Mathematics 1110H – Calculus I: Limits, Derivatives, and Integrals
TRENT UNIVERSITY, Fall 2023

Plotting with SageMath
Due just before midnight on Friday, 22 September.*

If you want to get started on this assignment before attending your first lab in MATH 1110H, please read *Getting Started with* `sage.trentu.ca`, which you can find in the SageMath 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 *Sage for Undergraduates*, which you can also find in the SageMath folder, is probably a good idea. (There are other possibly useful resources in that folder, too, like Maya Peters' *Glossary of commands* for the SageMath taught in MATH 1110H.) You might also want to check out Sections 10.1 and 10.4 in our textbook, *Single Variable Calculus*, by David Guichard, for the basics of parametric curves and polar coordinates, if you haven't seen them before.

In each of questions **1**–**4**, use SageMath to plot the required curves. Please note that not every curve you are asked to plot is the graph of a function; in fact, most are not.

1. Plot the following graphs in Cartesian coordinates. [*Hint:* `plot`] *[2 = 4×0.5 each]*
   a. $y = x$ for $-2 \leq x \leq 2$.
   b. $y = |x|$ for $-2 \leq x \leq 2$.
   c. $y = \frac{1}{2}\left(x^2 - 4\right)$ for $-2 \leq x \leq 2$.
   d. $y = -\sqrt{4 - x^2}$ for all x for which this is defined.

2. Plot the following implicitly defined curves. [*Hint:* `implicit_plot`] *[2 = 4×0.5 each]*
   a. $x^2 + y^2 = 4$ for all x and y for which this equation makes sense.
   b. $|xy| = 1$ for all x and y for which this equation makes sense.
   c. $x^2 + 4y^2 = 4$ for all x and y for which this equation makes sense.
   d. $\left(x^2 + y^2\right)^2 - 4x\left(x^2 + y^2\right) - 4y^2 = 0$ for all x and y for which this equation makes sense.

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

4. Plot the following curves in polar coordinates. [*Hint:* `polar_plot`] *[2 = 4×0.5 each]*
   a. $r = 1$ for $0 \leq \theta \leq 2\pi$.
   b. $r = 2\cos(\theta)$ for $0 \leq \theta \leq 2\pi$.
   c. $r = \cos(2\theta)$ for $0 \leq \theta \leq 2\pi$.
   d. $r = 2\left(\cos(\theta) - 1\right)$ for $0 \leq \theta \leq \pi$.

5. Some of the curves in questions **1**–**4** are part or all of other curves in questions **1**–**4**. Identify as many such cases as you can. *[2]*

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* You should submit your solutions via Blackboard's Assignments module, preferably as a single pdf. If submission via Blackboard fails, please submit your work to your instructor by email or on paper.