

CEE 6510 – Fall 2004 – Assignment No. 2

[1] Write a Matlab function that generates a table of values of $x = [0, 0.5, 1.0, \dots, 10]$, $y = 2 \sin(x) + 3 \cos(x)$, $z = e^{-0.1x} \cos(3x-2)$, $w = zxy$, and writes it to a text file.

[2]. Write a Matlab function that reads the data from the table written in program [1] as a matrix R . The program should separate the data in R into values of x , y , z , and w , and produce plots of y vs. x , z vs. x , and w vs. x in the same set of axes. Add labels to the axes and a title to the plot.

[3]. The numerical integration of a function $y = f(x)$ in the interval $a < x < b$ can be accomplished by dividing the interval into n equally-spaced subintervals of size $\Delta x = (b-a)/n$. The nodes in the interval will be given by $x_k = a + (k-1)\Delta x$, for $k = 1, 2, \dots, n$, so that for $k = 1$, $x_1 = a$, and for $k = n+1$, $x_{n+1} = a + n \Delta x = b$. The integral, $I = \int_a^b f(x)dx$, can be approximated by any of the following formulations:

$$I_L = \sum_{k=1}^n f(x_k) \cdot \Delta x,$$

or,

$$I_R = \sum_{k=1}^n f(x_{k+1}) \cdot \Delta x.$$

(a) Write a Matlab function that takes as input the name of the function f , the limits of integration a and b , and the number of required sub-intervals, n , and returns the values of I_L and I_R . (b) Calculate the numerical integral for $f(x) = 1-x^2$, $a = -1$, $b = 1$, and values of $n = 10, 20, 50, 100, 500, 1000$. (c) Produce a plot of the values of I_L and I_R as functions of n . Add a title and labels to the axes of the plot.

[4]. Given a set of (x,y) data as those shown in Table 1 (see below), it may be possible to obtain a linear regression of the form $y=a+bx$ for these data. The calculation of the linear regression coefficients, a and b , for the data is accomplished by setting up the matrix equation (these are the *normal equations* based on the *least-square* method):

$$\begin{bmatrix} n & \sum_{i=1}^n x_i \\ \sum_{i=1}^n x_i & \sum_{i=1}^n x_i^2 \end{bmatrix} \cdot \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} \sum_{i=1}^n y_i \\ \sum_{i=1}^n x_i y_i \end{bmatrix}.$$

(a) Write a Matlab function that will read the data vectors x and y from a text file. The data should look as shown in Table 1, i.e., two rows of data. The function should calculate the summations shown in the matrix equation above, set up the matrix equation, and solve it for a and b . Finally, the function should produce a plot of the original data as circles, and of the fitted data (namely, the line $y = a+bx$) as a continuous line. The graph

should show a legend identifying the original and fitted data, and include labels for the axes as well as a title. (b) Execute the function for the data in Table 1.

Table 1. Data for linear regression

x	1	3	4	6	8	9	11	14
y	1	2	4	4	5	7	8	9

[5]. Modify functions *GVF.m* and *Gvftds.m* so that they calculate the normal and critical depths of flow, as well as a backwater curve, for a circular open channel of diameter D .

The formulae for the geometric properties for a circular cross-section are the following:

$$\mathbf{b} = \cos^{-1}\left(1 - 2\frac{y}{D}\right), \quad A = \frac{D^2}{4}(\mathbf{b} - \sin(\mathbf{b})\cos(\mathbf{b})), \quad P = \mathbf{b}D, \quad T = D \cdot \sin(\mathbf{b}),$$

where y = depth of flow, and \mathbf{b} = half-angle.

The function should inform the user that values of y larger than D cannot be entered in reply to function prompts.

Submit:

- Word document showing problem statement, functions or scripts used to solve problem, and output showing solution. Include your name in this document.
- M-files with Matlab scripts and functions.
- Input or output text files.

How to submit your assignment:

Place the Word document, m -files, and input and output text files in a zip file. E-mail the zip file to: gurro@cc.usu.edu