DELFT UNIVERSITY OF TECHNOLOGY September 2006
Faculty of Electrical Engineering, Mathematics and Computer Science

MATLAB INTRODUCTION EXERCISE

General:

This exercise will give you a brief introduction to the software package Matlab. The exercise has to be conducted at the start of your practical work. Working out the Matlab introduction exercise will cost about 4 hours. It is recommended (and expected) to work out this exercise, at least in part, before entering the first meeting (meeting 1).

Fill in:

Name :
Student ID :
Name :
Student ID :
Name :
Student ID :

Guidelines

Answers need to be written on the assignment form. Prints and plots need to be enclosed on separate sheets.

Show all your work when consulting the attendant. The attendant will verify whether your answers, plots and prints are correct. If so, the attendant will record that you have completed this part of the work.

It is advisable to check intermediate answers, when working in the computer room.

Remark:

This exercise contains multiple parts. Generally speaking, all parts are relevant for a technical engineer. However, minimal demands are:

wi3097TUp: **At least part I**
wi3200INp: **Part I and part II**

PART I: BASIC MATLAB

<u>Intermezzo:</u> It is advisable to use script files. Go to the file menu and choose for new, m.file. You enter the Matlab editor. Type

```
x=1
y=1;
plot(x, y,'+')
```

in the editing window, Next, go to the debug menu and choose save and run. Choose a convenient folder (directory) to store the script file. Give the file the name tmp.m. Then, save the file in the selected directory by clicking the OK button, which also triggers running of the script file[1]. Go to the central window and check the workspace to see that the variables x and y exist. Also, have a look in the command window and the graphical window. Next, go to the command window and type

```
clear; close; clc;
```

in order to clear the workspace, to close the graphical window and to clear the command window. Use from now on the editor to build and run scripts, with the suggested names ex1.m, ex2.m, ….

<u>Exercise 1</u> *(Matlab manual:* section 4, section 5*)*

Compute $5.1^{1.7}$

*<u>Answer (in **format short e**) :</u>*

<u>Exercise 2</u> *(Matlab manual:* section 9*)*

Compute $y = e^{x} + \sin \pi x + x^{10}$ for $x = 0.357$

*<u>Answer (in **format short e**) :</u>*

<u>Exercise 3</u> *(Matlab manual:* section 6*)*

Given are the complex numbers

$z_1 = 1 + i,\quad z_2 = 1 + 2i.$

[1] Note that you first have to change the Matlab current directory (just above the Command Window) to your selected directory, before you can successfully run the script.

Compute $z_1 z_2$, $|z_1 z_2^2|$.

Answer:

$z_1 z_2 =$ $|z_1 z_2^2| =$

Exercise 4 (Matlab manual: section 7, section 8*)*

Given is the matrix

$$A = \begin{bmatrix} 5 & -10 & 1 \\ -10 & 5 & -3 \\ 1 & -3 & 2 \end{bmatrix}.$$

Assume $B = A^3$. Determine B_{23}. Let v be the first column of A and let w be the second row of A. Compute vw and wv.

Hint: vw and wv will have different size!

Answer:

$B_{23} =$ vw = wv =

Exercise 5 (Matlab manual: section 8*)*

Given is the matrix A from the previous question. We denote the entries of A with a_{kl}, i.e. $A = (a_{kl})$. The matrix $C = (c_{kl})$ is formed by setting

$$c_{kl} = a_{kl}^3.$$

Determine det(C).

Hint: Use operations in array sense to form C, and calculate the determinant afterwards.

Answer:

det(C) =

Exercise 6 (Matlab manual: section 8*)*

Given is the vector $v = (v_i)_{i=1}^{n}$. We need to compute

$$\|v\|_1 = \sum_{i=1}^{n} |v_i|.$$

Present the Matlab command for this. First use **help norm** to obtain information.

Answer:

Matlab command reads:

Exercise 7 (Matlab manual: section 16*)*

Given is the matrix A from exercise 4 and the vector b

$$b = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}.$$

Determine the solution x of $Ax = b$.

Answer:

$$x = \begin{bmatrix} \\ \\ \\ \end{bmatrix}.$$

Exercise 8 (Matlab manual: section 11*)*

Compute the numbers x_n, n = 1, …, 250 from

$$x_1 = 0.1$$
$$x_{n+1} = 3.5 x_n (1 - x_n), \quad n = 1,\ldots,249$$

and determine x_{241}, x_{242}, x_{245}, x_{246}, x_{249}, x_{250}, (note the period four in this 'chaotic' system.)

*Answer (in **format short e**) :*

x_{241} = x_{242} =

x_{245} = x_{246} =

x_{249} = x_{250} =

Exercise 9 (*Matlab manual:* section 11, 16)

In the inverse power method the recurrence relation $Ax_{k+1} = x_k$ plays an important role. Given is the matrix A and vector b from exercise 7. Set $x_1 = b$ and define x_k, k=2,3,…, by recurrency:

$$Ax_k = x_{k-1},$$

Determine the x_k's for k = 2,..,10. First, use the backslash \ for solving the system. Next, make use of the LU-decomposition of A. Do you make the decomposition in or outside the loop?

Answer:

$$x_{10} = \begin{bmatrix} \\ \\ \end{bmatrix}$$

Matlab commands used to determine x_{10} are:

Exercise 10 (*Matlab manual:* section 7)

You have to generate the row vector with the following components

$$y(n) = \begin{cases} 1, & 1 \le n \le 10 \\ 5, & 11 \le n \le 20. \end{cases}$$

Generate this vector by concatenating two sub vectors. Repeat this task in case y is a column vector, with the above entries. Let the attendant check whether you have used the correct Matlab commands.

