

Concluding Remarks about Phys 410

In this course, we have ...

Developed a quantitative and precise description of classical mechanical systems

Re-visited Newtonian mechanics at a slightly higher level

Momentum, angular momentum, work, kinetic energy, conservative forces, potential energy

Detailed examination of some interesting forces:

drag force (both linear and quadratic in v)

Lorentz force

Rocket motion

Central force

Coriolis and Centrifugal forces

Learned about inertial and non-inertial reference frames,

and how they affect the equations of motion (Coriolis, centrifugal)

Lagrangian and Hamiltonian mechanics

generalized coordinates, constraints, calculus of variations, Lagrange's and Hamilton's equations

The physics of small oscillations about stable equilibrium points

Driven damped oscillations, resonance, Fourier series

Considered orbits for inverse-square-law forces, and scattering

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Rotation of rigid bodies about an arbitrary axis

Inertia tensor, principal moments, principal axes

The motion of coupled oscillators

Normal modes, normal coordinates

Considered nonlinear mechanics: Driven damped pendulum: attractors, harmonics, sub-harmonics, period doubling bifurcations, Feigenbaum number, sensitivity to initial conditions, the Lyapunov exponent, period-doubling cascade, chaos, bifurcation diagrams, state-space orbits, and the Poincaré section

Relativistic Mechanics: Kinematics and Dynamics

Time dilation, length contraction, Lorentz transformation, Lorentz invariance

A Graduate Classical Mechanics class covers essentially the same topics...

Some “Take-Away” Skills for Phys 410

Recognize $m\ddot{\vec{r}} = -k\vec{r}$ and recall the general solution ...

Know how to write down vector quantities in terms of components in various coordinate systems (Cartesian, spherical, cylindrical), and take dot products, cross products, etc.

Identify constraints, choose appropriate generalized coordinates, write down the Lagrangian, find the conjugate momenta, write down the Hamiltonian. Solve them.
Exploit ‘ignorable coordinates’ and the associated conservation laws

Recognize ‘small oscillations’ situations and attack them systematically

Transform a 2-body problem to the CM + relative coordinates, solve each problem systematically

Recognize and exploit conservation laws

Recognize the presence of nonlinearity and utilize nonlinear dynamics concepts to understand the motion

Understand and utilize the power of simple principles to explain complex physical phenomena
Einstein’s postulates of special relativity