Computer course

Winter semester 13/14

1. EXERCISE

Main focus: First steps using Mathematica
Complex numbers
Matrices, Vectors
Functions
Derivatives
Gradient

Check your results using Mathematica.

1. Give the complex number $z = \frac{e^{\frac{5}{2}\pi i}}{1-i}$ in arithmetic, polar form and exponential form.
2. Calculate the trace and the determinant for the matrix: $\begin{pmatrix} 2 & -4 & 2 \\ -1 & 1 & 2 \\ 2 & -5 & 0 \end{pmatrix}$
3. Calculate for the vectors $\vec{a} = (-2, 0, 2)$ and $\vec{b} = (1, -1, -2)$: their absolute values $|\vec{a}|$, $|\vec{b}|$, the scalar product $\vec{a} \cdot \vec{b}$ and the vector product $\vec{a} \times \vec{b}$!
4. Find the roots and stationary points of the followings and plot:
   (a) $f(x) = 3x^2 + 4x + 1$
   (b) $g(x) = 2x^3 - 8x^2 + 12x - 8$ (Hints: one complex root is $x_0 = 1 + i$.)
   (c) $h(x) = x^4 - 8x^2$
   (d) $u(x) = \frac{x^2-4}{x+1}$ (Find the asymptotes instead of the stationary points.)

   Compare the plots.
5. Calculate the derivatives for the functions: $x^2 e^{-x}$; $\dfrac{e^{-x^2}}{x}$.
6. Determine the force fields $\vec{F}(\vec{r})$ for the given potentials: $V(x, y, z) = \dfrac{x^2}{16} + y^2 + \dfrac{z^2}{36}$, $W_1(\vec{r}) = r$, $W_2(\vec{r}) = \cos r$, and $W_3(\vec{r}) = r \cdot \cos r$ (with $r = |\vec{r}| = \sqrt{x^2 + y^2 + z^2}$)! Plot the equipotential surfaces of $V(x, y, z) = 5$, $W_1(\vec{r}) = 0.5$, $W_2(\vec{r}) = 0.5$ and $W_3(\vec{r}) = 0.5$ in the three dimensional cube from -5 to 5 in all three directions! Compare the results!
7. Comprehend the examples from the introduction, chapter 1,2 and 5, creating a new Notebook by your own!

Comment: It is often necessary to restart Mathematica with all parameters and variables (**Evaluation** > **Quit Kernel** > **Local**). The command `Clear["Global‘*"]` clears the program of all definitions of the current session. The option `PlotRange` is often usefull to have a better understanding of the functions in a plot.