Lab Nr. 1, Numerical Calculus

Review of Matlab

1. **Matlab files .m**

   - *script, live script* and *function* files

2. **Vectors and matrices**

   - generation
   - operations (dot and matrix operations)
   - special matrices

3. **Polynomials**

   - evaluation, *polyval*
   - rootfinding, *roots*

4. **Graphics**

   - *plot, plot3* with options
   - *subplot*
   - *mesh*

5. **Display**

   - *disp*
   - *fprintf* with options

Applications

1. Let $p(x) = x^5 - 5x^4 - 16x^3 + 16x^2 - 17x + 21$.

   a) Plot the graph of p on the interval $[-4, 7.2]$.

   b) Compute $p(-2.5)$.

   c) Find the roots of p.

2. Plot the functions $f, g, h : [0, 2\pi] \to \mathbb{R}$, $f(x) = \sin x$, $g(x) = \sin 2x$, $h(x) = \sin 3x$, on the same figure, in three tiled positions, one on top of the other.

3. For $R, r \in \mathbb{R}_+$, consider the *epicycloid* (also called *hypercycloid*), given by the parametric equations

$$
\begin{cases}
x(t) &= (R+r)\cos t - r\cos\left(\left(\frac{R}{r}+1\right)t\right) \\
y(t) &= (R+r)\sin t - r\sin\left(\left(\frac{R}{r}+1\right)t\right)
\end{cases}
, \quad t \in [0, 10\pi].
$$

Plot its graph, for $R = 3.8, r = 1$ (see details at https://en.wikipedia.org/wiki/Epicycloid).

4. Plot the function of two variables $f : [-2, 2] \times [0.5, 4.5] \to \mathbb{R}$, $f(x, y) = \sin{(e^x)} \cos{(\ln y)}$ (using both *mesh* and *plot3*).

Optional

5. Consider the expression

$$f(n) \;=\; 1 + \cfrac{1}{1 + \cfrac{1}{1 + \cfrac{1}{1 + \cfrac{1}{\cdots}}}},$$

where $n \in \mathbb{N}$ is the number of fractions $\left(\text{e.g., } f(0) = 1 + 1, f(1) = 1 + \dfrac{1}{1 + 1} = \dfrac{3}{2}\right)$. Compute $f(2), f(10), f(100)$ and $f(2025)$. What can be noticed?