Instructor Boaz Ilan
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Lecture time & location Monday and Wednesday, 12:30 pm – 1:45 pm, COB 272

Office hours: by appointment.

Course goal

My goal is that by the end of this course you will have learned:

- What are the universal linear and nonlinear dispersive equations and their salient features.
- Analytical and computational techniques for deriving and solving these equations.
- Related research topics.

Graduates of MATH 292 should be able to fulfill the following **learning objectives**:

1. Apply asymptotic and perturbation methods to derive reduced equations.
2. Find analytically and computationally solitary wave solutions.

Prerequisites

Instructor's consent. An advanced course in partial differential equations (such as Math 221) and / or in asymptotic methods (such as Math 223) is strongly encouraged.

Course outline

- Dispersive waves: equations and key physical phenomena; derivations using the methods of stationary phase and steepest decent.
- KdV and NLS equations: application to water waves and nonlinear optics; derivations – the failure of regular perturbation methods and success of matched asymptotic expansion and multiple scales.
- Solitary waves and solitons: analytical and computational techniques; examples from optics and condensed matter physics.
- Research topics: collapse, dispersive shock waves, stability of solitary waves.

Recommended reading

1. Asymptotics and perturbation methods
   M. J. Ablowitz and A. S. Fokas, *Complex Variables: Introduction and Applications*, Cambridge University Press, 2003;
   E. T. Copson, *Asymptotic Expansions*, Cambridge University Press, 1965;
   A. Erdélyi, *Asymptotic Expansions*, Dover, 1956;
   J. Kevorkian and J. D. Cole, *Perturbation Methods in Applied Mathematics*, Springer, 1981;
   A. H. Nayfeh, *Perturbation Methods*, Wiley, 2000.

2. Linear and nonlinear dispersive waves

N. Bleistein, *Mathematical Methods for Wave Phenomena*, Academic Press, 1984;
P. G. Drazin and R. S. Johnson, *Solitons: An introduction*, Cambridge University Press, 1989;
E. Infeld and G. Rowlands, *Nonlinear Waves, Solitons and Chaos*, Cambridge University Press, 2000;
J. Lighthill, *Waves in Fluids*, Cambridge University Press, 1978;
C. Sulem and P-L. Sulem, *The Nonlinear Schrödinger Equation: Self-Focusing and Wave Collapse*, Springer, 1999;
G. B. Whitham, *Linear and Nonlinear Waves*, Wiley, 1974.

Grade determination

Your final grade in the course will be based on the following approximate scheme: 90% homework problems and 10% active participation in class.

Homework

Homework will be given and collected approximately every other week. You are encouraged to work in groups, but all work turned in must be your own.

Dropping the Course

Please see the UC Merced General Catalog for details.

Special accommodations

Student Affairs determines accommodations based on documented disabilities. If you qualify, please submit a letter from Disability Services to the instructor; every effort will be made to accommodate your needs.

I will also make every effort to accommodate students whose religious beliefs/obligations lead to scheduling conflicts with exams, assignments, or attendance. Please speak with me during the first two weeks of this course regarding any potential accommodations.

Academic integrity

Academic integrity is the foundation of an academic community and without it none of the educational or research goals of the university can be achieved. All members of the university community are responsible for its academic integrity. Existing policies forbid cheating on examinations, plagiarism and other forms of academic dishonesty. The current policies for UC Merced are described in the Academic Honesty Policy. See http://studentlife.ucmerced.edu/ $\rightarrow$ "Student Judicial Affairs."