Homework #0 • MATH 462 • Think Fluids!

- please respect page limits.
- submit your write-up Thursday 15 January (unless indicated otherwise).
- you are encouraged to use the webct discussion forum.
- refer to *Guidelines for Reports*.
- **please attach another copy of the student info sheet to the front of your write-up for part A**.

A) Think Fluids! ($\leq$1 page, due Monday 12 January) Discover a personal interest in fluids by researching a topic of individual choice and writing a short two-paragraph essay. The topic can really be anything which raises awareness of the ubiquity of fluid motion. For instance: a specific fluid phenomena (waterspouts, the Antarctic circumpolar current), a biography (Ernst Mach, Gustave-Gaspard Coriolis), a technology (artificial heart valves, inkjet printers), or a current socio-scientific concern (global warming, oil spills). **Creativity counts.** Discuss the fluid aspects of your topic (especially mention those that are quantitative/mathematical); be specific and state facts. Give references; they can be either print, or web-based (please verify accuracy). You may attach one image. Be prepared to announce your topic in next Monday's lecture.

Please post your essay on the web, and/or attach a link/copy to a posting on the webct discussion group. Be prepared to announce your topic in Monday's lecture.

***) 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 *code01.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 file *w01line.m* 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.