Physics 4931B/Physics 9807B – Physical Fluid Dynamics
Fall 2012

Instructor: Dr. John de Bruyn

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Office Hours: MWF 1:30-2:30 (usually), or make an appointment, or take your chances and drop in anytime.

Lecture Times: Tuesdays, 2:30-4:30 and Thursdays, 2:30-3:30
Room: PAB 106

Text: Fluid Mechanics by P. K. Kundu and I. M. Cohen (Academic Press, Burlington, MA, 2008). There is a newer edition, too. It doesn't matter which edition you buy.

Some other recommended books: (not required, but useful as references)

Elementary Fluid Dynamics by D. J. Acheson (Oxford University Press, Oxford, 1990). This was the text for this course the last couple of times I taught it. It's a good book, but I switched because I like the order of topics in Kundu better. I also find Kundu to be a bit more "Physics-y" in its style.

Physical Fluid Dynamics by D. J. Tritton (Clarendon, Oxford, 1988). A nice book with less math and more physical insight than most texts.

Fluid Mechanics by L. D. Landau and E. M. Lifschitz (Butterworth-Heinemann, Oxford, 1987). A classic, but not an easy read.

Course homepage: Course information, resources, assignments, deadlines, and other important information will be posted on the Owl page for this course. You can access this page via https://owl.uwo.ca/portal. Use your UWO username and password to log in. Please check this page regularly.

There is also a public web page for the course which contains some basic information about the course. You can access it at http://www.physics.uwo.ca/~debruyn/phys4931/phys4931.html

Course Outline: This course is an introduction to fluid dynamics. I will assume that you are familiar with vector calculus (div, grad, curl, the divergence theorem, etc.), that you are comfortable with ordinary differential equations (separation of variables, etc.), and that you understand Newton's Laws. Additional mathematical tools, possibly including PDEs, tensors, and complex analysis, will be introduced as needed. The course will focus on developing a physical understanding of fluid dynamical phenomena, as well as on how to solve problems mathematically. In addition to traditional lectures, we will spend some time on problem solving, discussions, and "special events" such as lab tours and guest speakers.

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The graduate version of the course, Phys 9807, will involve additional assignment questions, a more in-depth term paper, and may involve additional meetings with the instructor as required.

I expect the content of this course to evolve over the term, depending on the interests of the class and the rate at which we find ourselves flowing through the material. Roughly speaking, the topics I hope to cover include:

1) phenomenological introduction to fluid dynamics, kinematics and conservation laws
2) the Navier-Stokes equations
3) various approximations to the Navier-Stokes equations:
    a) ideal fluids, the Euler equations, irrotational flow
4) viscous flow
    a) Stokes flow, drag
    b) lubrication theory and thin film flow
5) waves
    a) surface waves
    b) internal gravity waves
    c) nonlinear waves: solitons, shocks
6) non-Newtonian fluids
7) other topics as time permits: hydrodynamic instabilities, airfoil theory, turbulence, boundary layers, granular flows, astrophysical flows, biophysical flows ….

Evaluation Scheme

Physics 4931		**Physics 9807**	
Assignments (4)	30%	*Assignments* (4)	25%
Term project	20%	*Term project*	25%
Proposal: 2%		Proposal: 2%	
Report: 14%		Report: 18%	
Oral presentation: 4%		Oral presentation: 5%	
Midterm test	15%	*Midterm test*	15%
Final Exam	35%	*Final Exam*	35%

Assignments will involve a combination of analytical and numerical calculations. Some experience with Matlab (e.g., Phys 3926), Maple, or another high-level mathematical programming language would be helpful but is not required.

The term project will involve an essay on a topic too be chosen in consultation with the instructor. Alternative forms of project (experiments, for example) will be considered – again, consult with the instructor. Phys 4931 students will be required to give a 20-minute presentation to the class on the subject of their project. Phys 9807 students will give a full 50-minute lecture.

Late assignments or projects will be docked marks.

The midterm test will be held in the normal class timeslot on a date to be decided. The final exam will be a three-hour written exam covering all material treated in the course. The exam time will be posted on the course web site when it becomes available. Students needing to make travel arrangements are advised to

book a travel date *after the end* of the examination period. *No makeup exams will be given to accommodate travel!*

Course Policies

- Religious holidays: A student who, due to unavoidable conflicts with religious holidays which (a) require an absence from the University or (b) prohibit or require certain activities (*i.e.*, activities that would make it impossible for the student to satisfy the academic requirements scheduled on the day(s) involved), is unable to write examinations and term tests on a Sabbath or Holy Day in a particular term shall give notice of this fact in writing to his or her Dean as early as possible but not later than November 15th for mid-year examinations and March 1st for final examinations, *i.e.*, approximately two weeks after the posting of the mid-year and final examination schedule respectively. In the case of mid-term tests, such notification is to be given in writing to the instructor within 48 hours of the announcement of the date of the mid-term test. The instructor(s) in the case of mid-term tests and the dean in the case of mid-year and spring final examinations will arrange for special examination(s) to be written at another time. In the case of mid-year and spring final examinations, the accommodation must occur no later than one month after the end of the examination period involved. It is mandatory that students seeking accommodations under this policy give notification before the deadlines, and that the Faculty accommodate these requests. The list of approved dates is given in http://www.uwo.ca/equity/docs/mfcalendar.htm.

- Academic misconduct:
  - Cheating: University policy states that cheating is a scholastic offence which can result in an academic penalty (which may include expulsion from the program). If you are caught cheating, there will be no second warning. Complete information on the University policies on academic offenses can be found at http://www.uwo.ca/equity/docs/mfcalendar.htm.
  - Plagiarism: Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing (such as footnotes or citations). Plagiarism is a major academic offence. For more details, see http://www.uwo.ca/univsec/handbook/appeals/scholoff.pdf.
  - Plagiarism or cheating will not be tolerated. Penalties will vary depending on the seriousness of the offence. They can range from a grade of zero on an assignment or essay, to failure of a course, to expulsion from the University.
  - If you have any questions at all on this issue please consult with your instructor