**MATH 265**
**FALL 2009**
**EXAM 2**

1. Consider the cone $z^2 = x^2 + y^2$ and the plane $z - my = 2$ where $m$ is a constant.
   a) (5 pts) What is the shape of the curve if $|m| < 1$?.
   b) (5 pts) What is the shape of the curve if $|m| > 1$?.
   c) (5 pts) What is the shape of the curve if $|m| = 1$?.

2. (5 pts) Consider the twisted cubic $\vec{r}(t) = \langle 2t, t^3, -t^2 \rangle$. Find the parametric equations for the tangent line to this twisted cubic at $(-2, -1, -1)$.

3. (5 pts) Find the maximum curvature on the function $f(x) = \ln(x)$ and find the point where this maximum curvature occurs.

4. Consider a particle traveling through space with velocity given

$$\vec{v}(t) = \langle \sin(t), 2, \cos(t) \rangle$$

with $t \geq 0$ and $\vec{r}(0) = \langle 1, 0, 0 \rangle$.
   a) (5 pts) Find the position function $\vec{r}(t)$ and compute its unit tangent vector.
   b) (5 pts) Find the unit normal vector for $\vec{r}(t)$.
   c) (5 pts) Find the binormal vector for $\vec{r}(t)$.
   d) (5 pts) Find the displacement of the particle as $t$ goes from 0 to $\pi$.
   e) (5 pts) Find the total distance traveled by the particle.

5. (5 pts) Find the length function for the curve defined by the equations $x = \cos(t^2), y = \sin(t^2), z = 2t$ (starting at $t = 0$).

6. (5 pts) Let $\vec{r}(t)$ be a vector-valued function with the property that its position vector is always perpendicular to its tangent vector. Show that the curve determined by $\vec{r}(t)$ lies on a sphere of some constant radius $R$.