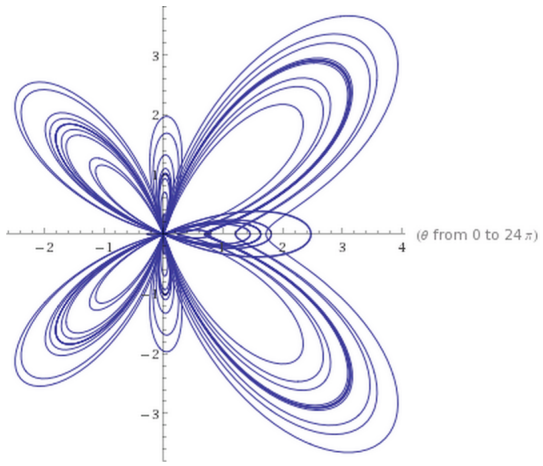
Textbook problems from Stewart *Calculus*, 7th edition.

- §10.3: 3, 5, 10, 15, 17, 21, 29, 31, 33, 35, 39
- §10.4: 2, 3, 8, 12, 23, 30

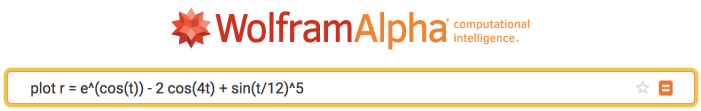
Supplementary problems:

1. The following polar equation is called *Dr. Fay's Butterfly*.

$$r = e^{\cos\theta} - 2\cos(4\theta) + \sin^5\left(\frac{\theta}{12}\right)$$



You can generate plots like this with Wolfram Alpha from any web browser. I made the plot above by typing the following input (note that I use used t instead of θ, which Wolfram was able to understand).



(a) Try modifying the "12" in this equation to other values (e.g. change it to 1, 2, or values larger than 12). How does this affect the appearance of the curve? (Use Wolfram Alpha or a computer program or calculator of your choice)

(b) Try modifying the number "2" in this equation (e.g. change it to 1.9, 1, or values larger than 2). How does this affect the appearance of the curve?

(c) Modify the equation in some other way of your choice, and describe how the butterfly changes in response.

This problem will not be graded strictly, and a few words are sufficient for your answers. You are just meant to experiment a little and see what happens.

2. (**Optional**, for extra credit) Shown below is a vessel called an amphora. You may assume that the grid lines behind the photograph are spaced 1 inch apart. By assuming that the amphora is shaped like a solid of revolution, estimate the volume of the amphora. Since there

is obviously not a function that gives the exact curve along the edge of the amphora, you will need to use some estimation technique (e.g. a Riemann sum); clearly explain the method of approximation that you are using.

Your answer does not need to be exactly correct to receive points, as long as it is a plausible figure and your method makes sense.