SİVAS UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF ENGINEERING AND NATURAL SCIENCES

EEE 104- ALGORITHMS AND PROGRAMMING II

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Experiments Manual Report

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Content

Lab 1:

1. Enter the matrix
M = [1,-2,8,0] and N = [1 5 6 8; 2 5 6 9]
Perform addition on M and N and see how matlab reacts.

2. Find the transpose of null matrix using matlab

3. Write a MATLAB program to perform the division operation on the following matrix
A = [24,-30, 64,-81], b= [6,5,8,9] and verify the result.

4. Write a matlab program to perfom addition operation using 2x3 matrix. Assume any numbers

5. Enter the matrix
A = [1 6 9 8 5; 9 3 5 8 4; 5 6 3 5 7], B = [6 5 9 3 5; 6 5 4 8 5; 6 3 5 7 9],
C = [2 5 9 3 4; 5 6 3 7 8; 9 8 6 5 4]
Find [(A+B)+C]T

6. Enter the matrix
A = [1 6 9 8 5; 9 3 5 8 4; 5 6 3 5 7], B = [6 5 9 3 5; 6 5 4 8 5; 6 3 5 7 9],
C = [2 5 9 3 4; 5 6 3 7 8; 9 8 6 5 4]
Find $[(A-B)+C]^{-1}$

7. Write a matlab program to perfom addition operation using 3x2 matrix. Assume any numbers

8. Write a MATLAB program to perform the division operation on the following matrix
A = [25,-35, 121,-21], b= [5,5,11,3] and perform the transpose function on the answer

9.Find the addition of null matrix and unity matrix of order 3x3.

10. Enter the Matrix the following Matrices and multiply M and N using M*N. Observe the output in the command window.

$$M = \begin{matrix} -1 & 2 & 4 \\ 2 & -1 & -1 \\ 4 & 2 & 0 \end{matrix} \quad N = \begin{matrix} 1 & 2 \\ 3 & -1 \\ 1 & 1 \end{matrix}$$

Lab 2:

1. Try the following
Enter the following statements in the command window:

```
>> clear all; clc; % clear the workspace and the Command Window
>> f=2; w= 2*pi*f; % specify a frequency in Hz and convert to rad/sec
>> T= 0.01; % specify a time increment
>> time = 0 : T : 0.5; %specify a vector of time points
>> % evaluate the sine function for each element of the vector time
>> x= sin(w*time);
>> plot (time,x) % plot x versus time
```

2. Obtain a print of the plot. Explain the purpose of the statements hold on and hold off.

```
>> clear all; clc;
>> T= 0.05; t = 0 : T :5;
>> x = exp(-t);
>> plot(t,x); hold on; plot(t,-x); plot(t,1-x); plot(t,x-1); hold off
>> grid on
```

3. Scalar variables. Make the following variables

- $a=10$
- $b=2.5\times10^{23}$
- $c=2+3i$, where i is the square root of -1
- $d=e^{2\pi j/3}$, where j is the square root of -1 and e is Euler's number (use **exp**, **pi**)

4. Scalar equations. Using the variables created in question 3, calculate x and y.

a. $x = \frac{1}{1+e^{(-\frac{a-15}{6})}}$

b. $y = \left(\sqrt{a} + \sqrt[21]{b}\right)^{\pi}$,recall that $\sqrt[g]{h} = h^{1/g}$, and use **sqrt**. You can also use **nthroot** (refer to the MATLAB help to understand the difference between **nthroot** and fractional power)

Lab 3:

1. Make the following variables

a. $$aMat = \begin{bmatrix} 2 & 2 & 2 & \dots & 2 \\ 2 & 2 & 2 & \dots & 2 \\ 2 & 2 & 2 & \dots & 2 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 2 & 2 & 2 & \dots & 2 \end{bmatrix}$$ a 9x9 matrix full of 2's (use **ones** or **zeros**).

b. $$bMat = \begin{bmatrix} 1 & 0 & 0 & \dots & 0 \\ 0 & 2 & 0 & \dots & 0 \\ 0 & 0 & 3 & \dots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \dots & 1 \end{bmatrix}$$ a 9x9 matrix of all zeros, but with the values [1,2,3,4,5,4,3,2,1] on the main diagonal (use **zeros, diag**).

c. $$cMat = \begin{bmatrix} 1 & 11 & 21 & \dots & 91 \\ 2 & 12 & 22 & \dots & 92 \\ 3 & 13 & 23 & \dots & 93 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 10 & 20 & 30 & \dots & 100 \end{bmatrix}$$ a 10x10 matrix where the vector 1:100 runs down the columns (use **reshape**).

d. $$dMat = \begin{bmatrix} \text{NaN} & \text{NaN} & \text{NaN} & \text{NaN} \\ \text{NaN} & \text{NaN} & \text{NaN} & \text{NaN} \\ \text{NaN} & \text{NaN} & \text{NaN} & \text{NaN} \end{bmatrix}$$ a 3x4 NaN matrix (use **nan**).

e. $$eMat = \begin{bmatrix} 13 & -1 & 5 \\ -22 & 10 & -87 \end{bmatrix}$$

f. Make **fMat** be a 5x3 matrix of random integers with values in the range -3 to 3 (first use **rand** and **floor** or **ceil**, then only use **randi**).

