UNIVERSITY AT BUFFALO | DEPARTMENT OF MATHEMATICS

MTH 839: Numerics for Nonlinear Waves

Fall 2026 | Course Syllabus

Course Information

Instructor	Sergey A. Dyachenko
Email	sergeydy@buffalo.edu
Course webpage	`www.acsu.buffalo.edu/~sergeydy/mth839_f2026.html`
Class meetings	Monday and Wednesday, 12:30–1:50 p.m.
Classroom	Math 205
Office hours	To be announced

Course Description

This graduate topics course introduces computational methods for the analysis of nonlinear waves. Particular attention is given to the numerical construction of special solutions, including solitary waves, localized states, and periodic traveling waves, and to the study of their properties, stability, and dynamics.

Examples may be drawn from nonlinear dispersive equations and free-surface fluid dynamics. The course emphasizes the connection between mathematical formulation, numerical algorithms, implementation, and careful interpretation of computational results.

Optional Reading

Jianke Yang, *Nonlinear Waves in Integrable and Nonintegrable Systems*, SIAM, 2010. This book is an optional reference and is not required. Additional notes, readings, and computational materials will be provided as appropriate.

Tentative Course Topics

1. Nonlinear wave equations and special solutions.
2. Solitary waves, localized states, and periodic traveling waves.
3. Spectral and finite-difference discretization methods.
4. Iterative methods for nonlinear stationary problems.
5. Numerical continuation and parameter-dependent families of solutions.
6. Linearization, eigenvalue problems, and spectral stability.
7. Time integration and the dynamics of perturbed nonlinear waves.
8. Selected applications to dispersive and water-wave models.

The selection, sequence, and depth of topics may be adjusted as the course progresses.

Computational Work and Academic Integrity

Computational assignments and projects should present the mathematical problem, the numerical method, the relevant code and computational results, and a clear interpretation of the findings. Students are responsible for verifying the accuracy and reliability of their computations.

Students may discuss ideas and computational techniques with one another, but all submitted work must reflect their own understanding and independent contributions. Any material or code obtained from other sources must be appropriately acknowledged.

There will be no midterm or final examinations.

Guidelines for the Use of Artificial Intelligence

AI tools may be used to clarify course material, explore examples, and assist with programming. However, students must develop their own solutions to assigned problems and must be able to explain all submitted reasoning and code. AI may not be used to generate mathematical solutions that are submitted as the student's own work.