

GE U111 ENGINEERING PROBLEM SOLVING & COMPUTATION, SPRING 2004
HOMEWORK #7

DATE ASSIGNED: March 22, 2004
DATE DUE: March 29, 2004 (at the beginning of class)
READING: Chapter 4 (JK)

- Solve both problems below in MATLAB **using 2 solution methods**.
- You should submit a fully commented (documented) m-file (use % comments), and the correct output from running the m-file. Your name should be displayed on the top of each m-file (use display command).
- On Monday you must:
 1. Email both m-files to the TA (by the start of class).
 2. Turn in a packet that includes
 - ◆ a diskette with both m-files
 - ◆ cover page with the usual information (name, date, assignment, class, section)
 - ◆ table of contents
 - ◆ printed copies of each m-file
 - ◆ any results
 - ◆ report (as explained below) summarizing the problem, how you solved it, & your interpretation of the results

Part (A) : “This is Elementary”

Overview. Using data provided, you will set up a system of simultaneous linear equations to solve a molecular composition problem. You will then write and execute an m-file to solve the problem. This will involve entering the correct values in the appropriate arrays and conducting the correct matrix operations.

Setting the Stage: While conducting engineering research, you discover several new compounds that are similar to amino acids. Six of these compounds are named in Table 1 below. In the center section of the table, the relative composition of unknown elements is given for each compound. Finally, the last column contains molecular weight of each compound. Your mission: Identify each of the unknown elements (U, V, W, X, Y, and Z) by solving for their atomic weights.

Table 1. Composition Table

NAME OF COMPOUND	COMPOSITION	MOLECULAR WEIGHT
Clonine	$V_2W_4Y_7Z_{12}$	1913.7768
Zhengaphan	$U_8V_5W_2X_3Y$	1294.6165
Eponine	$U_{12}WX_5Y_6Z_4$	1472.5731
Vaddephan	$V_4X_8Z_{11}$	1841.2794
Jaegernine	$W_8X_6YZ_{10}$	2184.7270
Knotaphan	$U_7VW_3X_2Y_4$	1096.3810

Methodology: Organize a set of 6 simultaneous linear equations in 6 unknowns, using the subscripts as coefficients for the associated variables.

$$\text{Example- Clonine: } 0U + 2V + 4W + 0X + 7Y + 12Z = 1913.7768$$

Use MATLAB matrix operations and computations to solve for the values of the unknown elements. Similar to the examples from class, the coefficients from the 6 equations will be used to construct the matrix **A**. The unknown atomic weights are represented by the vector **X**, with the product being the resultant vector **B**. The matrix equation is therefore $\mathbf{A} \cdot \mathbf{X} = \mathbf{B}$. To solve for **X**, you would find the inverse of **A** and multiply times **B**.

$$\mathbf{X} = \text{inv}(\mathbf{A}) * \mathbf{B}$$

MATLAB will also do the matrix operations without using the inverse, using the **special division operator, **.

$$\mathbf{X} = \mathbf{A} \setminus \mathbf{B}$$

In linear algebra, this solution ($\mathbf{A} \cdot \mathbf{X} = \mathbf{B}$) is found using various matrix based algorithms, but MATLAB makes it easy!

Problem Formulation: Set up the problem. For consistency, please calculate to 4 decimal places throughout the lab.

- Organize the information from Table 1 into 6 equations in 6 unknowns.
- Include these equations in your report.

MATLAB Work: Write the MATLAB code and obtain output to solve the element problem:

Submit an m-file to solve the set of simultaneous linear equations. Document all your steps using the **% comment** symbol. Run the program and print and submit the results. Follow these instructions:

- You may decide which method to use to create the m-file.... remember to put your diskette in & change the directory to the a: drive (use cd a:).
 - (a) In Command Window, make a diary file during interactive session → save diary as HW7abc.m (where abc are your initials) and modify in the Editor / Debugger → then execute it.
 - (b) In Editor / Debugger, write m-file from scratch → save it as Lab2_...m (where ... are your initials) → then execute it.
 - (c) Copy commands from Command Window to Editor Window, as you test them, removing the >> command prompts → save it while in the Edit Window as Lab2_...m (where ... are your initials) → then execute it.
- Using the **display** command, place your name, class time, and assignment on the first line of the code:
disp('Ima Student, GE U111 – Section X, Homework 7 – Part A')
- Assign the matrix **A**. Be sure you have the correct rows and columns. Allow it to display to the screen.
- Assign the vector **B**. Allow it to display to the screen.
- Write code to find the solution to **X** with the proper MATLAB commands.
- Execute the m-file when you think you've got it to obtain the solution vector **X**.
- Print out the m-file with matrix **A**, **B**, and the solution computations to hand in.
- Print out the output from the executed m-file to hand in.

