Syllabus for Phys. 2513, Dynamic Systems
(Aug. 17, 2020)

Classical mechanics is one of the earliest and well established fields of physics. It is inconceivable that one can study more advanced subjects, such as quantum mechanics, statistical physics, and electromagnetism, without a good knowledge of classical mechanics. The subject also allows students to learn and practice mathematical methods, such as vector calculus, variational principle, Fourier method, and stability analysis, that are commonly used by physicists in attacking real-world problems.

In Newton's view, our universe is entirely mechanical and thus deterministic, like a giant clock. To describe deterministic motions, Newton invented calculus. In this class we will start with a short review of dynamics of single non-interacting particles. The general principle of least action (or Lagrangian and Hamiltonian dynamics) will be presented and applied to systems consisting of different constraints. The complexity of motion increases markedly once interactions between particles are introduced. We will spend considerable time studying two-particle systems, such as planetary motion and coupled harmonic oscillators. We will generalize our understanding of two particle motion to systems consist of many particles. Here two classes of systems can be specified; one concerns with rigid bodies and the other concerns with elastic deformations. These systems are generally called continuous media within which collective excitations in terms of waves are possible. We will devote some times to address this important subject of continuum mechanics.

It should be noted that although Newtonian mechanics is beautiful and full of predictive power, modern physics showed that such a world of view is incomplete. This incompleteness stems from the fact that many natural phenomena are tainted by noise. Such noise can be a result of quantum fluctuations via the Heisenberg uncertainty principle or thermal fluctuations, known as the k_BT-effect. Remarkably, due to the pioneer work of E.N. Lorenz, we now know that nonlinear interactions among the constitutive parts of a system can generate noise themselves and thus spoil determinism of a classical mechanic system. This last effect, known in popular literature as chaos, greatly expands the scope of classical mechanics and forms a vibrant field of current research. We wish to touch upon this fascinating subject by the end of the term.

We would use the textbook by Alexander L. Fetter and John D. Walecka, "Theoretical Mechanics of Particles and Continua," 2nd edition. There will be homework assignments every week, and students are required to complete the homework on time. Each day of delay, without a legitimate excuse, will be a 15% of reduction in the score. Altogether there will be three exams, two midterms and one final. Your final score for the course will be determined by the homework (20%), the midterms (25%x2), and the final (30%). From time to time, I will offer additional problems that you can earn extra credits. You do not need to do these extra-credit problems as they will not compromise your grade. However, if you do, they can boost your performance.

Tentatively I have set my office hour at 11-12 on Monday and Friday with the following Zoom ID: 930 318 119 29. This may change as I learn more about your schedules, e.g., different time zones for some students. Aside from this fixed office hour, you should feel free to contact me by e-mail to set up additional appointments. Here is my contact information: 408 Allen Hall, 624-0873, xlwu@pitt.edu.

We are fortunate to have a grader, Mr. Troy Raen, for this class. He can be reached by the following e-mail address: troy.raen@pitt.edu.

What to be covered?

I have been underestimated the "weight" of this textbook; it was designed for two semesters but we have only one. So, we will cover the first six chapters. Some part of Ch. 7 Strings, and perhaps part of Ch. 12 Viscous Fluids.

A tentative exam schedule:

Midterm1: Sept. 18 (Friday)
Midterm2: Oct. 23 (Friday)
Final: to be in the final week (details unknown)

For your convenience, the lecture and office-hour zoom ID are listed below:

Lecture (MWF 10-10:50): 939 807 733 45

Office Hour (MF 12-1): 933 766 933 89