Planning a course based on
Classical Mechanics: From Particles to Continua and Regularity to Chaos
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1. A first course on mechanics for undergraduates has been taught by starting with background on vectors, kinematics, polar coordinates and vector calculus (Appendix A) followed by the framework of Newtonian mechanics (Sect. 3.1, 3.2), Galileo's relativity principle and Newton's laws (Sect. 3.3), concepts of phase space, conservation laws and their illustration via collisions (Sect. 3.4), motion in one dimension (Sect. 1.1, 1.2), Kepler's laws and Newton's law of gravity (Sect. 2.1), an introduction to the harmonic oscillator and simple pendulum (Sect. 1.1, 6.1, 1.5), uniformly accelerated frames (Sect. 9.1) and the elements of special relativity (Sect. 4.1, 4.2, 4.3, 4.4, 4.5, 4.6).
2. A second course on mechanics could cover Lagrangian mechanics (Sect. 3.5, 3.6, 3.7, 3.8, 3.9, 3.10), Hamiltonian mechanics (Sect. 3.14, 3.15), Poisson brackets (Sect. 3.21), canonical transformations (Sect. 10.1,10.4, time permitting), the gravitational 2-body problem (Sect. 2.2, 2.3), small oscillations and normal modes (Sect. 13.1), damped harmonic oscillations (Sect. 6.4, time permitting), rigid bodies (Sect. 8.1, 8.2, 8.3, 8.4, 8.5) and noninertial frames of reference (Sect. 9.2).
3. The content of a Master's course would depend on student background. It may be based on a selection from the following topics, with some being assigned as reading projects: motion in one dimension (Sect. 1.1, 1.2, 1.5), the Kepler problem (Sect. 2.1, 2.2, 2.3, 2.4, 2.5*), the formalism of Newtonian, Lagrangian and Hamiltonian mechanics (Sect. 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.12, 3.14, 3.15, 3.18*, 3.19, 3.21, 3.22), driven oscillations (Sect. 6.8) or anharmonic oscillations (Sect. 7.1), rigid body dynamics (Sect. 8.6, 8.7, 8.9, 8.10, 8.11, 8.12), canonical transformations (Sect. 10.1, 10.2, 10.4, 10.5, 10.6, 10.7, 10.8, 10.10), angle-action variables (Sect. 11.1, 11.2, 11.3, 11.4) and the Hamilton-Jacobi equation (Sect. 12.1, 12.3, 12.4).
4. A course on nonlinear dynamics could treat vector fields in one and two dimensions (Sect. 5.1, 5.2*, 5.3, 5.4*), planar vector fields arising from small oscillations (Sect. 6.1, 6.2, 6.3, 6.4, 6.5, 6.6*, 6.7*), the pendulum (Sect. 7.1) or anharmonic oscillator (Sect. 7.4, 7.5*), infinitesimal canonical transformations (Sect. 10.6), Liouville's theorem (Sect. 10.8), Poincaré recurrence (Sect. 10.9*), angle-action variables (Sect. 11.1, 11.2, 11.3, 11.4), Liouville integrability and KAM tori (Sect. 11.7*), normal modes (Sect. 13.2), stability of periodic solutions (Sect. 13.4), bifurcations of vector fields (Sect. 14.1, 14.2) and chaos (Sect. 15.1, 15.4).
5. An introductory continuum mechanics course (sans elasticity) may be based on the unstarred sections in Chapters 16, 17, 18 and 19.
6. Mathematical supplements from Appendix B may be introduced when the need arises or in a course on mathematical methods of physics.
7. In planning courses, instructors should feel free to omit passages based on student background and time available. Many chapters are self-contained, so teachers may treat topics in an order they are comfortable with. For instance, motion in noninertial frames could be discussed before rigid bodies, although the corotating frame of a rigid body is a nice example of a noninertial frame.