Course Details

Instructor

My names is Stefan LLEWELLYN SMITH. My e-mail address is `sgls@ucsd.edu`. My e-mail address is sgls@ucsd.edu, but if you have a question, talk to me before or after class, or come to office hours.

Schedule

Lectures: TuTh 11:00 am–12:20 pm on Zoom. My e-mail address is `sgls@ucsd.edu`, but if you have a question, talk to me before or after class, or come to see me. Office hours: I will aim to be available twice a week on Zoom at times TBD; you can also make an appointment. It is your responsibility to come and find me if you have questions, concerns, etc. Problem class: time TBD.

TA

Jack Pechac `jpechac@eng.ucsd.edu`.

Homework

There will be give homeworks. They will be posted a week before they are due; see the website for dates. No late homework will be accepted; hand in (or get someone else to hand in) what you have done on the due date.

Canvas site

Lectures slides, videos, solutions and the like will be posted to it.

Assessment

The grade in this course is based on homeworks, a midterm, and a final exam. An approximate division is 20%, 30% and 50%, but this is by no means definite. Exams will be "open-note", i.e. you may bring in hand-written material. No calculators, no cell phones, no computers during midterm or final exams, no uploading to or consulting CourseHero, Chegg, etc. There will be no make-up exams except in exceptional circumstances.
Your final grade is the culmination of a quarter-long effort. I do not like giving C grades and lower for graduate courses. Please try and keep me happy.
I encourage you to discuss the material among yourselves. When it comes to assigned homework however, everything you turn in should be essentially your own. If you and a

friend have worked too closely on a problem, please say so. Needless to say, collaboration is not permitted during exams.

Prerequisites

In theory, calculus, differential equations, linear algebra, complex analysis, freshman physics. In practice, MAE 294A/SIO 203A. This is a graduate class. If you think you can master these prerequisites concurrently, you can try.

Rough syllabus

Phase plane analysis: review of phase line and phase plane, some bifurcation theory.

Perturbation theory: algebraic problems, regular and singular perturbation theory, dominant balance.

Method of Multiple Scales

Matched Asymptotic Expansions: review of regular and singular problems, formal inner and outer solutions, matching by intermediate variable and van Dyke's rule.

WKB: Liouville–Green expansions, WKB expansion, connection formulas.

Asymptotic Expansion of Integrals: Laplace's method, stationary phase, maybe some steepest descents...

Textbooks

There is no specific textbook for this class. You may find the following useful. First *Advanced Mathematical Methods of Scientists and Engineers* by Bender & Orszag (BO). This hard but good. Another good book on perturbation methods is *Perturbations Methods* by Hinch. This overlaps with BO, but the emphasis is different. See also *Singular perturbation theory : mathematical and analytical techniques with applications to engineering* by R. S. Johnson.
A classic reference on applied mathematics is *Methods of Mathematical Physics* by Jeffreys & Jeffreys. A remarkable book even today. Two other good books on the general material, which concentrate on the physical background, are *Methods of Mathematical Physics* by Matthews & Walker, and *Mathematical Methods for Physicists* by Arfken (I prefer the second edition). An excellent book covering special functions and asymptotic methods is *Asymptotics and Special Functions* by F. Olver. Good references for complex analysis are *Functions of a Complex Variable* by Carrier, Krook & Pearson, and *Complex Variable* by Ablowitz & Fokas.
You should start becoming familiar with mathematical handbooks. The one true word is in the *Handbook of Mathematical Functions*,

edited by Abramowitz & Stegun (AS). There is also a new version. For integrals, series and products, see *Table of Integrals, Series, and Products* by Gradshteyn & Ryzhik (GR).

Academic integrity

See UCSD's policy on (there is a link on the class web page). Don't do it.

OSD Accommodation

Please come and see me at least two weeks before exams to discuss.

Stefan G. Llewellyn Smith

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Research interests:

Fluid dynamics. Acoustics and fluid-structure interactions. Asymptotic methods. Industrial mathematics.

Interests:

Japanese; cocktails; bread; genealogy; rowing; the oceans.

Education:

- Queens' College, University of Cambridge, 1993–Oct 1996. PhD 1996.
- Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, 1992–1993.
- Queens' College, University of Cambridge, 1988–1992. Certificate of Advanced Study (Part III of the Mathematical Tripos) with Distinction, 1992. BA (Honours) First Class (Parts IA, IB & II), 1991.

Some recent publications:

Stolerman, L. M., Getz, M., Llewellyn Smith, S. G., Holst, M. & Rangamani, P. 2020 Stability analysis of a bulk-surface reaction model for membrane-protein clustering. *Bull. Math. Biol.*, *82*, 30.

Hernández, E. S., Llewellyn Smith, S. G. & Cros, A. 2020 Resonance of a flexible plate immersed in a von Kármán vortex street. *J. Mech. Sci. Tech.*, *34*, 1459–1465.

Rocha, C., Constantinou, N., Llewellyn Smith, S. G. & Young, W. R. 2020 The Nusselt numbers of horizontal convection. *J. Fluid Mech.*, *894*, A24.

Chang, C. & Llewellyn Smith, S. G. 2020 Density and surface tension effects on vortex stability. I Curvature instability. Accepted by *J. Fluid Mech.*

Christopher, T. & Llewellyn Smith, S. G. 2020 Hollow vortex in a corner. *J. Fluid Mech.*, *908*, R2.