2. Use MATLAB built-in functions for the following:

- Define matrix **A** of dimension 2 by 4 whose (i,j) entries are **A(i,j) = i + j**.
- Extract two **2x2** matrices **A1** and **A2** out of matrix **A**:
    - **A1** contains the first two columns of A.
    - **A2** contains the last two columns of A.
- Compute matrix **B** as the sum of **A1** and **A2**.
- Compute the **eigenvalues** and **eigenvectors** of **B**.
- Solve the linear system **B x = b**, where **b** has all entries equal to 2.

3. Follow the instructions till you get the result

Plotting multiple lines and colors. In class, we saw how to plot a single line in the default blue color on a plot. You may have noticed that subsequent plot commands simply replace the existing line. Here, we'll write a script to plot two lines on the same axes.

a. Open a script and name it **twoLinePlot.m**. Write the following commands in this script.

b. Make a new figure using **figure**

c. We'll plot a sine wave and a cosine wave over one period

i. Make a time vector *t* from 0 to 2π with enough samples to get smooth lines.

ii. Plot **sin(t)**

iii. Type **hold on** to turn on the 'hold' property of the figure. This tells the figure not to discard lines that are already plotted when plotting new ones. Similarly, you can use **hold off** to turn off the hold property.

iv. Plot **cos(t)** using a red dashed line. To specify line color and style, simply add a third argument to your plot command (see the third paragraph of the **plot** help). This argument is a string specifying the line properties as described in the help file. For example, the string **'k:'** specifies a black dotted line.

d. Now, we'll add labels to the plot

i. Label the x-axis using **xlabel**

ii. Label the y-axis using **ylabel**

iii. Give the figure a title using **title**

iv. Create a legend to describe the two lines you have plotted by using **legend** and passing to it the two strings **'Sin'** and **'Cos'**.

e. If you run the script now, you'll see that the x-axis goes from 0 to 7 and y-axis goes from -1 to 1. To make this look nicer, we'll manually specify the x and y limits. Use **xlim** to set the x-axis to be from 0 to 2π and use **ylim** to set the y-axis to be from -1.4 to 1.4.

f. Run the script to verify that everything runs right.

Lab 4:

1. Solve the following using matrix and vector representation in MATLAB:

ZI=V

a) where the 3×3 matrix Z and the 3×1 vector V are given by:

$$Z = \begin{bmatrix} 0 & 4 & -1 \\ -2 & 1 & 0 \\ 5 & 0 & 3 \end{bmatrix}, \quad V = \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}$$

b) Solve the system of equations:

$$3x_1 + 5x_2 - 9x_3 = 6$$

$$-3x_1 + 7x_3 = -2$$

$$-x_2 + 4x_3 = 8$$

c) Solve the system of equations:

$$6i_1 - 4i_2 = 10$$

$$4i_1 - i_2 = 5$$

2. Throwing a Ball. Below are all the steps you need to follow, but you should also add your meaningful comments to the code as you write it.

***a.** Start a new file in the **MATLAB Editor** and save it as **throwBall.m**.*

***b.** At the top of the file, define some constants (you can pick your variable names):*

1. Initial height of ball at release = 1.5 m
2. Gravitational acceleration = 9.8 m/s²
3. Velocity of ball at release = 4 m/s
4. Angle of the velocity vector at the time of release = 45 degrees

c. Next, make a time vector that has **1000 linearly spaced values** between **0 and 1**, inclusive.

d. If **x** is distance and **y** is height, the equations below describe their dependence on time and all the other parameters (initial height **h**, gravitational acceleration **g**, initial ball velocity **v**, angle of velocity vector in degrees **θ**). Solve for **x** and **y**:

1. $x(t) = V\cos\left(\frac{\theta\pi}{180}\right)t$ We multiply **θ** by **π / 180** to convert degrees to radians.
2. $y(t) = h + V\sin\left(\frac{\theta\pi}{180}\right)t - \frac{1}{2}gt^2$

e. Approximate when the ball hits the ground.

