**Instructor** Boaz Ilan
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**Lecture time & location** Monday and Wednesday, 12:00 pm – 1:20 pm, SSB 110

**Office hours:** by appointment.

**Course goal**

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

- What are the universal partial differential equations that describe linear and nonlinear dispersive waves.
- How radiative transport theory describes the propagation of light waves in random media.
- How asymptotic and perturbation methods can simplify such equations and extract the salient features of their solutions.

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

- Apply asymptotic techniques to solve approximately differential and integral equations.
- Apply perturbation techniques to derive reduced equations.

**Prerequisites**

An advanced course in partial differential equations is strongly encouraged. Experience with asymptotic methods would be helpful, but is not required.

**Course outline**

- The linear and nonlinear Korteweg de-Vries and Schrödinger equations
  - Application to water, light, and ultracold mater waves.
  - Asymptotic reduction from hyperbolic wave equations. The failure of regular perturbation methods and the success of matched asymptotic expansion and multiple scales.
  - Special solutions: solitary waves and solitons, dispersive shock waves, collapse.
- Radiative transport equations
  - Application to optics: solar energy and optical tomography.
  - Derivation for waves in random media.
  - Asymptotic derivation of the diffusion approximation. Boundary layers.

**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.
   N. Bleistein and R. A. Handelsman, *Asymptotic Expansions of Integrals*, Dover 2010.
   J. Kevorkian and J. D. Cole, *Perturbation Methods in Applied Mathematics*, Springer, 1981.
   A. H. Nayfeh, *Perturbation Methods*, Wiley Press, 2000.

2. Linear and nonlinear dispersive waves
   M. J. Ablowitz, *Nonlinear Dispersive Waves: Asymptotic Analysis and Solitons*, Cambridge University Press, 2011.
   N. Bleistein, *Mathematical Methods for Wave Phenomena*, Academic Press, 1984.
   P. G. Drazin and R. S. Johnson, *Solitons: An introduction*, Cambridge University Press, 1989.
   G. B. Whitham, *Linear and Nonlinear Waves*, Wiley Press, 1974.

3. Radiative transport
   S. Chandrasekhar, *Radiative Transfer*, Dover Publications, 1960.
   A. Ishimaru, *Wave Propagation and Scattering in Random Media*, Wiley-IEEE Press, 1999.

**Grade determination**

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

Note: there will be no final exam as indicated on the Registrar's website.

**Homework**

Homework will be assigned primarily at the beginning of the course for most topics and collected during the semester. You are encouraged to work in groups, but all work turned in must be your own.

**Projects**

Individual projects will be offered during the course. If you choose to do a project, you do not need to turn in the homework. Projects will be collected during the last week of the semester.