SYLLABUS for course PHYD38 (in-person), Spring 2023
Title: Nonlinear Physics and Chaos

Lectures (L) on Mo. in EV 140, 10:00-12:00 (12 blocks of 2 hrs of lectures)
Tutorials (T) on Mo. in IC 320, 13:00-14:00
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9 Jan L1, (no tutorial 1st day)
16 Jan L2, T1
23 Jan L3, T2
30 Jan L4, T3 <-- assig #1, due 10:00, submit on Quercus
6 Feb L5, T4
13 Feb L6, T5 <-- assig #2 due 10am
20 Feb -- -- reading week
27 Feb L7, T6 = midterm 55 min. Starts 13:05, finish 14:00
6 Mar L8, T7
13 Mar L9, T8 <-- assig #3 due 10am
20 Mar L10 --
27 Mar L11,T9 <-- assig #4 10am; course drop date w/o acad. penalty
3 Apr L12,T10
xx Apr final TBA

This syllabus will change slighty during the course, please download updates every week. Numbers in square brackets are chapters in Strogatz book

0. Introduction to the course structure, requirements, and main textbook: S. Strogatz "Nonlinear Dynamics and Chaos" 2nd ed. 2018

1. Chaos, Fractals and Dynamics and the
   Importance of being nonlinear [1]

2. 1-D Flows
   Flows on a line [2]
   Bifurcations [3]
   Catastrophes [3]
   Flows on a circle [4]

3. 2-D Flows
   Linear systems [5]
   Phase plane portraits [6]
   Limit cycles [7]
   Bifurcations again [8]

4. Chaos
   Lorenz Equations [9]
   1-d maps [10]
   Fractals [11]
   The exponential fractal
   Strange attactors [12]

5. Nonlinear data analysis
   Machine Learning, Machine Intelligence
   Neural Networks

NONLINEAR WORLD
(Additional topics a few of which may be presented, time allowing):

Stability and bifurcations in Engineering
   Euler beam buckling as bifurcation
   Nonlinear behavior of materials
Nonlinearity, chaos and complexity in Physics and Astrophysics
   The three body and N-body systems
      Orbits, Lagrange points, Lyapunov timescales in planetary and galactic systems

Nonlinear continuum mechanics
- Incompressible and compressible fluids
- Vortices and turbulence in air and water
- Turbulent jets

Dynamics of galacic and protoplanetary disks
- Linear and nonlinear stability and evolution
- Nonlinear waves, Fluid resonances, Particle resonances

Nonlinear optics

Quantum chaos

Noise and corruption of signals in physical systems
- Noise: white, pink, black, non-power law
- Convolution, PSF. Deconvolution. Wiener & Kalman filters

Chaotic stock market

Modeling and forecasting of nonlinear time-dependent processes