1. Find the index when the height first becomes negative **(*use find*).**
2. The distance at which the ball hits the ground **is the value of** x **at that index.**
3. Display the words**:**
   The ball hits the ground at a distance of X meters.
   (where X is the distance you found in part ii above)

f. Plot the ball's trajectory

1. Open a new figure **(*use figure*).**
2. Plot the ball's height on the y-axis and the distance on the x-axis **(*use plot*).**
3. Label the axes meaningfully and give the figure a title **(*use xlabel, ylabel, and title*).**
4. Hold on to the figure **(*use hold on*).**
5. Plot the ground as a dashed black line**.**
   - This should be a horizontal line going from **0 to the maximum value of x (*use max*).**
   - The height of this line should be **0** (*see help plot for line colors and styles*).

Run the script and verify that the ball indeed hits the ground around the distance you estimated in **e-ii**.

Lab 5:

1. Write Matlab program to print a table of three columns where the first column represents the numbers from 1 to 10 (10 students), the second column is the age of each student and the third column is the height of each student. The program should then sort the students according to age (18 – 25 years) and height (taller than 175 cm).

Student No.	Age	Height
1	16	170
2	17	180
3	20	178
4	23	170
5	24	182
6	30	178
7	25	166
8	18	180
9	35	162
10	17	180

2. Write Matlab code to evaluate the following function for any value of x:

$$y = \begin{cases} \dfrac{x+1}{x-1} & x > 1 \\ x^2 + x - 1 & -1 \le x \le 1 \\ ln(x^2) & x < -1 \end{cases}$$

3. Write a While Loop to plot the following function over the range $-2 \le x \le 6$

.

$$y = \begin{cases} e^{x+1} \quad \text{for } x < -1 \\ 2 + \cos(\pi x) \quad \text{for } -1 \le x \le 5 \\ 10(x-5) + 1 \quad \text{for } x > 5 \end{cases}$$

Lab 6:

Convergence of infinite series.

We'll look at two series that converge to a finite value when they are summed.

a. Open a new script in the MATLAB Editor and save it as `seriesConvergence.m`.

b. First, we'll deal with a geometric series $\sum_{K=0}^{\infty} p^k$. We need to define the value of ppp and the values of k:

i. p=0.99

ii. k is a vector containing the integers from 0 to 1000, inclusive.

c.Calculate each term in the series (before summation):

i. geomSeries=p^k (this should be done elementwise)

d. Calculate the value of the infinite series: We know that G;

$$G = \sum_{K=0}^{\infty} p^k = \frac{1}{1-p}$$

e. Plot the value of the infinite series:

i. Plot a horizontal red line that has x values 0 and the maximum value in k (use `max`), and the y value is constant at G.

f. On the same plot, plot the value of the finite series for all values of k:

i. Plot the cumulative sum of `geomSeries` versus k. The cumulative sum of a vector is a vector of the same size, where the value of each element is equal to the sum of all the elements to the left of it in the original vector. (Use `cumsum`, and try `cumsum([1 1 1 1 1])` to understand what it's doing.) Use a blue line when plotting.

g. Label the xxx and yyy axes, and give the figure a title (`xlabel`, `ylabel`, `title`). Also, create a legend and label the first line as 'Infinite sum' and the second line as 'Finite Sum' (`legend`).

h. Run the script and note that the finite sum of 1000 elements comes very close to the value of the infinite sum.

i. Next, we will do a similar thing for another series, the p-series:

$$P = \sum_{n=0}^{\infty} \frac{1}{n^p}$$

j.At the bottom of the same script, initialize new variables:

i. p=2p = 2p=2

ii. nnn is a vector containing all the integers from 1 to 500, inclusive.

k. Calculate the value of each term in the series:

pSeries=$\frac{1}{n^p}$

l. Calculate the value of the infinite p-series. The infinite p-series with p=2 has been proven to converge to:

$$P = \sum_{n=0}^{\infty} \frac{1}{n^p} = \frac{\pi^2}{6}$$

m. Make a new figure and plot the infinite sum as well as the finite sum, as we did for the geometric series:

i. Make a new figure.

ii. Plot the infinite series value as a horizontal red line with x values 0 and the maximum value in nnn, and the y value is constant at P.

iii. Hold on to the figure, and plot the cumulative sum of `pSeries` versus nnn (use `hold on`, `cumsum`).

iv. Label the x and y axes, give the figure a title, and make a legend to label the lines as 'Infinite sum' and 'Finite sum' (use `xlabel`, `ylabel`, `title`, `legend`).

n.Run the script to verify that it produces the expected output.

