Exercise Sheet 0

Exercise 0  If you already worked with MATLAB you can skip this exercise. Do not skip the other exercises on this exercise sheet!

Type the following expressions. What do they do?

```matlab
>> a = 7
>> a = 7;
>> b = [1, 2, 3]
>> c = [1; 0; -1;0]
>> b(1)
>> e = 1:2:8
>> D = [1, 2, 3, 4; 5, 6, 7, 8; 9, 10, 11, 12]
>> D(2,1) = 4
>> D(:,1)
>> D(2,:)
>> D(:,2:4)
>> D'
>> eye(3)
>> zeros(2,3)
>> ones(3,2)
>> E = diag(b)
>> D*c
>> c*D
>> c*D'
>> size(D)
>> whos
>> clear a b
>> sin(x)
>> x = [0, pi/4, pi/2, 3*pi/4, pi];
>> sin(x)
>> x = 0:pi/10:2*pi;
>> plot(x,sin(x))
>> help format
>> pi, format long, pi
>> ans
```

Note: The two greater-than signs (>>) are the MATLAB prompt. Do not type them.
Exercise 1
Find a short MATLAB expression to build the matrix
\[
A = \begin{pmatrix}
1 & 2 & 3 & 4 & 5 & 6 & 7 \\
9 & 7 & 5 & 3 & 1 & -1 & -3 \\
4 & 8 & 16 & 32 & 64 & 128 & 256
\end{pmatrix}.
\]

Exercise 2
Give a MATLAB expression that uses only a single matrix multiplication with $A$ to obtain
- the sum of columns 3 and 5 of $A$
- the last row of $A$
- a version of $A$ with rows 1 and 3 swapped

Exercise 3
Build the matrices
\[
B = \begin{pmatrix}
2 & -1 & 0 \\
-1 & 2 & -1 \\
0 & -1 & 2
\end{pmatrix}, \quad C = \begin{pmatrix}
5 & 1 \\
1 & 5
\end{pmatrix} \quad \text{and} \quad D = \begin{pmatrix}
1 & 4 \\
2 & 5 \\
3 & 6
\end{pmatrix}.
\]
Calculate the matrices
\[
E = \begin{pmatrix}
B & D \\
D^T & C
\end{pmatrix}
\]
and
\[
F = E + 2 \cdot \begin{pmatrix}
1 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 1
\end{pmatrix}.
\]

Exercise 4
Calculate the matrix $G$ with
\[
G_{i,j} = \begin{cases}
0 & \text{for } i = 4, 5 \text{ and } j = 1, 2, 3, \\
E_{i,j} & \text{else}.
\end{cases}
\]

Exercise 5
Build the matrix
\[
H = \begin{pmatrix}
1 & 4 & -3 & 0 \\
-1 & 2 & 0 & 3 \\
5 & 3 & -4 & 4 \\
-5 & 2 & 1 & 1
\end{pmatrix}
\]
and replace all negative entries with zero.
Build the matrix $H_L$ which consists of the lower triangular part of $H$ and the matrix $H_U$ which consists of the upper triangular part of $H$ (Use the MATLAB help command for the functions tril and triu).
Exercise 6

Build the matrix

\[ I = \begin{pmatrix}
4 & 2 & 1 & 3 \\
6 & 7 & 2 & 2 \\
3 & 5 & 9 & 1
\end{pmatrix} \]

and

- assign the first row of \( I \) to a vector \( u \)
- assign the last 2 rows of \( I \) to a vector \( v \)
- add up the columns of \( I \)
- add up the rows of \( I \)
- convert \( I \) into a 4-by-3 array

Exercise 7

Given the arrays \( x = [1, 4, 8] \), \( y = [2, 1, 5] \) and \( A = [3, 1, 6 ; 5, 2, 7] \), determine which of the following statements will correctly execute and provide the result. If the command will not correctly execute, state why it will not.

- \( x + y \)
- \( x + A \)
- \( x' + y \)
- \( A - [x' \ y'] \)
- \([x ; y'] \)
- \([x ; y] \)
- \( A - 3 \)

Exercise 8

Build the vector

\[ x = (-5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5)^T \]

and calculate the vector \( y \in \mathbb{R}^{11} \) with

\[ y_i = \cosh(x_i). \]

Build the matrix

\[ V = \begin{pmatrix}
-8 & 4 & -2 & 1 \\
-1 & 1 & -1 & 1 \\
0 & 0 & 0 & 1 \\
1 & 1 & 1 & 1 \\
8 & 4 & 2 & 1
\end{pmatrix} \]

and calculate the solution \( \zeta \in \mathbb{R}^4 \) of

\[ V\zeta = (y_i)_{i=4,...,8}. \]

Exercise 9

Plot a circle with the radius \( r = 2 \), knowing that the parametric equation of a circle is \([x(t), y(t)] = [r \cos(t), r \sin(t)]\) for \( t = [0, 2\pi] \).
Exercise 10
Plot a sphere, which is parametrically defined as

\[
(x(t; s); y(t; s); z(t; s)) = [\cos(t) \cos(s); \cos(t) \sin(s); \sin(t)]
\]

for \( t, s = [0, 2\pi] \) (use surf).

Exercise 11
Create a MATLAB script `sinplot.m` containing the following lines

```matlab
x = 0:0.2:6;
y = sin(x);
plot(x,y);
title('Plot of y = sin(x)');
```

and then run it by:

```matlab
>> sinplot
```

Check how `sinplot` affects the workspace:

```matlab
>> clear
>> who
>> sinplot
>> who
```

Exercise 12
Create the following function `average` and store it as `average.m`.

```matlab
function avr = average(x)
% AVERAGE computes the average value of a vector x and returns it in avr
% Notes: an example of a function
n = length(x);
avr = sum(x)/n;
return;
```

Call

```matlab
>> help average
```

and run the function by typing

```matlab
>> avr = average(1:10)
```

You might find the following MATLAB tutorial helpful:

http://www-ai.math.uni-wuppertal.de/SciComp/students/Matlab-primer.ps.gz