

***Syllabus for “Chaos and Complexity” MAP 3930H.201
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Background:

In the early 70's, a new field of science, Chaos, was developed. That field revealed many interesting features related to natural phenomena. From those studies, in the past 10 to 15 years, we have seen the emergence of another new area that attempts to bring everything in nature and in our life into a coherent universal theory, the “Theory of Complexity”. It addresses broad range of phenomena from the formation of matter, the oceans, the mountains and rivers, the turbulent weather, the unpredictable stock market, and even the evolution of life and the universe. It touches everything we encounter in our society and traverse many distinct disciplines. In this course, we will attempt to acquaint honor students, from any major, with the implications and consequences of this new theory, and to provide them with a working knowledge of the same. They will also gain experience in scientific thinking and reasoning, and in presenting their thoughts and ideas to others, verbally and by the written word.

The field of Complexity is so young that there is not even a consensus as how to define the term “complexity”. Nevertheless, the development of the new field has a potential to unite scientists from different fields.

The first part of the course will consist of lectures by the faculty on the basics of Chaos and Complexity in nature and in our life. Then we will move into discussing how one applies the scientific method to develop a “theory”.

The theories of Chaos and Complexity will then be used as illustrations of this development. The applications of Chaos and Complexity will also be covered.

We anticipate that the above will take about 5-6 weeks. During this time, the students will select research subtopics in Chaos and/or Complexity that they find interesting. After discussing with instructors, they then will research that topic, write a research paper on it, and also make a presentation to the entire class on that (or another) research topic.

These textbooks do not give a mathematical treatment of these subjects, but rather approach these topics from a verbal description of the mathematics, their implications, and their results.

Textbooks:

Required:

CHAOS: Making a New Science, James Gleick [Penguin Books (1987)].

Complexity: The Emerging Science at the Edge of Order and Chaos, M. Mitchell Waldrop [Simon & Schuster (1992)].

Recommended:

EXPLORING CHAOS, Ed. Nina Hall [Norton & Co. (1993)].

The Quark and the Jaguar—Adventures in the Simple and the Complex, Murray Gell-Mann [W. H. Freeman and Company, New York (1994)].

ASSIGNMENTS:

The major assignments for this course will consist of a research paper, and a presentation to the class. There will be 3-4 quizzes from time to time. The final grade will be based on the following criteria:

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| 1. Research paper | 40% |
| 2. Presentation | 40% |
| 3. Quizzes | 10% |
| 4. Attendance | 10% |

The grading of the research paper will be based on 1) understandability, 2) quality of the English, 3) neatness, and 4) how well the student has addressed the application of, and the implications of, Chaos and/or Complexity, to their chosen topic.

The student will be free to choose their presentation topic, and it needs not be the same as the research topic, but usually would be. The grading of any presentation will be based on how well the student communicates his/her ideas to his/her peers. Clarity, simplicity, and utilization of visual aids will be of importance in evaluation of any student evaluation. The peers will be invited to submit comments on all student presentations. The professors will communicate constructively peer evaluations to the student who made the presentation. These peer evaluations will be used to complement the professors' evaluations of the student presentations.

RULES FOR PRESENTATION AND TERM PAPER:

1. The outline and a bibliography must be submitted by Feb. 7. The outline must be somewhat detailed, defining what topics you will cover in each section of the paper. It must be approved before you continue.
2. It is expected that your paper will be more than just a literature survey or a history. It must require some application of the scientific method on your part, whereby you are to ask a question, propose an explanation, test your explanation,

and then present your case for what your conclusions are. You also need to make Complexity.

3. Before Apr. 4, your research paper must have been submitted.
4. All research papers will also contain a glossary, which will define **all** technical terms used in the paper. What terms must be included? Well, if most of your classmates could not define a given term in your paper, then that term must be included in the glossary. The definition(s) of any term in the glossary must be in your own words, and must be sufficiently clear such that any of your classmates and instructors could read the definition and understand the meaning of the term.
5. The research paper must be a maximum of twelve pages, excluding any title page or table of contents, in 12 pt. font, double spaced, with no more than one inch side and bottom margins, and a 1.5 inch top margin.
6. You are expected to use correct English grammar and to have no misspellings in your paper.
7. You are also expected to compose the paper so that all sections and paragraphs flow easily from one to the next, with the expressed ideas and concepts being easily followed and understood by the reader (be that reader one of your classmates, or Prof. Luo or Kaup).
8. The grade of a research paper will be based, in most part, on how well you can meet the above deadlines and criteria.
9. Each day an item is late, will translate into a 1 point penalty. Thus one week late will be a penalty of almost one letter grade.

Attendance will be based on a simple roll call at the beginning of class.

Course Outline

Based upon 2 classes each week, and 14 weeks of classes, we would expect to schedule the topics and presentations as follows:

Week 1 – The Scientific Method, Observations, Critical Thought, and Truth. (Prof. Kaup)

Weeks 2-3 – Chaos: Description and Applications. (Prof. Kaup)

Week 4-5 – Complexity: Description and Applications. (Prof. Luo)

Week 6 – Presentations Hints for Students, Quizzes, etc. (Profs. Kaup and Luo)

Weeks 7-14 – Guided Oral Presentations by the Students, and Guided Discussions.

Sometime during the first three weeks, we will also arrange for a reference librarian to give at least one presentation on how the students can make use of the resources of the library and the Internet.

The students will be expected to arrange their own presentation, with the assistance of the professors. Early on, the students will submit outlines of their proposed presentation topics and state what their resources will be. The professors will give the students feedback on their outlines. Within a couple of weeks before their scheduled

presentations, each student will review his/her proposed presentation with the professor, to ascertain how well it meets the criteria #4) under grading and criteria #2) of the rules.