Lab 7:

Note: Label all the axes and title all the plots, use a legend if your plot requires it.

1.The table below shows the grades of three examinations of ten students in a class.

STUDENT	EXAM #1	EXAM #2	EXAM #3
1	81	78	83
2	75	77	80
3	95	90	93
4	65	69	72
5	72	73	71
6	79	84	86
7	93	97	94
8	69	72	67
9	83	80	82
10	87	81	77

(a) Plot the results of each examination.
(b) Use MATLAB to calculate the mean and standard deviation of each examination.

2. The voltage v and current I of a certain diode are related by the expression:

$$i = I_s exp\left[\frac{v}{nV_T}\right]$$

If $Is=1.0\times10^{-14}$, n=2.0, and V_T=26 mV,
plot the current versus voltage curve of the diode for diode voltage between 0 and 0.6 volts.

3. A message signal m(t)m(t)m(t) and the carrier signal c(t)c(t)c(t) of a communication system are, respectively:

m(t)=4cos(120πt)+2cos(240πt)
c(t)=10cos(10,000πt)

A double-sideband suppressed carrier s(t) is given as:

s(t)=m(t)c(t)

Plot m(t), c(t), and s(t) using the subplot command.

4. The repulsive Coulomb force that exists between two protons in the nucleus of a conductor is given as:

$$F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$$

If q1=q2=1.6×10^{-19} C, and

$$\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^9\, \mathrm{Nm}^2/\mathrm{C}^2$$

sketch a graph of force versus radius r. Assume a radius from 1.0×10^{-15} to 1.0×10^{-14} m with increments of 2.0×10^{-15} m.

5. The current flowing through a drain of a field-effect transistor during saturation is given as:

$$i_{DS} = k(V_{GS} - V_T)^2$$

If V_T=1.0 volt and k=2.5k mA/V², plot the current i_{DS} for the following values of V_{GS}: 1.5,2.0,2.5,…5 V.

6. For an R-L circuit, the voltage v(t)v(t)v(t) and current i(t)i(t)i(t) are given as:

v(t)=10cos(377t)
i(t)=5cos(377t+60°)

Sketch v(t) and i(t) for t=0 to 20 milliseconds.

Lab 8:

1. The gain versus frequency of a capacitively coupled amplifier is shown below. Draw a graph of gain versus frequency using a logarithmic scale for the frequency and a linear scale for the gain.

Frequency (Hz)	Gain (dB)	Frequency (Hz)	Gain (dB)
20	5	2000	34
40	10	5000	34
80	30	8000	34
100	32	10000	32
120	34	12000	30

2. A complex number z can be represented as:

$z=re^{j\theta}$

The n^{th} power of the complex number is given as:

$zn=r^{n}e^{jn\theta}$

If r=1.2 and θ=10°, use the polar plot to plot $|z^n|$ versus nθ for n=1 to n=36.

3. The horizontal displacement x(t) and vertical displacement y(t) are given with respect to time t as:

x(t)=2t

y(t)=sin(t)

For t=0 to 10 ms, determine the values of x(t)) and y(t). Use the values to plot x(t) versus y(t).

Lab 9:

1. The graded index fiber core equation describes the refractive index profile of a graded index optical fiber. It is typically given by:

$$n(r) = n_0\sqrt{1 - 2\Delta\left(\frac{r}{a}\right)^{n_{\max}}}$$

Where:

- $n(r)$ is the refractive index at radius r where r varies between 0 to a,
- $n0$ is the refractive index at the center of the core, which is 1.5,
- Δ is the relative index difference, which 0.01,
- a is the radius of the core (25um), and
- $n$max is the profile parameter that determines the shape of the refractive index profile, which will be 2, 4, 8 10 and 20.

Plot the profile of this fiber Label the axes and give a title to the figure.

2. Consider the following parametric functions:

$$x = \sin(t)\left(e^{\cos(t)} - 2\cos(4t) - \sin^5\left(\frac{t}{12}\right)\right)$$

$$y = \cos(t)\left(e^{\cos(t)} - 2\cos(4t) - \sin^5\left(\frac{t}{12}\right)\right)$$

where t varies from 0 to 12π with an increment of 0.01π. Plot on the same figure function x in magenta, diamond and function y in cyan, right-pointing triangle. Label the axes and give a title to the figure.

