NAME: _____

Problem	Points
1	/16
2	/13
3	/13
4	/20
5	/19
6	/19
BONUS	/10
Total	/100

INSTRUCTIONS:

1. Answer the following 6 problems. If you have time, attempt the bonus problem.
2. Write your answers in the space provided. If you do not have enough space, continue on the back side of the *previous* page.
3. Show all details of your work. Answers without justification will receive zero points.
4. Neither notes, books nor calculators are allowed in the exam. You may use a $3'' \times 5''$ notecard.
5. Relax. Think before (and after) doing.

1. Find the area of the parallelogram with vertices $A(-2,1),\ B(0,4),\ C(4,2)$, and $D(2,-1)$.

2. Find an equation of the plane through the point $(1,-1,-1)$ and parallel to the plane $5x-y-z=6$.

3. Classify and sketch the surface $y^2 = x^2 + \frac{1}{9}z^2$.

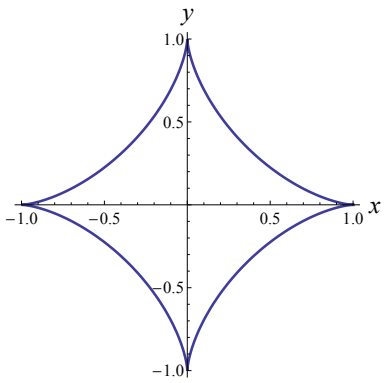
4. For the curve

$$\mathbf{r}(t) = \cos t\,\mathbf{i} + 3t\,\mathbf{j} + 2\,\sin 2t\,\mathbf{k}$$

   (a) Find the unit tangent vector $\mathbf{T}(t)$ at the point where $t = 0$.

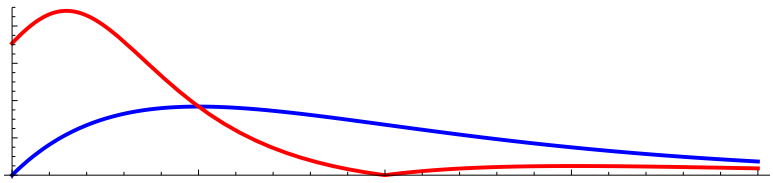
   (b) Find the parametric equations for the tangent line to the curve at $t = 0$.

5. The hypocycloid (shown below) is the curve parametrized by $x = \cos^3 t,\ y = \sin^3 t$. Find the length of the curve.



6. (a) Compute the curvature of the plane curve $y = x\,e^{-x}$ for $x \geq 0$.

(b) The curve $y = x\,e^{-x}$ and the curvature of this curve are shown on the graph below. Identify (with reasons) which is which.



(c) At what point does the curve $y = x\,e^{-x}$ have minimal curvature?

BONUS Given nonzero vectors $\mathbf{a}$ and $\mathbf{b}$, do the equations $\mathbf{a} \times \mathbf{c} = \mathbf{b}$ and $\mathbf{a} \cdot \mathbf{c} = |\mathbf{a}|$ uniquely determine the vector $\mathbf{c}$?