Physics 311: Advanced Dynamics
Syllabus – Fall 2022

Instructor:

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Office Hours: MW 11:00 AM - 12:00 PM, or by arrangement

Time & Location:

(a) Generalized coordinates
(b) D'Alembert's principle
(c) Lagrange's Equations
(d) Hamiltion's principle of least action
(e) Symmetry principles and conserved quantities – Noether's theroem
(f) Examples: Central fields and Kepler's problem
Lagrangian for particle motion in an electromagnetic field

3. Small Oscillations (Linear systems)

(a) Equilibrium and linearization of the equations
(b) Normal coordinates
(c) Parametric Resonance

4. Hamiltionian Dynamics and Transformation Theory

(a) Hamilton's canonical equations
(b) Hamiltonian phase flows and Liouville's Theorem
(c) Poisson brackets
(d) Canonical (Symplectic) transformations
(e) Generating functions
(f) Hamilton-Jacobi theory

5. Completely Integrable systems

(a) Separable systems
(b) Action-angle variables
(c) Integrable systems and invariant tori
(d) Integrable invariants of Poincaré-Cartan

6. Regular and Chaotic Motion of Hamiltionian Systems

(a) Surfaces of section:
Poincaré mappings
Fixed points and cycles
(b) Stability of periodic orbits
(c) Integrable and ergodic systems
(d) One-degree of freedom
(e) Two degrees of freedom – Numerical exploration:
Invariant curves, islands, chaotic regions
Examples:
Henon-Heiles potential
Quadratic mappings
(f) KAM theorem
(g) Many degrees of freedom

7. Mechanics of continuous systems: Strings

   (a) Small oscillations in many degrees of freedom
   (b) Transition from discrete to continuous systems
   (c) Wave equation
   (d) General string equation (homogenous):
       Eigenfunction expansion and Sturm-Liouville theory
       Variational properties:
   (e) Inhomogenous equation:
       Green's function method
   (f) Energy flux

Textbook:

A.L Fetter and J.D. Walecka, *Theoretical Mechanics of Particles and Continua*, Dover Publications, Mineola NY, ISBN 0-486-43261-0 (2003). We'll cover Chaps 1-4,6,7

A.L Fetter and J.D. Walecka, *Nonlinear Mechanics: A Supplement to Theoretical Mechanics of Particles and Continua*, Dover Publications, Mineola NY, ISBN 9780486136998 (2006). This can be found online in PDF form. We'll look mostly at sections I and III

Other Recommended Texts:

H. Goldstein, C. Poole, J. Safko *Classical Mechanics* Third Edition, Addison-Wesley, ISBN 0-201-65702-3 (2002).

L.D. Landau and E.M. Lifshitz *Mechanics*, Addison-Wesley, (1960).

Other references will be posted to Blackboard

Grading:

Weekly assignments & Quizzes 50%

Take-home Midterm exam 20%

Take-home Final exam 30%

Homework Problems:

Homework problem sets will be posted approximately weekly or biweekly on Blackboard with a due date set at the beginning of a class meeting that is at least one week later than the assignment is posted.

Please either prepare your assignments on a computer, or else scan all handwritten pages of the homework assignment and submit as a single PDF file to gradescope.com. I will give you instructions about how to do this in advance of the due date for the first assignment.

The following policy will apply to the maximum possible score for each homework assignment:

On time	100%
One class session late	50%
More than one class session late	0%