Syllabus for ASE 396:
Dynamics of Planetary Systems

Class time: TTh 2-3:30pm
Class room: WRW 413
Instructor: Dr. Joseph M. Hahn
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Course summary:

The laws of physics are used to solve for and investigate in some detail the orbital motion of two and three gravitating bodies, the motion of a small body orbiting near a resonance with a planet, and the tidal evolution of planetary satellites and extra solar planets, and the physics of planetary rings.

Texts:

Lectures are based on the textbook that I am writing, *The Dynamics of Planetary Systems and Astrophysical Disks*, to be published by Wiley. Chapters relevant to this course will be made available to the students and lecture notes will be posted online.

Grading:

33.3% for assignments
33.3% for midterm exam
33.3% for final exam

Prerequisites:

Undergraduate course on classical mechanics, one that uses differential equations.

Topics covered:

Review of classical mechanics:

coordinate systems and reference frames, Newton's laws of motion, forces, torques, energy, momentum, angular momentum, the gravitational potential, Gauss law and the Poisson equation.

The two-body problem:

the equations of motion, integrals of the motion, Kepler's laws, elliptical, parabolic, and hyperbolic motion, the orbit in space and time, epicyclic motion and the guiding center approximation, Gauss' planetary equations, evolution of the two-body problem over time, orbit decay due to aerodynamic drag and Poynting-Robertson drag, orbital precession in a non-Keplerian potential.

Three-body problems:

motion in a rotating reference frame, the Jacobi integral, zero velocity curves, Lagrange points, tadpole and horseshoe orbits, Hill's equations, the Hill sphere and Roche limit.

Motion near an orbital resonance:

Lindblad, mean-motion, and secular resonances, motion of a particle near a resonance, librating and circulating orbits, resonance trapping.

Tidal evolution of satellite orbits:

The tidal bulge and potential, tidal quantity factor and the Love number, the evolution of the lunar orbit, evolution of Martian satellites, tidal heating of Io, establishing the Laplace resonance among the Galilean satellites, tidal evolution of extra-solar planets.

Planetary rings:

Saturn's dense A and B rings, Jupiter's tenuous dust rings, the Earth's dust ring, and assessing spacecraft dust impact hazard.