3. Write a MATLAB script that generates a 3D plot of the radiation pattern for a simple antenna. The antenna has a cosine-squared pattern given by:

$$P(\theta, \phi) = \left|\frac{1}{2}\cos(\theta) + \frac{1}{2}\right|^2 \cdot \left|\frac{1}{2}\cos(\phi) + \frac{1}{2}\right|^2$$

where θ is the elevation angle (from -pi/2 to pi/2) and ϕ is the azimuth angle (from -pi to pi). The plot should show the 3D radiation pattern over the entire sphere.

Instructions:

- Define a grid of elevation and azimuth angles.
- Calculate the radiation pattern using the given formula.
- Create a 3D plot of the radiation pattern as a function of elevation and azimuth angles.
- Label the axes appropriately.

4. You are given a set of exam results for a class of students. Each student's score is represented as a percentage out of 100. Write a MATLAB script that calculates the distribution of scores and presents it as a pie chart. Instructions:

- Define a vector scores containing the exam scores of the students.
- Calculate the percentage of students who scored in each of the following ranges: 0-20, 21-40, 41-60, 61-80, and 81-100.
- Create a pie chart to visualize the distribution of scores.
- Label each slice of the pie chart with the corresponding score range.

Hint: Use the histcounts function to calculate the histogram of scores and then convert it to percentages. Use the pie function to create the pie chart.

Lab 10:

1. Given below is the table of a few electrical scientists.

Name	Lived	Research field
Charles-Augustin de Coulomb	1736–1806	electrostatic force
Andre Marie Ampere	1775–1836	electrodynamics
Michael Faraday	1791–1867	electricity and magnetism
James Clerk Maxwell	1831–1879	electromagnetic field theory
Nikola Tesla	1856–1943	electromagnetic technology

Give MATLAB statements to

a) create a cell named electrical scientists with sub-cells named: name, lived,

b) and research field

c) display the cell

d) display the first sub-cell field, then change the names in that sub-cell to upper case letters, do this by the character data type.

2. Give MATLAB statements to define character data type variables as follows.

a) String named first, middle, and last of the name James Clerk Maxwell

b) String named full by horizontally concatenating last, first, and middle with comma and a blank between last and first and a blank between first and middle. Give two ways.

c) Array named Full by vertically concatenating last, first, and middle.

3. Usually, cells are most useful for storing strings, because the length of each string can be unique.

a) Make a 3x3 cell where the first column contains the names: 'Joe', 'Sarah', and 'Pat', the second column contains their last names: 'Smith', 'Brown', 'Jackson', and the third column contains their salaries: \$30,000, \$150,000, and \$120,000. Display the cell using **disp**.

b) Sarah gets married and decides to change her last name to 'Meyers'. Make this change in the cell you made in a. Display the cell using **disp**.

c) Pat gets promoted and gets a raise of \$50,000. Change his salary by adding this amount to his current salary. Display the cell using **disp**.

Lab 11:

1. The voltage, v, across a resistance is given as (Ohm's Law), $v = Ri$, where i is the current and R the resistance. The power dissipated in resistor R is given by the expression $P = Ri^2$.
   If R = 10 Ohms and the current is increased from 0 to 10 A with increments of 2A, write a MATLAB program to generate a table of current, voltage and power dissipation.

2. Simplify the complex number z and express it both in rectangular and polar form.

$$z = \frac{(3 + j4)(5 + j2)(2\angle 60^0)}{(3 + j6)(1 + j2)}$$

3. Write a MATLAB function to obtain the roots of the quadratic equation $ax^2 + bx + c = 0$

4. For an R-L circuit, the voltage v (t) and current i (t) are given as,

$$v(t) = 10\cos(377t)$$
$$i(t) = 5\cos(377t + 60^0)$$

   Sketch v (t) and i(t) for t = 0 to 20 milliseconds.

Lab 12:

1. Write a function named *quadratic* that would calculate the roots of a quadratic equation. The function would take three inputs, the quadratic coefficient, the linear coefficient and the constant term. It would return the roots.

The function file quadratic.m will contain the primary function *quadratic* and the sub-function *disc*, which calculates the discriminant.

2. Import a text file and specify Delimiter and Column Header. Let us create a space-delimited ASCII file with column headers, named *weeklydata.txt*.

Our text file weeklydata.txt looks like this:

SunDay	MonDay	TuesDay	WednesDay	ThursDay	FriDay	SaturDay
95.01	76.21	61.54	40.57	55.79	70.28	81.53
73.11	45.65	79.19	93.55	75.29	69.87	74.68
60.68	41.85	92.18	91.69	81.32	90.38	74.51
48.60	82.14	73.82	41.03	0.99	67.22	93.18
89.13	44.47	57.63	89.36	13.89	19.88	46.60

3. Write a function file to solve the equivalent resistance of series connected resistors, R_1, R_2, R_3, …, R_n.