

Doctoral Program in Physics

Physics 71100: Analytical Dynamics

Instructor: V. PARAMESWARAN NAIR
Office hours: Mondays, Wednesdays 1:00 PM to 2:00 PM
Email contact info: vpnair@ccny.cuny.edu
Further info at: <http://nair.ccny.cuny.edu>
Class Schedule: Mondays, Wednesdays 11:15 AM to 1:00 PM
Room TBA

Course Designation:

Graduate, Ph.D. and M.S. students

Prerequisites:

Standard undergraduate level courses

Textbook:

There is no prescribed textbook for this course. A few recommended books are the following:

1. S.T. Thornton and J.B. Marion, *Classical Dynamics of Particles and Systems*, Cengage Learning Inc., 2008
2. V.I. Arnold, *Mathematical Methods of Classical Mechanics*, Springer, 1978, 1989. (This is a fairly formal approach; there will be some points of contact with my approach.)
3. H. Goldstein, C. Poole and J. Safko, *Classical Mechanics*, Pearson, 2001.
4. J.V. Jose and E.J. Saletan, *Classical Dynamics : A Contemporary Approach*, Cambridge University Press, 1998.
5. L. Landau and E. Lifshitz, *A Course of Theoretical Physics: Mechanics*, Butterworth-Heinemann, 1976.

Strictly speaking I will not follow any of these books in detail, I will use my own lecture notes. These will be posted and will be available to you shortly.

Topics covered:

1. Lagrangian formulation
Newtons' laws and Galilean invariance; Calculus of variations; Lagrangian equations; Variational principle; Particle motion in different coordinate systems; double pendulum, etc.; How to construct a Lagrangian.

2. Central potentials
Center of mass and relative coordinates; Central potentials; Kepler problem and planetary motion; General central potentials; Scattering; Cross section, examples.
3. Small oscillations
Small oscillations around equilibria; normal modes; triatomic molecule; lattice vibrations; Parametric resonance.
4. Rotations
Isometries and rotations; Motion in a noninertial frame; Rigid body dynamics; Euler equations, Euler top, Lagrange top.
5. Hamiltonian formulation
Canonical equations; Poisson brackets; Canonical transformations; Properties of canonical transformations; Liouville's theorem; Hamilton-Jacobi theory, applications of H-J method.
6. Special relativity
Lorentz transformations as isometries; Kinematic effects, time-dilation, length contraction, Doppler effect, headlight effect; Relativistic point-particle; Motion in uniform electric and magnetic fields.

Course outcomes:

Students will be able to understand a number of analytical techniques for formulations and solution of classical problems and relate their knowledge to the quantum versions over a broad range of topics.

Grading:

There will be one midterm examination and a final examination. They will contribute to your final grade with weights of approximately 20% and 50%, respectively. These will be *closed book* exams.

Homework:

There will be homework assignments, approximately one set for each week. They be listed on my website, I will also send you an alert when I post them. These will be graded, and they do contribute to your final grade with a weight of 30%. The assignments are considered an integral part of the course, often introducing topics I do not have time for in class, and it is very important that you do these problems.

Attendance:

Regular attendance is very important. There is a lot of diverse topics and if you miss a class, it can seriously affect learning of subsequent material. If you are absent for an exam, your grade for that exam will be zero. *There will be no make-up exams, except in dire medical emergencies, supported by a doctor's certificate.*