Hint: Avoid loops, use **ones** in stead.

Answer:

Matlab commands to generate y are:

Exercise11 (Matlab manual: section 12*)*

Make a table in the command window containing the values (x, y(x)), with

$$y(x) = \sin x\ ,\ x = k\frac{\pi}{10} \text{ and } k = 0, 1, \ldots, 10.$$

Give your answers in **format short**.

Exercise 12 (*Matlab manual*: section 1.2, section 8, section 14)

The vectors x, y, z are given by

$$x(n) = nh,\ h = 2/N,\ N = 100,$$
$$y(n) = \sqrt{x(n)},$$
$$z(n) = (x(n))^2, \quad n = 0, \ldots, N.$$

a. Generate the vector x without using loop statements. Present two ways, directly without using standard Matlab functions and also using the Matlab function **linspace**.

b. Create the vectors y and z without using loop statements.

Hint: Use array operations to make z from x.

c. Display the functions $\sqrt{x}$, x^2 on the interval [0,2] as graphs. Put them in one figure and make use of the vectors mentioned above. Make the two graphs visually different (use the

Matlab command **help plot** to find out how you can do this). Let your plot be checked by the lecturer.

Hint: Use hold on to display two plots in one figure.

Answer:

a. Matlab commands read:

b. Matlab commands read:

Exercise 13 (*Matlab manual*: section 15.1)

Given is the function

y = sin(x)/x.

Make a script file called ex13.m that computes y for a given value of x. Then, assign the value 0.1 to x in the command window, and run the script from the command line.

Answer:

y =

Exercise 14 (*Matlab manual*: section 15.2)

Given is the function

f(x) = sin(x)/x.

Make a function file called f14.m for this function. Evaluate f(x) for x=0.1 by calling the function from the command line in the command window.

Hint: Modify the file ex13.m by adding a suitable first line.

Answer:

f =

The function file f14.m reads:

Exercise 15 (*Matlab manual*: section 15.2)

Modify the function file f14.m slightly, such that it also gives correct results for a vector argument x. Then, create the vector x=[1:5]/10 in the command window and evaluate f(x).

Hint: The result should be a vector.

Answer:

f =

Exercise 16 (*Matlab manual*: section 15.2, section 14)

Given is the function of two arguments

f(j,x) = sin(jx)/x.

Make a function file called f16.m for this function. Evaluate this function twice, for j=1 and for j=2, with x the vector [1:10]/10*π. Plot the results as two graphs in one figure. Let your plot be checked by the attendant.

Answer:

The function file f16.m reads:

Exercise 17 (*Matlab manual*: section 6, section 14)

It is given that $\lambda = -0.4 + i$. Consider the complex function Q: $\mathbf{R} \rightarrow \mathbf{C}$ given by

$Q(h) = 1 + \lambda h$,

the amplification factor of the Euler time stepping method. Our interest is towards its modulus MQ = |Q|. Make a plot of MQ as a function of h, where $0 \leq h \leq 2$. Let your plot be checked by the attendant. The positive value of h for which |Q| = 1 is denoted by h_{max}. Determine h_{max}

with an accuracy of 0.01. Do this graphically by adding gridlines to the graph using the command **grid** (and if necessary, use the Matlab command **zoom**).

Hint: h must be along the x-axis of the plot.

Answer:

h_{max} =

Exercise 18 (*Matlab manual*: section 14)

Given is the function f : $\mathbf{R}^2 \rightarrow \mathbf{R}$

$f(x,y) = x^2 \sin(y)$.

Make a plot of the surface of f on the region $0 \leq x \leq 1$, $0 \leq y \leq 3$.

Hint: First define a product grid $G = x \otimes y$ on this region, using **meshgrid**. Then create a two-dimensional array f containing the values of the function on this grid (do not use loops).
Note that the number of rows of f is equal to the size of y and the number of columns of f is equal to the size of x.

Answer:

Matlab commands to build f:

PART II: Symbolic Computing

Exercise 1: (Matlab manual: section 18, section 14)

Given is the function

$$f(x) = \cos(\pi x).$$

a. Compute the derivative of f at x=0.2. (of course, using **diff**.)
b. Use the result to find an equation of the tangent line to the curve f(x) at x=0.2.
c. Make a plot of the tangent line and the function f, using the interval [0,1].

Hint: Create vectors containing x and y values before using the **plot** command.

Answers: (5 decimal digits suffice)

a. $f'(0.2)$=

b. y=

Matlab command used:

Exercise 2: (Matlab manual: section 18)

Given is the function

$$f(x, y) = \frac{\sqrt{1 + 4x^2 + 4y^2}}{1 + x^4 + y^4}$$

a. Compute the partial derivatives f_x, f_y at the point $(x_0,y_0)=(1,2)$.
b. Give the equation for the tangent plane of f(x,y) at the point (x_0,y_0).

Answers:

a. f_x =

f_y =

b. z =

Matlab commands used:

Exercise 3: *(Matlab manual:* section 18)

Given is the linear differential equation

$$\frac{d^2y}{dt^2} - 9\frac{dy}{dt} + 8y = e^{8t}.$$

1. Compute the general solution y(t) to the differential equation.
2. Compute the solution which satisfies the initial conditions y(0) = y'(0) = 1.
3. Plot the solution obtained in part b for the interval $0 \leq t \leq 0.5$. Zoom in to find the intersection of y(t) and the line y=2.

Answers:

a. y(t) =

b. y(t) =

c. (2 decimals suffice) t_{int} =

Matlab commands used: