

SCIENTIFIC & ENGINEERING PROGRAMMING

II Year Electronics and Computer Engineering, FoEPhaM, WUST

3 Mathematica Lab Class 3 – Algebraic equations and functions

3.1 The scope

To get familiar with Mathematica interfaces, to perform basic calculations with equations, to define functions, conditionals, and loops, to learn graph plotting.

3.2 Prerequisites

Before the classes you should know, how to:

- define and solve algebraic equations,
- define Mathematica functions, compute their values,
- define conditionals,
- generate function plots.

3.3 Tasks

3.3.1 Solving algebraic equations

1. Find the roots of the polynomials (utilize *Solve* and *Roots* functions – compare the obtained results and their formats, check the correctness of the result):

(a) $x^2 + x - 6$,

(b) $x^2 + 2x - 6$,

(c) $x^3 + 3x^2 - 4$,

(d) $x^3 + x^2 - 4$,

(e) $x^5 - 3x^4 - 9x^3 + 31x^2 - 36$,

(f) $x^5 - x^4 - 9x^3 + 31x^2 - 36$.

2. Determine the variables x , y , and z fulfilling the equation: $2 \begin{bmatrix} x+2 & y+3 \\ 3 & 0 \end{bmatrix} = \begin{bmatrix} 3 & 6 \\ y & z \end{bmatrix}^T$.
Check the correctness of the result.

3. Solve the matrix equation: $3 \left(\begin{bmatrix} 1 & 0 \\ -3 & 3 \\ 2 & 5 \end{bmatrix} - X \right) = X + \begin{bmatrix} 4 & 3 \\ 0 & 6 \\ -1 & 2 \end{bmatrix}$. Check the correctness of the result.

4. Find the scalar parameters a , b , c for which with a certain matrix A one has the relationship:

(a) $A \begin{bmatrix} 1 & 3 & 1 \\ 2 & 1 & 1 \end{bmatrix} = \begin{bmatrix} -1 & 2 & a \\ 4 & 2 & b \end{bmatrix}$,

(b) $\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} A \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 0 & b & 2 \\ a & -2 & c \end{bmatrix}$.

5. Find the value of the parameter s , for which vectors $p = \begin{pmatrix} s \\ 2 \\ 1-s \end{pmatrix}$, and $q = \begin{pmatrix} s \\ 1 \\ -2 \end{pmatrix}$ are perpendicular. Check the correctness of the result.
6. Find the coefficients a , b , and c of the function $y(x) = a2^x + b3^x + c4^x$, which for x equal to $-1, 0, 1$ returns the values $3/4, 1, 1$, respectively. Check the correctness of the result.

3.3.2 Functions definition

7. Define the functions $f(x) = \frac{x^3}{x^4+1}$, $g(x, y) = \sqrt{25 - x^2 - y^2}$, and $h(x, y) = \begin{pmatrix} x + 2y \\ xy \end{pmatrix}$. Calculate $f(5)$, $g(1, 2)$, and $h(f(3), 2)$.
8. Define the function $f(x)$ which for its scalar argument returns absolute value of sine of the argument.
9. Define the function $f(x)$ which for its scalar argument returns value of sine of the argument when it is positive, and zero otherwise.
10. Define the function $sign(x)$ which returns $-1, 0$, or 1 , according as x is less than, equal to, or greater than 0 . Use four different notions: using `If`, `Which`, `Piecewise` statements, and using a conditional function definition.
11. Define the function $sum(x)$ which for its argument being a list returns the sum of list elements.
12. Define the function $sumPositive(x)$ which for its argument being a list returns the sum of list positive elements.
13. Define the function $sumAll(x)$ which for its argument being a list returns the sums of positive, and negative list elements, as well as the sum of the elements, which sign cannot be determined.
14. Define the function $poly(c)$ which for its argument being a vector $(c_0, c_1, c_2, c_3, \dots)$ returns the polynomial of x with the vector elements taken as the polynomial coefficients: $c_0 + c_1x + c_2x^2 + c_3x^3 + \dots$
15. Define the function $gcd(m, n)$ that implements the Euclidean algorithm for finding the greatest common divisor of m and n .

3.3.3 Generating plots

16. Plot functions defined in the tasks [7–10](#).

3.3.4 Bonus task

17. Find the sum of the sequence

$$\frac{1}{1+2} + \frac{2}{2+3} + \dots + \frac{10}{10+11}$$