Always justify your work and explain your reasoning. You are encouraged to use calculators or the computers for calculations, but you may not use the Internet-connections to the outside world. Some problems may require numerical methods as closed form formulas may not be possible.

1. Consider the triangle $ABC$ with vertices $A(8.9, 1.2, 0.0)$, $B(1.2, 8.9, 0.0)$ and $C(0.0, 1.2, 6.7)$.
   a.) Find the length $c$ of the edge $AB$.
   b.) Calculate the angle between the line segments $AB$ and $AC$.
   c.) Calculate the area of the triangle.
   d.) Find a unit-vector $\vec{N}$ that is perpendicular to the triangle.
   e.) Find an equation for the plane that contains the triangle.
   f.) Find the direction of the line of intersection of this plane with the $xy$-plane.
   g.) Find a parametric equation for this line of intersection.

2. Given that $\vec{u}$, $\vec{v}$, and $\vec{w}$ are vectors in 3-space, and that $t$ is a scalar, decide which of the following are scalars, which are vectors, and which quantities are not defined? Justify your reasoning!
   a. $(\vec{u} \times \vec{v}) \times \vec{u}$
   b. $t + \vec{w}$
   c. $\vec{v} + t (\vec{u} \times \vec{w})$
   d. $\frac{\vec{v} + \vec{w}}{\vec{v} \cdot \vec{w}}$
   e. $\vec{v} + \vec{w}$
   f. $\vec{u} \times \vec{w}$

3. Consider the parameterized curve $\vec{r}(t) = t \cos(e^t)\vec{i} + t \sin(e^t)\vec{j}$ with $0 \leq t \leq 4$.
   a. Describe the curve in words. Sketch the curve.
   b. How many times does the curve cross the positive $x$-axis? (Hint: How large is $e^4$?)
   c. Calculate the velocity and the speed as functions of time. (Chain and product rule!)
   d. Sketch the graph of the speed – label the axes! Is the speed increasing, decreasing or constant?
   e. How large is the speed at $t = 3$? Compare this with the circumference of a circle with radius 3.
   f. Calculate the length of the curve.
   g. Find the smallest time $t_1$ at which the velocity vector $\vec{v}(t_1)$ is horizontal and points to the left.

4. Suppose that a parameterized curve is such that at all times the velocity vector $\vec{v}(t)$ and the acceleration vector $\vec{a}(t)$ are perpendicular to each other. Use the following string of equations
   \[
   \frac{d}{dt}||\vec{v}(t)||^2 = \frac{d}{dt}(\vec{v}(t) \cdot \vec{v}(t)) = 2\vec{v}(t) \cdot \vec{a}(t)
   \]
   to explain (!) what this tells you about the speed $||\vec{v}(t)||$. 