GEO 280: Planetary Habitability

- Professor: Stephen Kane
- Class times: Tues/Wed 10:00am-11:20am
- Class location: Geology 1444
- Textbook: Planetary Sciences (Stephen Kane)
- Office: Pierce Hall 2360
- Office hours: Wednesdays, 1:00pm-3:00pm
- Phone: 951-827-6593
- Email: `skane@ucr.edu`
- Course website: `http://stephenkane.net/teaching/g280`

Prerequisites:

There are no official course prerequisites. However, the course will be taught assuming knowledge of basic astronomy, algebra, calculus, and computer programming.

Format:

4 units (counts as one of your "4x4" requirements); two 1.5 hour lectures per week; one 1 hour discussion section per week; three homeworks throughout quarter; a referee paper discussion in front of the class; a data project of your choice (and approved by the instructor) due in Week 10.

Meeting times:

Every Tuesday and Thursday, 10:00am-11:20am, in Geology 1444.

Course description:

One of the primary discoveries of recent years is that the frequency of planets increases towards smaller planets. Detection of large numbers of terrestrial (rocky) planets have brought the topic of planetary habitability to the forefront of astrobiology and exoplanet mission design. The topics included in this class are: habitability factors, planetary atmospheres and interiors, the role of magnetic fields, Milankovitch and geological cycles, biosignatures, and a detailed look at what we can learn from solar system bodies.

The course will require a working knowledge of astronomy, algebra, calculus, and coding. There will be a discussion component regarding the latest exoplanet research. Exoplanetary science is a very active research field and we will frequently read and discuss new research papers.

Discussion Section:

There will be regular (weekly) discussion sessions that include discussions of class material and homework problems. Special attention will be given to new research papers and press releases regarding exoplanets with relevance to the class. The discussions will also include summaries and study guides to be used for the final exam.

Requirements and Textbook:

- **Attendence:** Attendance is recommended for every lecture. Much of the assessment will be carried out in class and exams may contain questions covered in lectures but not elsewhere.
- **Textbook:** The textbook for the course is "Planetary Habitability" by Stephen Kane. Also recommended are "Planetary Sciences, Updated Second Edition" by Imke de Pater & Jack Lissauer, "Principles of Planetary Climate" by Raymond Pierrehumbert, and "Atmospheric Evolution on Inhabited and Lifeless Worlds" by David Catling & James Kasting.
- **Electronic Devices:** In general, the use of electronic devices such as laptops, tablets, and cellphones is not allowed in class.

Course Assessment:

- **Homework (30%):** There will be three homeworks during the semester. Most problems will require analytic solutions, however there will usually be one problem per assignment that will involve graphing and numerical solution with computer software such as Mathematica, MATLAB, or any programming language. The homework solutions must be provided in a legible format such that it is possible to read and grade.
- **Paper Discussion (30%):** Students will choose a refereed paper to discuss in front of the class, answering questions as they arise. The paper may be from planetary science, exoplanets, biology, geophysics, etc, but must discuss planetary habitability.
- **System Project (40%):** Students will be required to complete a project in which they provide a detailed study of a planetary system of their choosing in which at least one planet lies within the Habitable Zone. The written report may be up to 6 pages long (including plots).

Final grades will be assigned as follows:
A = 90% to 100%
B = 77% to 89%
C = 65% to 76%
D = 50% to 64%
F = below 50%

Student Learning Outcomes:

After successfully completing this course, students will:

1. Understand the primary factors that affect planetary habitability.
2. Understand how planetary atmospheres and interiors relate to habitbilituy.
3. Know how the energy balance for a planet is calculated.
4. Understand the properties of solar system bodies and what habitability lessons we can learn from them.
5. Know how geosignatures and biosignatures may be detected on exoplanets.
6. Master new scientific and technical methods with application to exoplanets and related fields.
7. Be much better prepared to carry out research in this field.

Class Schedule:

- Lecture 1 - Introduction
- Lecture 2 - Habitability Factors (Imke de Pater & Lissauer: Chapter 1)
- Lecture 3 - Stars
- Lecture 4 - Planetary Atmospheres (Imke de Pater & Lissauer: Chapter 4)
- Lecture 5 - Planetary Interiors (Imke de Pater & Lissauer: Chapter 6)
- Lecture 6 - Planetary Energy Balance (Pierrehumbert: Chapter 3)
- Lecture 7 - Habitable Zone I (Kopparapu et al. 2013, 2014)
- Lecture 8 - Habitable Zone II (Kopparapu et al. 2013, 2014)
- Lecture 9 - Earth as a Living Planet (Pierrehumbert: Chapter 1)
- Lecture 10 - Mars (Pierrehumbert: Chapter 1)
- Lecture 11 - Icy Moons (Imke de Pater & Lissauer: Chapter 6.3)
- Lecture 12 - Venus (Pierrehumbert: Chapter 1)
- Lecture 13 - Mercury & the Moon (Imke de Pater & Lissauer: Chapter 6.3)
- Lecture 14 - The Role of Giant Planets (Imke de Pater & Lissauer: Chapter 6.4)
- Lecture 15 - Stellar Influences (Imke de Pater & Lissauer: Chapter 3)
- Lecture 16 - Magnetic Fields (Imke de Pater & Lissauer: Chapter 7)
- Lecture 17 - Milankovitch Cycles (Pierrehumbert: Chapter 7)
- Lecture 18 - Geological Cycles (Imke de Pater & Lissauer: Chapter 5)
- Lecture 19 - The Next Steps
- Lecture 20 - Summary/Discussion

Medical Matters and Disability:

If you have a disability or believe you may have a disability, you can arrange for accommodations by contacting Services for Students with Disabilities (SSD) at 951-827-4538 (voice) or `specserv@ucr.edu` (email). Students needing academic accommodations are required to register with SSD and provide required disability-related documentation. This course does require students attend field experiences for credit. If you need specific disability-related accommodations to participate in the field experiences, please contact Services for Students with Disabilities and notify the instructor within the first two weeks of the course beginning. Similarly, if you have a pre-existing medical condition that affects your ability to participate in required class activities, you are responsible for informing the instructor, along with documented evidence of the condition, within the first two weeks of the course beginning.

Campus Resources:

There are an incredible variety of campus resources available to assist and support your academic experience at UC Riverside including writing support, tutoring, counseling, and wellness support. Do not hesitate to take advantage of them. A quick search of the campus website will usually point you the right direction.