24-311 NUMERICAL METHODS Fall 03

Carnegie Mellon University

PROBLEM SET 1

Issued: 8/28/03 (Thr)
Due: 9/4/03 (Thr) 11:50am
(Hand-in your paper in a box placed outside of Hamerschlag Hall B127.)
Weight: 4% of total grade (PS1-1 will not be graded. No need to hand-in anything for PS1-1.)

Note: *** Attach the last page of the problem set as the cover page of your paper. This helps us get more organized and avoid mistakes in grading.**
*** Write your code name on the backside of the cover page.**

PS1-1 Class home page, VRML, Mathcad

(1) Read through the class home page:
http://www.andrew.cmu.edu/course/24-311/

(2) Make sure you know how to download PDF files with your web browser and print them out using Adobe Acrobat Reader. Most handouts including problem sets (except this one:-) will be distributed as a PDF file only on the class home page. Please check the home page regularly and download, print out, and bring handouts and problem sets to class. (All Andrew machines have Acrobat Reader installed. You can download the Acrobat Reader software free from http://www.adobe.com/ for your home PCs.)

(3) Run your favorite web browser and make sure you can see the 3D view of the sample VRML2 files (*.wrl) listed in the "Reference" section of the class home page. On a PC in the Mechanical Engineering Computer Cluster use "Internet Explorer" to view a VRML file—a VRML viewer plug-in has been installed. On most of Andrew Windows machines you can use "Internet Explorer" to view VRML2 files. (See the Reference section for other alternatives.)

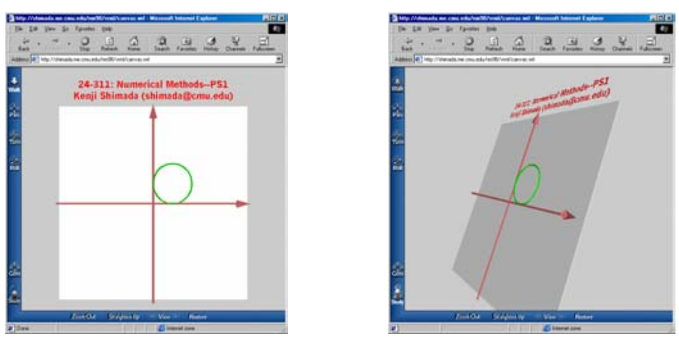

Figure 1. canvas.wrl viewed with Internet Explorer

(4) Run Mathcad, one of the popular commercial math software packages, and learn the basic operations in the overview and getting started tutorial. (To access the overview and getting started tutorial, select from the pull down menu Help => Recourse Center. Some useful Mathcad reference tables can be found in the Reference section of class web page: http://www.andrew.cmu.edu/course/24-311/reference.htm.

PS1-2 Mathcad—plotting a curve with the SI unit

The velocity of a falling parachutist v is given by

$$v = \frac{mg}{c}\left(1 - e^{-\frac{c}{m}t}\right)$$

where $g = 9.8 \text{ m/s}^2$. Plot the velocity from $t = 0 \text{ sec}$ to $t = 50 \text{ sec}$. Use a drag coefficient $c = 14 \text{ kg/s}$, a mass $m = 68.1 \text{ kg}$, and the gravitational constant $g = 9.8 \text{ m/s}^2$. Hand in a printout of your command script and the function plot. Use the SI unit in the command script and the function plot. Include the title of this problem and your name, e.g., "Velocity of Falling Parachutist by Kenji Shimada," at the top of your command script file.

PS1-3 Mathcad—forward finite divided difference

A storage tank contains a liquid at depth y, where $y = 0$ when the tank is half full. Liquid is withdrawn at a constant flow rate Q to meet demands. The contents are re-supplied at a sinusoidal rate $3Q\sin^2(t)$ (see Figure 2). The cross-sectional area of the tank is A.

(1) Suppose you are interested in finding how the liquid depth changes over time. What is the governing differential equation of the system?

(2) Use a numerical method (forward finite divided difference approximation) and solve for the depth y from $t = 0$ to 5 sec with a step size of 0.1 sec. Use the parameter values $A = 1200 \text{ m}^2$ and $Q = 400\ m^3/\text{sec}$. The depth is zero at $t = 0$.

This calculation can be done with a simple calculator, but use Mathcad. Hand in a printout of your command script and the function plot. Use the SI unit in the command script and the function plot. Also, use a looping structure for the iteration. Include the title of this problem and your name, e.g., "Storage Tank by Kenji Shimada," at the top of your command script file.

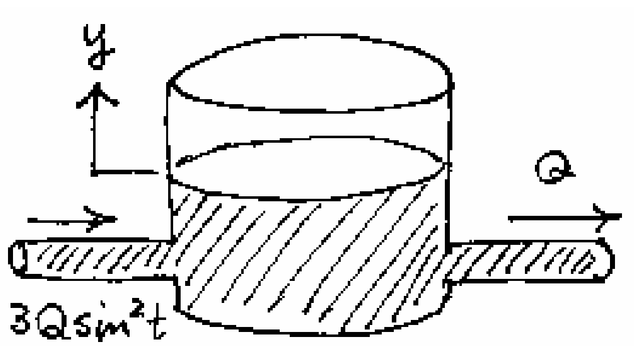

Figure 2. A storage tank containing a liquid

PS1-4 Errors in floating point arithmetic

(1) The polynomial function

$$y = x^3 - 5x^2 + 6x + 0.55$$

takes $y = 0.011917$ at $x = 2.73$. Evaluate the same function with 3-digit arithmetic with chopping. What is the relative error?

(2) Repeat (1) but express y as

$$y = \left[(x-5)x + 6\right]x + 0.55$$

Evaluate the function with 3-digit arithmetic with chopping. What is the relative error?

(3) When you write a computer program to evaluate a polynomial function, which expression would you use, (1) or (2)?

PS1-5 Taylor series expansion

(1) Find the second order approximation of the following function using the Taylor series expansion with a base point at $x = \pi/3$.

$$f(x) = x + \tan(x)$$

(2) Use the fourth-order Taylor series approximation to predict the value of the cosine function at $x = 0.01$ using a base point at $x = 0$.

$$f(x) = \cos(x)$$

PS1

The first letter of your LAST name

First Name

Last Name

PS1-2 (25 pts)	PS1-3 (25 pts)	PS1-4 (25 pts)	PS1-5 (25 pts)	Total (100 pts)

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