Homework #0 • MATH 462 • Think Fluids!

- submit a paper copy of your writing in the Tuesday 12 January lecture, webct-posting may appear later that evening.
- a 40-page matlab primer can be found on the class webpage.
- part **B)** is due noon on Friday 15 January (homework box #12).
- **please attach another copy of the student info sheet to the front of your part A) submission**.

A) Think Fluids! ($\leq$1 page, due Tuesday 12 January) Fluid mechanics is everywhere. Based upon an image, web article, or video clip, present your own interesting example of fluid dynamics in a real world context. Your choice of topic can be anything which raises awareness of the ubiquity of fluid motion, and the need for quantitative understanding. **Creativity counts** & will be judged by a panel of "experts" in the math department lunchroom.

Discuss the fluid aspects of your topic (especially mention those that are quantitative, scientific or mathematical); be specific and state facts. Attach a print-out of your web source, and include the specific links & references. Be prepared to announce your topic in the Tuesday 12 January lecture.

Post your essay on the web by a link or attached copy to the webct *think fluids!* discussion group. The subject line should contain your fluid topic. (Include a clickable link to the web source in your webct posting.)

***) Line Plots in Matlab** (optional) Matlab is a computing environment which allows both interactive use and pre-programmed scripts. Plotting is simple. As a first example, download *w01line.m* from the class webpage. It is a script which reproduces the line plots shown in Figure 2.12 (equation 2.37, page 47, Acheson) for $u_\theta(r)$. Play around by editing the script to see how it works. If you mess up the file, just download a new copy! Make the very minor modifications to reproduce the line plots shown in Figure 2.16 (problem 2.6, page 52, Acheson) for $u(y)$. Give the values of the constants you used (write on your submitted plots).

B) Some Vector Calculus (2 pages + 2 plots) Consider a scalar function of two variables,

$$\psi(x,y) = y\left(1 - \frac{1}{r^2}\right) + \frac{B}{2}\ln(r^2) \ ,$$

where $r^2 = x^2 + y^2$. Define a vector field $\vec{U}(x,y) = (u(x,y), v(x,y))$ where the scalar functions $u(x,y)$ and $v(x,y)$ are related to $\psi(x,y)$ by

$$u(x,y) = +\frac{\partial\psi}{\partial y} \quad ; \quad v(x,y) = -\frac{\partial\psi}{\partial x} \ .$$

Calculate these velocities and also show that the divergence of the velocity field is zero.

This vector field (exterior to the unit circle) is plotted by the script *w01flow.m*, where the value of B can be changed at the top of the file. For these flows, note that the locations (x^*, y^*) where the velocity field $\vec{U}(x^*, y^*)$ is exactly the zero vector depend on the value of B. Identify ranges of B which characterize the different behaviours of these *stagnation points*.

Use the matlab command *plot(xstar,ystar,'r*')*, which plots a red asterisk at a single point, to indicate the points of stagnation. Also indicate in black the contours which are associated with these points. Include two **annotated plots** which illustrate your results.

NAME & Places: (hometowns, etc)

Year & Program: (3^{rd} year MATH/APMA, for example)

E-Mail (req) & Local Phone (opt):

Quantitative Courses: (course # and term taken)

calculus & advanced calculus

linear algebra & analysis

courses with computing

quantitative courses (sciences, economics, etc)

Matlab & Maple – Experience: (yes/no)

Matlab & Maple – Access: (lab and/or home)

Other Computing Experience: (software, programming languages, web design)

Subjects of Interest: (specific maths, sciences, etc)

Educational Focus: (rank in order of priority: 1 = highest, 3 = lowest)

[ ] analysis/theory [ ] applications [ ] computing & graphics

Personal Course Objectives: (goals for this class & future plans)