COURSE INFORMATION
This graduate-level course is designed to help students make “quick and dirty” calculations across a range of disciplines. Problems covering material properties, fluid mechanics, heat and mass transfer, waves and the environment will be discussed. This is an in-person class.

INSTRUCTOR INFORMATION
Professors: Patrick Chuang pchuang@ucsc.edu & Francis Nimmo, fnimmo@ucsc.edu

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<tr>
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<th>Time</th>
<th>Location</th>
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<tbody>
<tr>
<td>Lectures</td>
<td>TuTh 1:30-3:05pm</td>
<td>D250 E&amp;MS</td>
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<td>Office Hours (FN)</td>
<td>TuTh 12:30-1:30pm or by appointment</td>
<td>A219 E&amp;MS</td>
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<tr>
<td>Office Hours (PC)</td>
<td>Thurs 11:30 am – 1:30 pm or by appointment</td>
<td>A254 E&amp;MS</td>
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TEXTBOOK
There is no set textbook for this course, but there are several books that cover helpful ground. Back of the Envelope Physics by C. Swartz and Guesstimation by Weinstein & Adam are both useful. Problems regarding energy consumption and the environment are treated well by Sustainable Energy by D.J.C. McKay. What If? by R. Monroe is entertaining. A very useful website is here, curated by Sanjoy Mahajan at MIT. Eugene Chiang at Berkeley has a very useful home page for a course similar to this one; Sterl Phinney at Caltech has another. The University of Maryland has a good Fermi Problem site. And here are some astrophysical examples from Ohio State.

LEARNING OUTCOMES
By the end of the course, students will have developed the following skills
● Become comfortable with one significant figure answers
● Be able to apply a variety of strategies to derive one significant figure answers
● Break down an estimation (“Fermi”) problem into component parts
● Be able to relate microscopic (atomic radius, binding energy) to macroscopic (surface tension, elastic moduli, conductivity) properties.
● Be able to derive equations for estimating time scales, length scales, etc. from foundational partial differential equations (e.g. heat equation, Navier-Stokes equations).
● Develop estimates of oscillator kinetic and potential energies under various scenarios
● Make quantitative estimates of heat transfer and diffusion timescales
● Understand mass transfer and turbulent transport in fluid dynamics

PREREQUISITES
None.
ASSIGNMENTS & ASSESSMENT
Assessment will consist of approximately 6 problem sets and one final exam (which will be oral).

GRADING POLICY
Problem sets will be due Tuesday 5pm.

Students will be evaluated as follows:

40% Problem Sets
40% Final exam
20% In-class engagement and participation

EXPECTATIONS
We expect students to attend all lectures and participate in all in-class problem solving and discussion.

STUDY GROUPS
You may wish to find one or more partners to study with. If you need help in finding a study partner then let us know. Experience shows that people in study groups generally perform better.

DISABILITY ACCOMMODATIONS
If you qualify for classroom accommodations because of a disability, please get an Accommodation Authorization from the Disability Resource Center (DRC) and submit it to us outside of class (e.g. office hours) within the first two weeks of the quarter.
Contact DRC at (831) 459-2089.

INSTRUCTOR FEEDBACK
Feedback will be provided as annotations on your submitted work.

STUDENT FEEDBACK
At the end of the quarter you will be asked to complete a Student Experience of Teaching survey for this course. SETs provide an opportunity for you to give valuable feedback on your learning that is honest and constructive. This anonymous feedback will help us consider modifications to the course that will help future students learn more effectively. There is some useful advice on how to give constructive feedback at CITL’s Guide to Giving Useful Feedback to Instructors and TAs.

FINAL EXAM DATE AND TIME
Final exams will be the week of Monday 20th March. These are individual oral exams in which each student will be asked to solve order-of-magnitude problems at the whiteboard (or equivalent).
COURSE SCHEDULE

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<th>Week</th>
<th>Reading and Activities</th>
<th>Deliverables</th>
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<tr>
<td>1 (Jan 10th)</td>
<td>Basic concepts</td>
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<td>2 (Jan 17th)</td>
<td>Material Properties</td>
<td>Problem Set #1</td>
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<td>3 (Jan 24th)</td>
<td>Heat &amp; Mass Transfer</td>
<td>Problem Set #2</td>
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<td>4-5 (Jan 31st)</td>
<td>Fluid Mechanics</td>
<td>Problem Set #3</td>
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<td>6 (Feb 14th)</td>
<td>Turbulence</td>
<td>Problem Set #4</td>
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<td>7-8 (Feb 21st)</td>
<td>Waves &amp; Oscillators</td>
<td>Problem Set #5</td>
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<td>9 (Mar 7th)</td>
<td>Energy and the Environment</td>
<td>Problem Set #6</td>
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<td>10 (Mar 14th)</td>
<td>Disasters</td>
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PLAGIARISM
Collaboration on homework assignments is permitted and encouraged. But the work that you hand in must be your own i.e. if we ask you to reproduce your work without your notes, you must be able to do so. If you use outside sources (such as web sites) then you must cite the source that you use.

WEEKLY BREAKDOWN OF HOURS
In principle the weekly breakdown should be as follows: 3.25h lectures, 5h homework, 6.75h reading. In practice we expect significant variations in these numbers, except for the lectures.