

Math 552 (3 credits) Section 101 Introduction to Dynamical Systems

Session 2024W Term 1 (Sep - Dec 2024)

Prerequisite: Two terms/semesters of undergraduate differential equations or dynamical systems (e.g. UBC MATH 215/255 & 256/316; UBC MATH 215 & 345).

Instructor: Yue-Xian Li

Office hours: TBA (See course Canvas page for updates)

Office location: Math Annex 1202

Contact details: Drop-in at office hours or (for simple questions) email to yxli AT math.ubc.ca)

Course Canvas Page: <https://canvas.ubc.ca/courses/149470>

Course Structure: Traditional in-person lectures using a projector and black boards. MWF 10:00-10:50 (Vancouver BC local time). Preliminary notes will be posted before lecture times on the course Canvas page, revised notes will be posted after lecture times on the course Canvas page.

Course Topics:

1. *Linear dynamical systems:* Linear continuous-time systems (ODEs, vector fields, flows); linear discrete-time systems (difference equations, maps); stable, unstable and centre sub-spaces; Floquet multipliers.
2. *Nonlinear dynamical systems:* Nonlinear continuous-time systems; nonlinear discrete-time systems; Poincaré maps; linearization, hyperbolicity, linearized stability; stable and unstable manifolds; two-dimensional Hamiltonian systems; Lyapunov functions.
3. *One-parameter local bifurcations:* Bifurcations in the line: fold, transcritical, symmetric pitchfork, flip; normal forms and Hopf bifurcations in the plane; centre manifolds.
4. *Hopfield networks as discrete-time dynamical systems:* Introduction to Hopfield networks in machine learning.

Course text & references: Optional

- Y. A. Kuznetsov, *Elements of Applied Bifurcation Theory*, Springer, New York (3rd ed. 2004). (The pdf file of an earlier version is available somewhere online.)
- J.J. Hopfield, *Neural Networks and Physical Systems with Emergent Collective Computational Abilities*. *Proc. Natl. Acad. Sci. USA*, Vol.79, pp. 2554-2558, 1982. (The pdf file is available online.)

Learning Assessment: See the course Canvas page.