CIVE 498/898 – Section 3

Computational Problem Solving in Civil Engineering

Assignment 1 – Due Wednesday, September 5th, 2012, at 1:00pm

Notes: Please show all your efforts. Please summarize your methods and answers for each problem in a document. This document can be submitted either electronically (yusong.li@gmail.com) or in hard copy. Please submit your MATLAB program file corresponding to each problem electronically.

Problem 1:

With the following matrices and vectors:

$$A = \begin{pmatrix} 10 & -3 \\ 4 & 2 \end{pmatrix}, \quad B = \begin{pmatrix} 1 & 0 \\ -1 & 2 \end{pmatrix}, \quad \mathbf{v} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}, \quad \mathbf{w} = \begin{pmatrix} 1 \\ 1 \end{pmatrix},$$

compute the following **both** by hand and in MATLAB. For the MATLAB computations, use the `diary` command to record your session.

(a) $\mathbf{v}^T\mathbf{w}$; (b) $\mathbf{v}\mathbf{w}^T$; (c) $A\mathbf{v}$; (d) $A^T\mathbf{v}$; (e) AB;

(f) BA; (g) $A^2\ (= AA)$;

(h) The vector $\mathbf{y}$ for which $B\mathbf{y} = \mathbf{w}$.

Problem 2:

Use MATLAB to produce a single plot displaying the graphs of the functions $\sin(kx)$ across $[0, 2\pi]$, for $k = 1, \ldots, 5$.

Problem 3:

2.23 The volume V of liquid in a hollow horizontal cylinder of radius r and length L is related to the depth of the liquid h by

$$V = \left[r^2 \cos^{-1}\left(\frac{r-h}{r}\right) - (r-h)\sqrt{2rh - h^2} \right] L$$

Develop a well-structured function to create a plot of volume versus depth. Test the program for $r = 2$ m and $L = 5$ m.

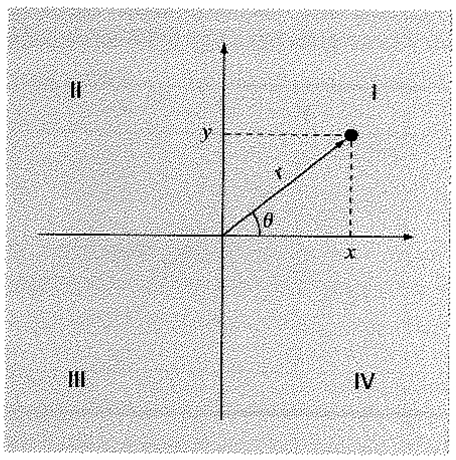
Problem 4:

2.14 Two distances are required to specify the location of a point relative to an origin in two-dimensional space (Fig. P2.14):

- The horizontal and vertical distances (x, y) in Cartesian coordinates
- The radius and angle (r, θ) in radial coordinates.

It is relatively straightforward to compute Cartesian coordinates (x, y) on the basis of polar coordinates (r, θ). The reverse process is not so simple. The radius can be computed by the following formula:

$$r = \sqrt{x^2 + y^2}$$



If the coordinates lie within the first and fourth coordinates (i.e., $x > 0$), then a simple formula can be used to compute θ

$$\theta = \tan^{-1}\left(\frac{y}{x}\right)$$

The difficulty arises for the other cases. The following table summarizes the possibilities:

x	**y**	**θ**
<0	>0	$\tan^{-1}(y/x) + \pi$
<0	<0	$\tan^{-1}(y/x) - \pi$
<0	$=0$	π
$=0$	>0	$\pi/2$
$=0$	<0	$-\pi/2$
$=0$	$=0$	0

(a) Write a well-structured flowchart for a subroutine procedure to calculate r and θ as a function of x and y. Express the final results for θ in degrees.

(b) Write a well-structured function procedure based on your flowchart. Test your program by using it to fill out the following table:

x	**y**	**r**	**θ**
1	0		
1	1		
0	1		
−1	1		
−1	0		
−1	−1		
0	−1		
1	−1		
0	0		