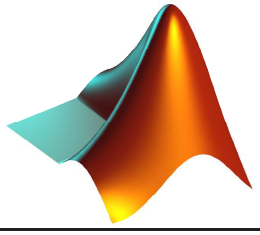

Laboratory exercise 3

Symbolic Toolbox – introduction and examples

1. Introduction

The aim of this exercise is to meet you with MATLAB's "Symbolic Toolbox", in simpler terms, with the ability to solve problems by using symbolic variables. This implies the creation of symbolic variables, solving systems of equations, integrals and differential equations, simplification and numerical evaluation of algebraic expressions, and to calculate mathematical orders.

2. Preparation for the exercise

Before coming to the exercise study materials from the lecture and descriptions of the following functions: `sym`, `syms`, `subs`, `pretty`, `digits`, `simple`, `limit`, `int`, `diff` and `ezplot`.

Working on exercise

Task 1

Symbolic Toolbox provides an option to set algebraic expressions using symbolic variables and subsequently determine their numerical values by entering values associated to the symbolic variables. To check these possibilities you must:

a) Define symbolic algebraic expression to calculate the factorial of $f(x) = x!$. Use the command `subs` to change algebraic expression in the form $f(y) = y!$ and determine how much is 10!. Next, define a new algebraic expression $g(y) = 10^y$ and the function $h(y)$ which is equal to the ratio of the sum and difference of functions $g(y)$ and $f(y)$. Determine the value of the function $h(y)$ for $y = 15$ using the fractional display and numeric value with 10 decimal places.

b) Define symbolic algebraic expression $f = 2\hat{}1.5$. Use the command `pretty` to try clearer way to print in the command window. Obtained numerical values of the algebraic expression can be calculated in a single (`single`) and double (`double`) precision. Find difference in the numerical values in the case of using a single and double precision.

Task 2

Defined matrix is:

$$T = \begin{bmatrix} \cos(\theta) & -\cos(\alpha)\sin(\theta) & \sin(\alpha)\sin(\theta) & a\cos(\theta) \\ \sin(\theta) & \cos(\alpha)\cos(\theta) & -\sin(\alpha)\cos(\theta) & a\sin(\theta) \\ 0 & \sin(\alpha) & \cos(\alpha) & d \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{1}$$

Use the adequate command of the Symbolic Toolbox to:

a) Show the defined matrix in a form of symbolic matrix.

b) Use the command `subs` to determine matrices $T_a(\theta, d, a, \alpha)$ and $T_b(\theta, d, a, \alpha)$ if the values are:

   a) $\theta = q_1$, $d = d_1$, $a = a_1$, $\alpha = \pi$;
   b) $\theta = q_2$, $d = 0$, $a = a_1$, $\alpha = 0$.

c) Determine matrix T_c, product of matrices T_a and T_b, and simplify her.

d) Calculate the numerical value of matrix T_c if the values are:

$$q_1 = \frac{\pi}{2}, \quad q_2 = \frac{\pi}{4}, \quad a_1 = 0.3, \quad d_1 = 0.5$$

Task 3

For defined function:

$$f(x) = \frac{4x^3 - 7x^2 - 7x - 9}{4x^4 - 7x^2 + 3x - 19} \tag{2}$$

With the use of Symbolic Toolbox determine:

a) Zeros of the numerator and denominator.

b) Function values in the break points.

c) Graphic representation of the function with marked zeros and break points.

d) Maxima an minima of the function and graphic representation of the first and second derivation.

e) Area below the function in interval $[-1, 1]$.