

MATH 4325: Modeling with Dynamical Systems

Section 001: TTh 2:00-3:20

Instructor: Dr. Thomas Carr

Contact Information: office- Dallas Hall 200, phone- 214-768-3460, email- tcarr@smu.edu

Office Hours: TThu 1:00-2:00pm.

Except in unusual circumstances I guarantee that I will be in my office during the designated office hours. You are always welcome to stop by or call at other times to see if I am available.

Textbook: *Nonlinear Dynamics and Chaos, second edition*, by Steven H. Strogatz.

Grading and exams

- Homework = 20 %
- First in-class, Tuesday, Sep 24 = 20 %
- Second in-class, Tuesday, Oct 29 = 30 %
- Final exam, Wednesday, Dec 18, 11:30am = 30 %

Please note the following

- Late homework will not be accepted.
- Makeup tests will not be given.
- There is no extra credit work.

Homework will be assigned approximately weekly. Completing and understanding the homework assignments are critical for success in the class. The lowest homework grade will be dropped. The following requirements will be taken into account when grading:

- Multiple pages should be bound (e.g. a staple).
- Work should be neat and easy to follow.
- All figures must have a caption describing what the figure illustrates and why it is important. Figures should be properly scaled so that the important features are prominent.

Dynamical Systems Software: We will make use of the Matlab programs `dfield` and `pplane`. The class web page has information about these programs and indicates where they are available for free on the web. Make sure you can run Matlab and these programs ASAP.

Honor Code: Please review the Honor Code documented in the SMU Undergraduate or Graduate Bulletin. The highest level of academic honesty and integrity will be expected.

Course Description:

Student learning outcomes

- Students will be able to analyze and describe bifurcations in 1D and 2D flows and maps.
- Students will be able to describe and sketch their phase space geometry of systems of nonlinear ODEs, as well as completely determine the solutions to linear systems of ODEs.

Topics

- Introduction to Dynamical Systems
- One-Dimension Dynamical Systems:
Direction field, equilibria, phase line, stability, local analysis and linear stability.
- Two-Dimension Dynamical Systems:
Equilibrium and linearization, Jacobian matrix, fundamental matrix and matrix exponentials, Jordan normal form, classification of linear critical points, Trajectories in the phase plane, nullclines, Hamiltonian systems, homoclinic and heteroclinic orbits, limit cycles and the Poincare' Bendixson theorem, periodic solutions, Floquet theory,
- Bifurcations:
Implicit function theorem, bifurcation points and diagrams. Specific types of bifurcations, e.g., transcritical, saddle-node, pitchfork, Hopf bifurcations.
- Discrete Dynamical Systems:
Poincare' maps, one-dimensional maps and cob-webbing, period-doubling and flip bifurcations, routes to chaos.
- Applications of theory to physical problems will be discussed throughout the course.

Official SMU notices:

- Disability Accommodations: Students needing academic accommodations for a disability must first register with Disability Accommodations & Success Strategies (DASS). Students can call 214-768-1470 or visit <http://www.smu.edu/Provost/SASP/DASS> to begin the process. Once approved and registered, students will submit a DASS Accommodation Letter to faculty through the electronic portal DASS Link and then communicate directly with each instructor to make appropriate arrangements. Please note that accommodations are not retroactive and require advance notice to implement.
- Religious Observance: Religiously observant students wishing to be absent on holidays that require missing class should notify their professors in writing at the beginning of the semester, and should discuss with them, in advance, acceptable ways of making up any work missed because of the absence (<https://www.smu.edu/StudentAffairs/Chaplain/ReligiousHolidays>).
- Excused Absences for University Extracurricular Activities: Students participating in an officially sanctioned, scheduled University extracurricular activity should be given the opportunity to make up class assignments or other graded assignments missed as a result of their participation. It is the responsibility of the student to make arrangements with the instructor prior to any missed scheduled examination or other missed assignment for making up the work. (See 2018-2019 University Undergraduate Catalogue)
- Student Academic Success Programs: Students needing assistance with writing assignments for SMU courses may schedule an appointment with the Writing Center through Canvas. Students wishing support with subject-specific tutoring or success strategies should contact SASP, Loyd All Sports Center, Suite 202; 214-768-3648; <https://www.smu.edu/sasp>.
- Caring Community Connections (CCC) program: This is a resource for anyone in the SMU community to refer students of concern to the Office of the Dean of Students. Faculty play a critical role in identifying students who are experiencing challenges, as you may be the first to notice a change in behavior such as class attendance or performance. The online referral form can be found at smu.edu/deanofstudentsccc. After a referral is submitted, students will be contacted to discuss the concern, strategize options, and be connected to appropriate resources. Additionally, should you have concerns about students and are unclear about what to do, please see the CCC Reference Guide, or contact the Office of the Dean of Students at 214-768-4564.