Interpretation of Results: Using the information above, you will answer the question: *What are the atomic weights of each of the elements that make up each compound?* Note that the values (U-Z) represent atomic weights of actual nonradioactive elements that can be found in the Periodic Table. Once you have determined the atomic weights of each unknown element, **identify each of the 6 elements by name** by looking them up in a chemistry resource. Look at a Periodic table found in your chemistry book or on the web. For example if X=52, then the element would be chromium, (symbol: Cr, atomic weight: 51.996, atomic number: 24).

Report:

- **Journal Entry Page** – Use a “Scientific Journal entry” format. (It is simply a dated record of scientific findings that a scientist or engineer creates for later reference. It documents and records what was found and what was done.) Format yours in the following way:
 - Upper left: Your name and title (you may invent your own plausible and impressive title)
 - Upper right: The name of the laboratory in which you work (you may make this up) and the date;
 - Include a brief introductory overview of what you were trying to accomplish (identify all of the elements). Describe your solution process. If you were successful, make sure you mention that too.
 - The equations generated from which you generated the solution.
 - A table that lists each variable (U-Z), the calculated value, the element it represents, its atomic symbol, its atomic weight, and its atomic number
 - Write a brief conclusion: interpreting your results and about the potential value of your approach.
 - Properly reference of the chemistry resource from which you found atomic weights and names of the elements
- **MATLAB Work**
 - Fully documented m-file with a proper solution method used. Your name should be displayed on it as well.
 - Print results / output from running your m-file (which should display your name and results).

Please arrange your lab report with the **Journal Entry Page** first, then the **MATLAB Work**.

**Journal Entry Page
Format Example:**

Fill in the remainder of the paragraphs and information that give a description of your process and results:

John Smith
Forensic Engineer

BioMed Engineering
20 February 2003

Today in our research we made some exciting discoveries
:
:

Using the following equations ... :

Clonine: $0U + 2V + 6W + 0X + 7Y + 12Z = 2090.1058$
:
Knotaphan:

Next, I took the coefficients from the equations and ...
:
:

These operations yielded the following results:

Variable	Calculated Value	Name of Element*	Symbol	Atomic Weight	Atomic Number
P	137.3402	barium	Ba	137.34	56
:					

This outcome is valuable because we have identified ...
:
:

*Author, I.M. (1998). Chemistry for Forensic Engineers. Boston: NU Press.

Part (B) : “Circuits”

Problem:

Table 2. Battery potential and resistance values.

Established values	
E	20 volts
R_1	10 ohms
R_2	10 ohms
R_3	20 ohms
R_4	20 ohms
R_5	20 ohms
R_6	20 ohms

For this circuit problem, write out the 2 equations in 2 unknowns, with the coefficient values and variables on the left hand side and the known values on the right hand side of each equation.

Methodology:

Use $V=IR$ where V =voltage (in volts) , I =current (in amps), R =resistance (in ohms)

In closed multi-loop circuits....

1. **The net changes in voltage must equal zero. (Kirchhoff’s Voltage Law)**
2. **The incoming current(s) must equal the out going current(s) at any junction (Kirchhoff’s Current Law)**

Solution: Using the above laws, you will get:

$$\begin{aligned}R_2 I_2 + R_3 I_2 + R_4 I_2 + R_6 I_2 - R_6 I_1 &= 0 \\ R_1 I_1 + R_6 I_1 + R_5 I_1 - R_6 I_2 &= E\end{aligned}$$

Substitute “known” values into the equations. Put equations in matrix format: $A \cdot X = B$. Use MATLAB to solve this set of equations using 2 methods. Submit your equations, your m-file and output, with your name and filename displayed on each. Be sure to fully document the code with proper units of measure: volts, ohms, amps.

Report: You can submit this report in the same format as in Part A (or use your own). Just be sure to include:

- Your name and class section
 - The date
 - A brief introductory overview of what you were trying to accomplish (solve for 2 unknown currents). Describe your solution process. If you were successful, mention that too.
 - The equations from which you generated the solution.
 - Your results (table form is easiest to read) for the 2 currents your program solved for.
 - Write a brief conclusion: interpreting your results and the potential value of your approach.
- **MATLAB Work**
- Fully documented m-file with a proper solution method used. Your name should be displayed on it as well.
 - Print results from running your m-file (which should display your name and results).

Please arrange your lab report with the **Journal Entry Page** (or what ever format you chose) first, then the **MATLAB Work**.