Introductory Computer Assignment to MATLAB
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Practical Information

For problem 4 you will need **earphones**. Remember that though MATLAB is a highly advanced programming language, the syntax is simple. A very basic exposure to computer programming is often enough to start out on MATLAB.

Problem 1 - Vectors and matrices

(a) Enter the following in MATLAB

$$A = \begin{bmatrix} 4 & 3 & 2 \\ 5 & 6 & 3 \\ 3 & 5 & 2 \end{bmatrix}, B = \begin{bmatrix} 3 & -1 & 2 & 6 \\ 7 & 4 & 1 & 5 \\ 5 & 2 & 4 & 1 \end{bmatrix}, b = [1\ 0\ 0]^T.$$

Find AB, A^{-1}, a matrix X such that $AX = B$ and a vector x such that $Ax = b$.

(b) *Without* using MATLAB, write down the sequences that the following MATLAB code will produce

- x1 = 0:1:5, x2 = 0:5
- x3 = 2:4:14, x4 = 13:-4:2
- x5 = pi*[0:1/2:2]

Verify your results using MATLAB.

(c) Write a command that will extract the even indexed elements of a length N vector x.

(d) Similarly, write a command that will extract the odd indexed elements of a vector x with unknown length, i.e the vector x has a given length but we do not know it.

(e) First, create a vector x6 that consists of 10 zeros. (Use the `zeros` command). Then replace the even indexed elements of x6 with the constant e. Solve this problem in two different ways, by using a for loop and (more elegant) using indexing techniques.

Problem 2 - Complex numbers

Let $z_1 = 2 + j$ and $z_2 = 3 - 4j$. Solve the following subproblems, first by hand, then verify your results using MATLAB.

(a) Compute the real and imaginary parts of z_1^*, $z_1 z_2$ and $\frac{z_1}{z_2}$.

(b) Find the magnitude and phase of z_1, z_2, z_1^*, $z_1 z_2$ and $\frac{z_1}{z_2}$. Write the z_1 in the form $z = re^{j\theta}$, where r is a non-negative real number.

(c) How are the magnitude and phase of z_1^* related to the magnitude and phase of z_1?

(d) How are the magnitude and phase of $z_1 z_2$ and $\frac{z_1}{z_2}$ related to the magnitudes and phases of z_1 and z_2?

Problem 3 - Plotting functions

In this problem we will exercise the basic plotting commands in MATLAB.

(a) Create a variable t that takes values from 0 to 2π with step 0.001. Let $y_1 = \sin(t)$, $y_2 = t^2 + \cos(t) + \frac{e^{t^2}}{10^{16}}$ and $y_3 = \cos(t)$. Then do the following

- Plot y_1 and y_2 versus t in *separate* figures.
- Plot y_1 and y_3 versus t in the *same* figure. y_3 should be plotted in red. See `help plot` for changing the color of a plot.
- Divide a figure in two by using the `subplot` command, then plot y_1 and y_3 in the upper part and y_2 in the lower part (all plots versus t).

(b) Create an index sequence n (step = 1) ranging from -10 to 10 and make a stem plot of $y_4 = \cos(2\pi\frac{n}{10})$ as a function of n.

For all plots label both the x and y axes and add suitable titles.

Problem 4 - Playing with sinusoids

(a) According to table below construct sinusoids of the form $A\sin(2\pi f t + \varphi)$. Use the time variable `t= 0:.0001:.33` to create a *"short"* sinusoid.

Sinusoid	Frequency	Amplitude	Length	Phase
y_A	220.00	1.5	Short	0
y_C	130.813	1.5	Short	0
y_{Cl}	130.813	1.2	Short	0
y_D	146.8632	1.5	Short	0
y_E	164.814	1.5	Short	0
y_{El}	164.814	1.5	Short	$\frac{\pi}{4}$
y_F	176.614	1.5	Short	0
y_G	195.998	1.5	Short	0
y_{Gl}	2195.998	1.5	Short	0

You can generate a sine wave the same way you generate a square wave. Read the help file on **square**.

Note that the resulting sinusoids from y_A to y_{Gl} are all vectors. That is we have vectors representing our signals.

(b) Use the MATLAB function `sound` to listen to some of the sinusoids defined above. Then determine the effect of changes in f, A and φ. You should look at the changes one at the time, i.e. compare:

- y_A and y_{Gl}
- y_C and y_{Cl}
- y_E and y_{El}

(c) Change y_{Cl}, y_{El} and y_{Gl} according to the table below. Use the time variable `t_l= 0:.0001:.66` to create a *"long"* sinusoid.

Sinusoid	Frequency	Amplitude	Length	Phase
y_{Cl}	130.813	1.5	Long	0
y_{El}	164.814	1.5	Long	0
y_{Gl}	195.998	1.5	Long	0

(d) Create signals (vectors) s_1, s_2 and s_3 which are concatenations of our previously defined sinusoids according to the following:

$$s_1 = \begin{bmatrix} y_C & y_D & y_E & y_F & y_{Gl} & y_{Gl} & y_A & y_A \end{bmatrix}$$
$$s_2 = \begin{bmatrix} y_A & y_A & y_{Gl} & y_F & y_F & y_F & y_F \end{bmatrix}$$
$$s_3 = \begin{bmatrix} y_{El} & y_{El} & y_D & y_D & y_D & y_D & y_{Cl} \end{bmatrix}$$

(To create such concatenations in MATLAB enter exactly as given above.) Then create $y = \begin{bmatrix} s_1 & s_2 & s_3 \end{bmatrix}$ and play y.