Show your work in details.

1. (4pts) The curve $C$ traced out by $\vec{r}(t)$ is given below.
   (1) Sketch the vectors: $\vec{r}'(t_1)$, $\vec{T}'(t_1)$.
   (2) Sketch the vectors: $\vec{T}(t_0)$, $\vec{N}(t_0)$ and $\vec{B}(t_0)$.
   (3) Sketch the osculating circles at $\vec{r}(t_0)$ and $\vec{r}(t_1)$.

2. (4pts) Let $C$ be the curve traced out by $\vec{r}(t)$. Suppose that we know the curvature of $C$ at $\vec{r}(t_0) = \langle 1, -2 \rangle$ is $\kappa = \frac{3}{2}$ and the unit normal vector is $\vec{N}(t_0) = \langle \frac{3}{5}, -\frac{4}{5} \rangle$. Give the radius, center and equation of the osculating circle at $\vec{r}(t_0)$.

3. (4pts) Let $f(x,y) = \sqrt{4-x^2-y^2}$.
   (1) Describe and sketch the domain of $f(x,y)$.
   (2) Sketch level curves $f(x,y) = c$ for $c = 0$, and $c = 1$ and $c = 2$.