UNIVERSITY OF BOLOGNA – FACULTY OF ENGINEERING

INTERNATIONAL MASTER CORSE IN CIVIL ENGINEERING 2011/2012

INTRODUCTION TO NUMERICAL METHODS

LAB1a: MATLAB BASICS

a)

Working directly in the Matlab Command Window, create the two matrices $A = \begin{bmatrix} 1 & -6 \\ 6 & 18 \end{bmatrix}$, $B = \begin{bmatrix} -1 & -21 \\ 10 & 6 \end{bmatrix}$, the column vector $v = [1 \;\; 2]^T$ and the scalar $k = 2$, check the existence (and the value, size, bytes and class) of the four created variables in the Matlab Workspace, then compute:

(ADDITION)	A + k	A + v	A + B	k + A	v + A	B + A
(SUBTRACTION)	A - k	A - v	A – B	k – A	v – A	B - A
(MULTIPLICATION)	A * k	A * v	A * B	k * A	v * A	B * A
	A .* k	A .* v	A .* B	k .* A	v .* A	B .* A
(RIGHT and LEFT DIVISION)	A / k	A / v	A / B	A \ k	A \ v	A \ B
	A ./ k	A ./ v	A ./ B	A .\ k	A .\ v	A .\ B
(EXPONENTIATION)	v ^ k	A ^ k				
	v .^ k	A .^ k				
(CONCATENATION)	A || k	A || v	A || B	$\begin{matrix} A \\ = \\ k \end{matrix}$	$\begin{matrix} A \\ = \\ v \end{matrix}$	$\begin{matrix} A \\ = \\ B \end{matrix}$
(TRANSPOSITION)	k^T	v^T	A^T			

PAY ATTENTION!!! Not all the operations are computable: why?

b)

Working directly in the Matlab Command Window, create the following matrix and perform the subsequent exercises:

$$A = \begin{bmatrix} 2 & 6 & -4 & 12 \\ -5 & -9 & 10 & 2 \\ -6 & 12 & 8 & 16 \\ 15 & -3 & 12 & 2 \end{bmatrix}$$

a) Create a vector v formed with the elements of the second row of A;

b) Compute the sum of the elements of v, after these have been divided (element by element) by the elements of the first column of A;

c) Create a matrix B 4x3 formed with all the elements between the second and the fourth column of A;

d) Create a matrix C 2x3 formed with all the elements of the first two rows and the last three columns of A;

e) Create A^t ;

f) Create a vector v formed with the minimums of the elements in each column of A^t

g) Create a vector v formed with the maximums of the elements in each row of A^t

h) Create a vector v formed with the sums of the elements in each row of A^t

i) Compute the sum of all the elements of A.

c)

Compute the sum of the first n natural numbers $\sum_{k=1}^{n} k = \frac{n(n+1)}{2}$ by creating and then using:

1) a Matlab **script**

2) a Matlab **function**

Which is the difference between **script** and **function**?

d)

An object is thrown vertically upwards with an initial velocity v_0 and reaches a height h in a time t, where $h = v_0 t - \frac{gt^2}{2}$. Write a Matlab function that calculates the time t required for reaching a given height h, for a given value of v_0. The function inputs are h, v_0 and g.

Test the function in the cases: a) $h = 170$ m, $v_0 = 60$ m/sec e $g = 9.81$ m/s^2

b) $h = 200$ m, $v_0 = 60$ m/sec e $g = 9.81$ m/s^2 : What can you conclude?

[case a) 4.4580 **-** 7.7744 ; case b) complex result]

e)

After exploring (by the Matlab help) the following commands for the creation of special matrices:

▪ **zeros**	zero matrix
▪ **ones**	matrix of ones
▪ **eye**	identity matrix
▪ **diag**	diagonal matrix
▪ **tril**	lower triangular matrix
▪ **triu**	upper triangular matrix
▪ **hilb**	Hilbert matrix
▪ **vander**	Vandermonde matrix
▪ **rand**	matrix of random numbers
▪ **magic**	matrix with equal row, column and diagonal sums

write a Matlab function for the creation of a tridiagonal n x n matrix A = $\{a_{ij}\}_{i,j=1,\ldots,n}$ with:

$$a_{ij} = \begin{cases} 0 & \text{if } |i-j| > 1 \\ a_{ij} = 2|i-j| + 1 & \text{if } |i-j| \le 1 \end{cases}$$

f)

After exploring (by the Matlab help) the potentialities of the command **plot** (in particular, how to plot with given **color**, **style** and **marker**), write a Matlab script that plots in the same graph the following two functions:

$y = cosh(x)$, $y = 0.5e^x$ for $x \in [-2,2]$

using different types of line and a legend in order to distinguish the curves.

g)

Write a Matlab script that plots the following functions in three different figures:

- $y = x^3 - 4x$ $x \in [-3,3]$
- $y = 3\cos(2x) - 2\cos(x)$ $x \in [0,2\pi]$
- $y = \dfrac{\sin(2x)}{x}$ $x \in [-6\pi, 6\pi]$ (PAY ATTENTION TO THE DOMAIN!)

h)

After exploring (by the Matlab help) the command **plot3**, write a Matlab script that plots the curve *f(t)* defined by the following parametric equations:

$$f(t): \begin{cases} x = a \cdot t \cdot \cos(t) \\ y = a \cdot t \cdot sen(t) \\ z = b \cdot t \end{cases}$$

where *a* and *b* are real constants.
Create a plot of the curve *f(t)* for each of the following four cases:

a) $b = 0.1$
b) $b = 0.5$
c) $b = -0.1$
d) $b = -5$

set $a = 1$ and $-10\pi \le t \le 10\pi$

Compare the four obtained plots by means of the command *subplot*.