Astronomy 510 Syllabus  
Spring 2016

About this course

This course is intended to prepare students to use numerical simulations to study complex problems in astrophysics and cosmology. Numerical methods and parallel computing will be covered together with the design, validation, and analysis of simulations. Emphasis will be placed on solving ordinary and partial differential equations that arise in astrophysical contexts.

Instructor

My name is Prof. Paul Ricker. Office hours are by appointment only; my office is 201 Astronomy. You can reach me by email (preferred) at pmricker@illinois.edu or phone at 4-1187.

The course web site, https://learn.illinois.edu/course/view.php?id=15037 (https://learn.illinois.edu/course/view.php?id=15037), will be used for all class assignments and announcements.

Textbook


**This course requires basic programming skills and access to a computer with a programming environment to complete.** The choice of operating system, programming language, and development environment are up to you. For work in astrophysics, the languages Fortran, C/C++, Python, or IDL are recommended. Most astronomers use Linux or Mac platforms, but it is possible to set up a basic astronomical software stack under Windows, and in any case you can easily run a virtual machine (e.g. using VirtualBox or VMWare) with Linux installed inside a Windows environment, provided your computer is relatively modern. You will also need to be (or become) familiar with some type of 2D plotting software, such as Gnuplot or (under Python) Matplotlib. The instructor is happy to offer suggestions on any of these topics, but he cannot assist in debugging programs or system setups and will not teach programming as part of this course.

Evaluation

Evaluation of assignments and exams will be done on a point system as follows.
<table>
<thead>
<tr>
<th>Total</th>
<th>1000 points</th>
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<tbody>
<tr>
<td>Homework</td>
<td>6 x 50 points each =</td>
</tr>
<tr>
<td>Final paper drafts</td>
<td>50 + 4 x 100 points each =</td>
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<tr>
<td>Twenty-minute talk</td>
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<tr>
<td>Final paper</td>
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Letter grades will be assigned only for the final course grade using the following scale. Ranges indicate total points for each grade.

<table>
<thead>
<tr>
<th>Letter grade</th>
<th>Point range</th>
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<tbody>
<tr>
<td>A</td>
<td>900.0 - 1000.0</td>
</tr>
<tr>
<td>B</td>
<td>800.0 - 899.9</td>
</tr>
<tr>
<td>C</td>
<td>700.0 - 799.9</td>
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<tr>
<td>D</td>
<td>600.0 - 699.9</td>
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<tr>
<td>F</td>
<td>0.0 - 599.9</td>
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Plus and minus grades will be given. The lower limit for each grade interval is subject to downward adjustment for the class if, in the instructor's judgment, the difficulty of the course work was too high. However, lower limits for each interval will not be increased.

**Homework**

Six homework assignments will be given via the course web site. They will be due online by 11:59 pm on the due dates specified in the schedule.

**Late assignments will be penalized 10 points (ie. 20%) per day.** Homework submission time will be determined by the course web server's clock. To avoid misunderstandings due to differences in clocks, you should not wait until the last minute to submit your homework.

Homework assignments can be uploaded to the course web site in any of several different formats. Portable Document Format (PDF) is greatly preferred. Other formats will only be accepted with prior approval and with good reason. If you prefer to write out your assignments longhand, you may submit them in this form provided that you scan them into one of the
Final papers

The final project in this course is designed to teach you how to design, carry out, analyze, and write up a set of numerical experiments to answer some astrophysical question. It need not produce an original research result. The point is to develop an understanding of the essential properties of high-quality numerical work, creating an appreciation for both the theoretical and the experimental aspects of such work along the way. The result will be a 15-page paper describing the work as though it were to be submitted to the Astrophysical Journal. Final papers are to be submitted through the course web page by 11:59 pm on the date indicated in the schedule. **Late submissions will be penalized 30 points (ie. 20%) per day.**

The final papers should address at least the following issues: why the topic/question is of interest, what methods were used, what control calculations were done, how the numerical experiments were designed and carried out, what the results were, and how they relate to other published work. You will need to estimate resource requirements for your calculations and work within a fixed allocation, though the details of these resource requirements need not be given in your final paper.

Though it is called the “final project,” in reality you will be spending most of the semester on it. You will encounter a learning curve with the software you will be using, and you will need time to set up initial conditions, perform tests, run your experiments, and analyze them. Past experience has shown that it is difficult for students to pace themselves appropriately, so several parts of the final project have independent draft due dates as described below.

A list of suggested topics may be found under "Suggested Final Paper Topics (https://learn.illinois.edu/mod/page/view.php?id=1316866)" on the course website. You are free to come up with your own topic. If more than one person chooses the same topic, I will work with you to identify unique approaches or subtopics.

The choice of simulation code for your project is up to you. However, in order to receive help from me on issues related to compiling or running the code, you must select one of the choices I have listed in the "List of Software Tools (https://learn.illinois.edu/mod/page/view.php?id=1316869)" on the course website. Each of these codes is freely available in source code form and is widely used in the astrophysical community. Each has different strengths.

Final paper drafts

The final project draft assignments will consist of the following items. Each must be submitted via the course website using the same guidelines as described above for homework assignments (with the exception that drafts may not be handwritten). **Late drafts will be penalized 10 points for the summary or 20 points for other drafts (ie. 20%) per day.**

1. A one-page project summary giving a descriptive title, a one-paragraph summary in your own words of the scientific problem to be addressed in your paper, one paragraph on the simulation code and problem setup you plan to use, and one paragraph describing the analyses you plan to perform on the simulation output.
2. A five-page scientific introduction explaining the problem you are studying and why it is interesting, and reviewing relevant theoretical, computational, and observational
You should have a working knowledge of and access to compilers for one or more languages suitable for high-performance numerical work, such as Fortran, C, or C++. Languages such as Java, Visual Basic, Lisp, etc., while being well-suited for other tasks, do not fall into this category. See the "List of Recommended Texts and Articles (https://learn.illinois.edu/mod/page/view.php?id=1316872)" on the course website for suggestions on language texts if you need to learn a numerical language or refresh your memory. We will not teach computer programming in this class, so you will need to do such studying on your own time.

You will also need access to data analysis and plotting software. The choice here is up to you. See the "List of Software Tools (https://learn.illinois.edu/mod/page/view.php?id=1316869)" on the course website for some suggestions.
Attendance

You are expected to attend class regularly. The lectures will include material that is not in the textbook, and this supplementary material will be required for homework assignments.

Honesty

Academic integrity lies at the core of the University's education and research missions; accordingly, you are expected to internalize the spirit as well as the letter of the University's rules on academic integrity (http://admin.illinois.edu/policy/code/article1_part4_1-401.html). Infractions of these rules -- including but not limited to cheating, plagiarism, falsification of data, and grade alteration -- will result in a grade of zero for the affected assignment(s) and documentation of the infraction in the student's academic file.

Accessibility statement

To insure that disability-related concerns are properly addressed from the beginning, students with disabilities who require reasonable accommodations to participate in this class are asked to see the instructor as soon as possible.