Fall 2020

PHYS 611-101: Advanced Classical Mechanics

Tao Zhou

Physics 611 Course Outline

Instructor: Prof. Tao Zhou, taozhou@njit.edu, Tel: 973-642-4931, Room: T478

Textbook: *Classical Mechanics*, by Herbert Goldstein, 2nd Edition, Addison Wesley.
Classical Mechanics, by John M. Finn, Infinity Science (2008).

Grade Decomposition
Class participation & Homework: 30%
Midterm Exam: 30%
Final Exam: 40%

Office hour: Monday 11:00 to 12:30, Wednesday 10:00 to 11:30

Learning Objective: Students are expected to learn the general formalism of Lagrangian and Hamiltonian mechanics, using the differential Lagrangian equation to solve classical mechanics problem, using the variational Hamilton's principle to solve very diverse problems outside of classical mechanics. Detailed knowledge of canonical transformation and Hamilton-Jacobi equation will help students greatly in their future study of graduate level quantum mechanics. Students are also expected to become familiar with the specific topics of central force, rigid body and small oscillations.

Learning Outcome Evaluation Metrics: Through in-class quiz and discussion, instructor can evaluate students' understanding of basic physical concepts. Through homework, instructor can evaluate students' problem solving capability. Mid-term and final exams offer instructor the opportunity to comprehensively test students' understanding of course material and problem solving capability.

At the end of the semester, students should be able to

- Using D'Alembert's principle to solve virtual work problems.
- Using Euler-Lagrangian equation to solve various mechanics problems, including constrain force problems, by taking advantage of the Lagrangian Multiplier method in combination with the Lagrangian Equations.
- Solving various central force problem, particularly related to the Kepler problem.
- Solve the rigid body rotation problems using Euler's equation.
- Solve small oscillation and related eigen value and eigen function problems.
- Understand the variational principle and its equivalence to the Lagrangian Equation, and use it to solve various problems, particularly non-mechanics related problems.
- Identify the criteria for canonical transformations using Poisson bracket methods
- Using Hamilton-Jacobi equation to solve various mechanic problems, in particular using the action-angle variables methods derived from H-J equation to solve periodic problems.

Topics:

Date and Lecture Topic	Text Assignment	Homework Assignment
Week 1: Survey of Newtonian mechanics of particles	**Chap. 1**	See detailed homework assignment after each lecture
Week 2: Langragian Equation	**Chap 3.1 – 3.4**	
Week 3: Lagrangian multiplier method	**Chap 3**	
Week 4: Hamilton's Principle and variational approach	**Chap 4**	
Week 5: Central force and gravity	**Chap 5**	
Week 6: Rigid body kinematics and dynamics	**Chap 7 & 8**	
Week 7: Midterm Exam	**Covers weeks 1 - 5**	
Week 8: Small Oscillation	**Chap 6**	
Week 9: Hamilton's equations	**Chap 3.4 - 3.6**	
Week 10: Canonical transformation	**Chap 9**	
Week 11: Hamilton-Jacobi Theory	**Chap 10**	
Week 12: Lagragian formulation of fields	**Chap 12**	
Week 13: Review		
Final Exam Period	**Final exam date to be announced**	**Comprehensive final exam**