PHYS 515 "CLASSICAL DYNAMICS"

Fall 2022 Syllabus

Instructor: Prof. Edison Liang, HBH Room 342, x3524, email: liang@rice.edu

Class Time: Tu Th 2:30 - 3:45 PM

Room: HBH 423 or TBD

Text: Fetter and Walecka, *Theoretical Mechanics of Particles and Continua*, Dover Paperback (2003 or latest edition)

Other References (most are available in HBH 310 or Fondren Library):

Thornton & Marion, *Classical Dynamics of Particles and Systems*
Goldstein, *Classical Mechanics*
Landau and Lifshitz, *Mechanics*
Landau and Lifshitz, *Fluid Mechanics (LL FM)*
Mathews & Walker, *Mathematical Methods of Physics*
Whitham, *Linear and Nonlinear Waves (W)*

Homeworks: ~ 2 problems every week**,** detailed guidelines to be posted later

Graders: TBD

Grades: 50% Homework, 15% Mid-Term Exam., 35% Final Exam.

Class website: see canvas.rice.edu (Zoom links will be provided for online lectures on canvas)

Rice Honor Code: Students are expected to uphold the Rice Honor Code. Students can discuss homeworks together, but should avoid turning in identical homeworks.

Course Objectives: This is a course on the classical dynamics of particles and continua. In addition to in-depth reviews of Lagrangian and Hamiltonian dynamics, students will be introduced to continuum mechanics in the context of classical strings and fluid mechanics. The physics of linear and nonlinear waves will also be highlighted.

Learning Outcomes: Students are expected to turn in homeworks every week, which will be graded, and complete take-home Mid-term and Final examinations. Students will acquire knowledge in important areas of classical dynamics of particles and continua through homeworks, and become fluent in solving problems in classical dynamics. They will also acquire basic analytic and mathematical skills needed in all graduate level physics courses, from tensor calculus to linear algebra and partial differential equations. The examinations will consist of both conceptual questions and computational problems to test the student's ability to think intuitively and compute analytically.

Any student with a documented disability that requires accommodation should contact both the course instructor and Disability Support Services in the Allen Center.

Class Format

Lectures will be delivered in person. Students are expected to attend lectures during class hours. Zoom recording of lectures will be available via canvas. Instructor may hold additional tutorial sessions upon public demand. Office hours for this course will be scheduled on TuTh following the class. Mask requirements will be enforced for all in-person meetings. Students needing individual help should contact instructor via email to schedule online or, if necessary, in person, meeting. Homeworks and examinations should be submitted online in pdf format, via canvas or email.

Title IX Responsible Employee Notification

Rice University cares about your wellbeing and safety. Rice encourages any student who has experienced an incident of harassment, pregnancy discrimination or gender discrimination or relationship, sexual, or other forms of interpersonal violence to seek support through The SAFE Office. Students should be aware when seeking support on campus that most employees, including myself, as the instructor/TA, are required by Title IX to disclose all incidents of non-consensual interpersonal behaviors to Title IX professionals on campus who can act to support that student and meet their needs. For more information, please visit safe.rice.edu or email titleixsupport@rice.edu.

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Tentative No. of Lectures	Topics	Text Chapter #
4	Laws of Motion and Conservation Laws, Inertial Frames, Noninertial and Rotating Frames, Galilean Transformation, Generalized Transformations, Tensor Notations	1, 2
4	Variational Principle and Lagrangian Dynamics: Constraints and Lagrange Multipliers, Hamiltonian, Symmetry and Constants of Motion, Similarity	3
2	Small Oscillations: Normal Modes and Eigenvalue Problems, Driven Oscillations and Resonance, Damped Oscillations, Anharmonic Oscillations	4
2	Brief Review of Rigid Body Motions: Euler Angles, Euler Equations of Motion	5
4	Hamiltonian Dynamics: Canonical Transformations, Action-Angle Variables, Hamilton-Jacobi Theory; Poisson Brackets, Transition to Quantum Mechanics, Symmetry Principles and Contact Transformations, Liouville's Theorem, Adiabatic Invariant	6
2	Strings: Waves, Green Function, Perturbation Theory, Initial and Boundary Value Problems	7, 8
4	Introduction to Fluid Mechanics, Euler & Navier-Stokes Equations, Sound Waves, Shock Waves	9 LLFM
3	Surface Waves, Solitary Waves, Bores	10, W
1	Hydrodynamic Instabilities	LLFM

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Sample mathematics topics covered in this course

1. Non-Cartesian coordinates, vector and tensor calculus, index notations.
2. Complex variables including contour integration.
3. Delta-function and distributions.
4. Ordinary differential equations: eigenfunction expansions and boundary value problems.
5. Matrices, eigenvectors and eigenvalues.
6. Linear partial differential equations and Green function techniques.
7. Variational methods.
8. Perturbation theory.
9. Nonlinear partial differential equations.