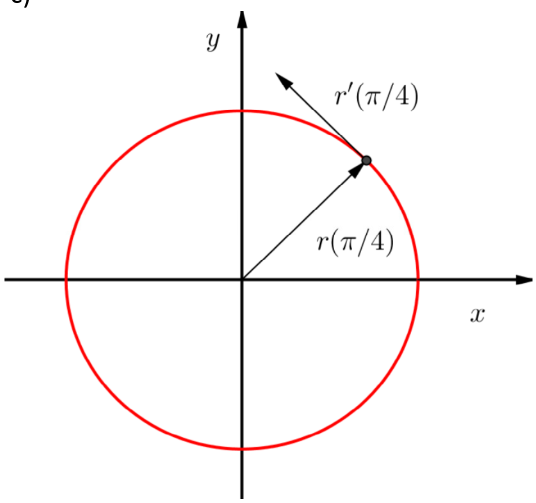
1) Given the vector function $\mathbf{r}(t) = \langle \cos t, \sin t \rangle$ find the following:

   a) Sketch the plane curve.

   b) Find $\mathbf{r}'(t)$

   c) Sketch the position vector $\mathbf{r}(t)$ and the tangent vector $\mathbf{r}'(t)$ for $t = \dfrac{\pi}{4}$

a) c)



b) $\boxed{\mathbf{r}'(t) = \langle -\sin t, \cos t \rangle}$

2) Find the derivative of the vector function

   a) $\mathbf{r}(t) = \langle t^3, -3t \rangle$

   b) $\mathbf{r}(t) = \langle a\cos^3 t, a\sin^3 t, 1 \rangle$

   c) $\mathbf{r}(t) = e^{t^2}\mathbf{i} - \mathbf{j} + \ln(1+3t)\mathbf{k}$

   d) $\mathbf{r}(t) = t\mathbf{a} \times (\mathbf{b} + t\mathbf{c})$

   a) $\boxed{\mathbf{r}'(t) = \langle 3t^2, -3 \rangle}$

   b) $\boxed{\mathbf{r}'(t) = \langle -3a\cos^2 t \sin t, 3a\sin^2 t \cos t, 0 \rangle}$

   c) $\boxed{\mathbf{r}'(t) = \left\langle 2te^{t^2}, 0, \dfrac{3}{1+3t} \right\rangle}$

   d) $\boxed{\mathbf{r}'(t) = \mathbf{a} \times \mathbf{b} + 2t(\mathbf{a} \times \mathbf{c})}$

3) Find the unit tangent vector $\mathbf{T}(t)$ at the point with the given value of the parameter t.

a) $\mathbf{r}(t)=\langle 6t^5, 4t^3, 2t\rangle, \quad t=1$

b) $\mathbf{r}(t)=\langle \cos t, 3t, 2\sin 2t\rangle, \quad t=0$

a) $\boxed{\mathbf{T}(1)=\left\langle \frac{15}{\sqrt{262}}, \frac{6}{\sqrt{262}}, \frac{1}{\sqrt{262}} \right\rangle}$

b) $\boxed{\mathbf{T}(0)=\left\langle 0, \frac{3}{5}, \frac{4}{5} \right\rangle}$

4) Find the open interval(s) on which the curve given by the vector function is smooth.

a) $\mathbf{r}(t)=(t-1)\mathbf{i}+\frac{1}{t}\mathbf{j}-t^2\mathbf{k}$

b) $\mathbf{r}(t)=(t^3+t)\mathbf{i}+t^4\mathbf{j}+t^5\mathbf{k}$

a) $\boxed{(-\infty,0)\cup(0,\infty)}$

b) $\boxed{(-\infty,\infty)}$

5) If $\mathbf{r}(t)=\langle t, t^2, t^3\rangle$, find the following:

a) $\mathbf{r}'(t)$

b) $\mathbf{T}(1)$

c) $\mathbf{r}''(t)$

d) $\mathbf{r}'(t)\times\mathbf{r}''(t)$

a) $\boxed{\langle 1, 2t, 3t^2\rangle}$

b) $\boxed{\left\langle \frac{1}{\sqrt{14}}, \frac{2}{\sqrt{14}}, \frac{3}{\sqrt{14}} \right\rangle}$

c) $\boxed{\langle 0, 2, 6t\rangle}$

d) $\boxed{\langle 6t^2, -6t, 2\rangle}$

6) Find parametric equations for the tangent line to the curve with the given parametric equations:
$x = \ln t,\ \ y = 2\sqrt{t},\ \ z = t^2$ at the point $(0,2,1)$.

$$\boxed{x = t,\ \ y = 2 + t,\ \ z = 1 + 2t}$$

7) Use the definition of the derivative to find $\mathbf{r}'(t)$ given that $\mathbf{r}(t) = \left\langle t^2, 0, 2t \right\rangle$.

$$\boxed{\lim_{\Delta t \to 0} \left\langle 2t + \Delta t, 0, 2 \right\rangle = \left\langle 2t, 0, 2 \right\rangle}$$

8) At what point do the curves $\mathbf{r}(t) = \left\langle t, 1-t, 3+t^2 \right\rangle$ and $\mathbf{u}(s) = \left\langle 3-s, s-2, s^2 \right\rangle$ intersect? Also find their angle of intersection correct to the nearest degree.

$$\boxed{(1,0,4),\ \ \theta = \cos^{-1}\frac{1}{\sqrt{3}} \approx 55^\circ}$$

9) Find the indefinite integral:

a) $\int \left(4t^3\mathbf{i} + 6t\,\mathbf{j} - 4\sqrt{t}\,\mathbf{k}\right) dt$

b) $\int \left(e^t\mathbf{i} + 2t\,\mathbf{j} + \ln t\,\mathbf{k}\right) dt$

a) $\boxed{t^4\mathbf{i} + 3t^2\mathbf{j} - \frac{8}{3}t^{3/2}\mathbf{k} + \mathbf{C}}$

b) $\boxed{e^t\,\mathbf{i} + t^2\mathbf{j} + \left(t\ln t - t\right)\mathbf{k} + \mathbf{C}}$

10) Evaluate the definite integral:

a) $\int_0^{\pi/2} \left(3\sin^2 t\cos t\,\mathbf{i} + 3\sin t\cos^2 t\,\mathbf{j} + 2\sin t\cos t\,\mathbf{k}\right) dt$

b) $\int_0^{3} \left\| t\,\mathbf{i} + t^2\,\mathbf{j} \right\| dt$

a) $\boxed{\mathbf{i} + \mathbf{j} + \mathbf{k}}$

b) $\boxed{\frac{1}{3}\left(10^{3/2} - 1\right)}$

11) Find $\mathbf{r}(t)$ if $\mathbf{r}'(t) = t^2\,\mathbf{i} + 4t^3\mathbf{j} - t^2\mathbf{k}$ and $\mathbf{r}(0) = \mathbf{j}$

$$\boxed{\frac{1}{3}t^3\,\mathbf{i} + (t^4 + 1)\,\mathbf{j} - \frac{1}{3}t^3\,\mathbf{k}}$$

12) If $\mathbf{u}(t) = \mathbf{i} - 2t^2\mathbf{j} + 3t^3\mathbf{k}$ and $\mathbf{v}(t) = t\,\mathbf{i} + \cos t\,\mathbf{j} + \sin t\,\mathbf{k}$ find $\frac{d}{dt}\left[\mathbf{u}(t)\cdot\mathbf{v}(t)\right]$.

$$\boxed{1 - 4t\cos t + 11t^2\sin t + 3t^3\cos t}$$