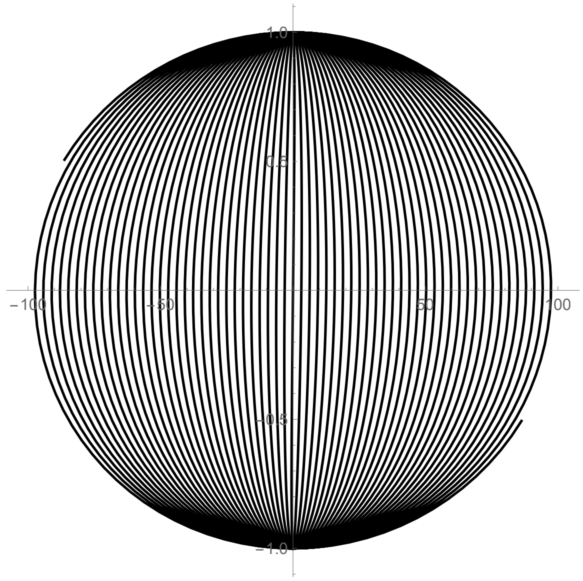
1. (50 points) Let $\vec{r}(t) : [-100, 100] \to \mathbb{R}^2$ be the following vector-valued function (illustrated):

$$\vec{r}(t) = \langle \ t\cos(t), \sin(t) \ \rangle$$



Use an appropriate method to find the curvature at any point of the curve. Be careful with the derivatives and simplify when it makes sense.

2. (50 points) Explicitly solve to a final number the double integral

$$\iint_R (4x^2 + y^2) \ dA,$$

where R is the elliptical region bounded by the equation

$$16x^2 + 4y^2 = 64.$$

3. Let $D \subset \mathbb{R}^2$ be the region that that is bounded by $y = \sqrt{x}$, $y = -x$, and $x = 4$.

(10 points) Sketch D.

(30 points) Let $f : D \to \mathbb{R}$ be the scalar field $f(x, y) = \ln(1 + x^2y^4)$. In whichever way you prefer, set up the integral that calculates the surface area of the graph of f over the region D. (Do not solve the double integral, unless Mathematica has been successfully uploaded into your brain.)

(20 points) Now, by virtue of Fubini's theorem, set up the integral in the way not used above. (Again, do not solve the double integral, unless your consciousness has been uploaded into the Mathematica Cloud City.)