

AM 9524B Nonlinear Dynamics:
Theory, Methodology and Application
(Winter Term 2024-2025)

1. Time & Place:

First class: January 7, 2025

February 15-23: Spring Reading Week (including Family Day)

Last day of classes: April 4, 2025

April 7-30: April examination period

April 18,20: Good Friday and Easter Sunday

2. Instructor: Dr. Pei Yu

Office: MC 283, Ext: 88783, E-mail: pyu@uwo.ca

3. Course Description

- (i) **Outline:** This course introduces basic theory and methodologies of dynamical systems, and applications to biological and physical systems. Recently developments in this area will also be discussed. Topics mainly focus on Maps and Ordinary Differential Equations, and Delay Differential Equations and Partial Differential Equations (diffusion-reaction problem) will also be discussed. Stability, bifurcations including Hopf, Bogdanov-Takens and homoclinic/heteroclinic bifurcations, which are mostly applied in applications, and chaos will be particularly considered. Manifold theory, normal form theory and perturbation theory will be introduced, with examples chosen mainly from biological systems and solved using both symbolic and numerical computations.

(ii) **Learning outcomes**

- To be familiar with basic theory and methodology of dynamical systems.
- To learn how to analyze stability and bifurcations in differential systems.
- To apply bifurcation theory to solve real-world problems.
- To use Matlab, Maple and other computer software to symbolically or numerically solve bifurcation problems.
- To learn basic concepts of chaos and fractals.

(iii) **Covered topics**

- Stability of equilibria and classification of singularity
- Periodic attractors and limit cycle theory
- Theory and computation for Hopf and B-T bifurcations
- Perturbation theory and symbolic computation
- Methods for computing center manifold and normal forms
- Introduction of Chaos and fractals
- Traveling wave and geometric singular perturbation theory
- Applications (mainly focused on biological systems)

(iv) **Delivery of Lectures: In-person** Class room teaching.

- (v) Contingency plan: Although the intent is for this course to be delivered in person, should any university-declared emergency requires some or all of the course delivered online, either synchronously or asynchronously, the course will adapt accordingly. The grading scheme will not change. Any remaining quizzes/midterm will also be conducted online as determined by the course instructor.

4. Course Materials

Course website: There is no textbook for this course. All course material including the Lecture notes (in .pdf format) will be posted to OWL: <https://westernu.brightspace.com/>. All information about this course including the course outline, assignment problems, exams, lectures, etc. will be posted only on OWL.

Students are responsible for checking the course OWL site (<https://westernu.brightspace.com/>) regularly for news and updates. This is the primary method by which information will be disseminated to all students in the class.

If students need assistance with the course OWL site, they can seek support on the OWL Brightspace Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800

5. Course Evaluation

The over course grade includes

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| (a) Assignments (5, once every two weeks): | 35% |
| (b) Course project (presentation and report): | 25% |
| (c) Final examination: | 35% |
| (d) Class attendance: | 5% |

6. Additional Statements

Religious Accommodation

When conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request an accommodation for their absence in writing to the course instructor and/or the Academic Advising office of their Faculty of Registration. This notice should be made as early as possible but not later than two weeks prior to the writing or the examination (or one week prior to the writing of the test).

Please visit the Diversity Calendars posted on our university's EDID website for the recognized religious holidays: <https://www.edi.uwo.ca>.

Accommodation Policies

Students with disabilities are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Accommodation_disabilities.pdf.

Academic Policies

The website for Registrar Services is <https://www.registrar.uwo.ca/>.

In accordance with policy,

https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf,

the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at their official university address is attended to in a timely manner.

Statement on Use of Electronic Devices: Calculators, computers, cellphones or any electronic devices which can be used for communication, are not allowed to be used in the final examination.

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf.

Remote Proctoring Service: Final examination in this course will be conducted in person. In the event of any university-declared emergency, the teaching will be changed to online, and the examination will be proctored using Zoom through OWL. By taking

this course, you are consenting to the use of this software and acknowledge that you will be required to provide personal information (including some biometric data) and the session will be recorded. Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. More information about this remote proctoring service, including technical requirements, is available on Westerns Remote Proctoring website at:

<https://remoteproctoring.uwo.ca>.

Support Services

Please visit the Science & Basic Medical Sciences Academic Advising webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic-related matters: <https://www.uwo.ca/sci/counselling/>.

Students who are in emotional/mental distress should refer to Mental Health@Western (<https://uwo.ca/health/>) for a complete list of options about how to obtain help.

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at

https://www.uwo.ca/health/student_support/survivor_support/get-help.html.

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education at

http://academicsupport.uwo.ca/accessible_education/index.html

if you have any questions regarding accommodations.

Learning-skills counsellors at Learning Development and Success (<https://learning.uwo.ca>) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Western University is committed to a thriving campus as we deliver our courses in the mixed model of both virtual and face-to-face formats. We encourage you to check out the Digital Student Experience website to manage your academics and well-being: <https://www.uwo.ca/se/digital/>.

Additional student-run support services are offered by the USC,

<https://westernusc.ca/services/>.