's book *Sage for Undergraduates*, which you can find in the SageMath folder in the Course Content section on Blackboard, is probably a good idea. (There are other possibly useful resources in that folder, too.) Should you wish to use another general purpose mathematics application, such as Maple or Mathematica, you may, but you're on your own for learning to use it and getting help.

In each of questions **1**–**4**, use SageMath, or a comparable program, to plot the required graphs.

1. Plot the following graphs in Cartesian coordinates. *[2 = 4×0.5 each]*
   a. $y = x^3 - x$ for $-2 \le x \le 2$.
   b. $y = 2^x$ for $-1 \le x \le 1$.
   c. $y = \sin(\pi x)$ for $0 \le x \le 4$.
   d. $y = \sin\left(\pi x^2\right)$ for $0 \le x \le 4$.

2. Plot the following implicitly defined curves. *[2 = 4×0.5 each]*
   a. $(x - 1)^2 + (y - 2)^2 = 4$ for $-1 \le x \le 3$ and $0 \le y \le 4$.
   b. $x + y = x^2 + y^2$ for $-0.5 \le x \le 1.5$ and $-0.5 \le y \le 1.5$.
   c. $4x^2 + 9y^2 = 36$ for $-3 \le x \le 3$ and $-2 \le y \le 2$.
   d. $\left(x^2 + y^2\right)^2 + 4x\left(x^2 + y^2\right) - 4y^2 = 0$ for $-5 \le x \le 1$ and $-3 \le y \le 3$.

3. Plot the following parametric curves. *[2 = 4×0.5 each]*
   a. $x = 3\cos(t)$ and $y = 2\sin(t)$ for $0 \le t \le 2\pi$.
   b. $x = t\cos(t)$ and $y = t\sin(t)$ for $0 \le t \le 2\pi$.
   c. $x = t^3$ and $y = t^9 - t^3$ for $-1 \le t \le 1\pi$.
   d. $x = 2\left(1 - \cos(t)\right)\cos(t)$ and $y = 2\left(1 - \cos(t)\right)\sin(t)$ for $0 \le t \le 2\pi$.

4. Plot the following curves in polar coordinates. *[2 = 4×0.5 each]*
   a. $r = 2^\theta$ for $-\pi \le \theta \le \pi$.
   b. $r = 2 + 3\sin(\theta)$ for $-\pi \le \theta \le \pi$.
   c. $r = 4\cos(\theta)$ for $0 \le \theta \le \pi$.
   d. $r = 4\cos(2\theta)$ for $0 \le \theta \le \pi$.

5. What is the equation in x and y that implicitly defines the curve given in polar coordinates in **4c** above? *[2]*