

$$9. \vec{r}(t) = \cos(t)\vec{i} + \sin(t)\vec{j} + t^3\vec{k}, \quad t_0 = \frac{\pi}{2}$$

$$\vec{r}'(t) = -\sin(t)\vec{i} + \cos(t)\vec{j} + 3t^2\vec{k}$$

$$\vec{r}''(t) = -\cos(t)\vec{i} - \sin(t)\vec{j} + 6t\vec{k}$$

$$\begin{aligned} \vec{r}'(t_0) &= \vec{r}'\left(\frac{\pi}{2}\right) = -\sin\frac{\pi}{2}\vec{i} + \cos\frac{\pi}{2}\vec{j} + 3\left(\frac{\pi}{2}\right)^2\vec{k} \\ &= -\vec{i} + \frac{3\pi^2}{4}\vec{k} \end{aligned}$$

$$\begin{aligned} \vec{r}''(t_0) &= \vec{r}''\left(\frac{\pi}{2}\right) = -\cos\frac{\pi}{2}\vec{i} - \sin\frac{\pi}{2}\vec{j} + 6\left(\frac{\pi}{2}\right)\vec{k} \\ &= -\vec{j} + 3\pi\vec{k} \end{aligned}$$

$$\frac{\vec{r}'(t_0)}{\|\vec{r}'(t_0)\|} = \frac{-\vec{i} + \frac{3\pi^2}{4}\vec{k}}{\sqrt{(-1)^2 + \left(\frac{3\pi^2}{4}\right)^2}} = \frac{-\vec{i} + \frac{3\pi^2}{4}\vec{k}}{\sqrt{1 + \frac{9\pi^4}{16}}} = \frac{-\vec{i} + \frac{3\pi^2}{4}\vec{k}}{\frac{1}{4}\sqrt{16 + 9\pi^4}}$$

$$\frac{\vec{r}''(t_0)}{\|\vec{r}''(t_0)\|} = \frac{-\vec{j} + 3\pi\vec{k}}{\sqrt{(-1)^2 + (3\pi)^2}} = \frac{-\vec{j} + 3\pi\vec{k}}{\sqrt{1 + 9\pi^2}}$$

$$10. \vec{r}(t) = t^4\vec{i} + 3t^2\vec{j}$$

$$\vec{r}'(t) = \underline{4t^3}\vec{i} + \underline{6t}\vec{j}$$

$$4t^3 = 0 \quad 6t = 0$$

$$\underline{t = 0} \quad \underline{t = 0}$$

NOT SMOOTH AT $t = 0$

SMOOTH
 $(-\infty, 0) \cup (0, \infty)$