MA-543 Spring 2024

Course: Ordinary Differential Equations and Dynamical Systems
CRN: 17540
Time: Tue/Thu 4:30 pm - 5:45 pm, Jan 08-Apr 27, 2023
Location: REC 114 (SCHM 114)
Instructional Modality: Face to Face

Instructor: Yuan GAO
Office hour: Tue/Thu 3:00-4:30pm; or other time via Email appointment
Office Location: Math 410
Email: gao662@purdue.edu
Office Phone number: 765-494-1965

Description:

Credit Hours: 3.00. This is a graduate–level course on Ordinary differential equations and Dynamical systems. The course will start with an introduction to the basic properties of differential equations, including solving linear systems, existence and uniqueness theory, flows and linearization, and linearized stabilities. With these preparations, I will introduce advanced concepts related to global existence, invariant/stable/unstable manifold, periodic orbits, limit sets, averaging, chaotic and bifurcation theory. The goal of the course is to introduce the fundamental mathematical ideas in dynamical systems.

Texts:

1. **Main textbook**: ***Differentiable Dynamical Systems, J.D. Meiss.*** **(Available online)**
   HWs will be assigned mainly according to this textbook.
2. Other references: There are lots of good references, for instance:
   * Stability Theory of Differential Equations, R. Bellman
   * Differential Equations, Dynamical Systems, and an Introduction to Chaos, Morris W. Hirsch, Stephen Smale and Robert L. Devaney
   * Mathematical Methods of Classical Mechanics, V. I. Arnold
3. Notes taken in class or materials posted on Brightspace.
4. If you need undergraduate-level ODE:
   Elementary Differential Equations and Boundary Value Problems, Boyce and DiPrima

Important prerequisites:
Linear algebra, differential equations (ODEs), mathematical analysis (concepts of convergence) and mathematical maturity.

There may be deviations from the schedule below, depending on class progress.

Approximated Schedule (subject to changes)**:**
Chapter sections refer to the main textbook.
1. Week of Jan. 11, Ch1;
2. Week of Jan. 18, Ch2;
3. Week of Jan. 25, Ch2, Ch3;

4. Week of Feb. 01, Ch3, Ch4;
5. Week of Feb. 08, Ch4;
6. Week of Feb. 15, Ch4, Ch5;
7. Week of Feb. 22, Ch5; Midterm Exam **on Feb 20;** No class on Feb 20;
8. Week of Feb. 29, Ch5;
9. Week of Mar. 07, Ch6;
10. Week of Mar. 14; Spring Break, no class;
11. Week of Mar. 21, Ch6
12. Week of Mar. 28, Ch6, Ch7
13. Week of Apr. 04, Ch7, Ch8(optional); Title and schedules of final report **Due on Apr 3.**
14. Week of Apr. 11, Ch9
15. Week of Apr. 18, Final Reports
16. Week of Apr. 25, Final Reports

No Final Exam.

Grading System:

1. Homework: 30%
• Biweekly assignments based on lectures and encouraged readings.
A very significant portion of your final grade.
- A biweekly assignment will usually be due on **Wednesday** (to be submitted via Gradescope to the TA; link: https://www.gradescope.com). The assignment will be posted on Gradescope on every other Thursdays, with **a specific due time**.
- **Missing homework counts as 0**; see policy below.
- **Late homework will be accepted up to 24 hours after the posted due date no questions asked**.
- There are around 5-10 Problems in each homework. Only 5 Problems (randomly chosen by TA) in each homework will be graded. Each written homework will be graded on a scale of 0-100.
- There are totally **6 HWs**, an average of your 6 scores for HWs will be your final HW grade.

2. Take-home midterm exam: 30%
• One take-home, **open-book, no-collaboration exams** released on Gradescope.
A very significant portion of your final grade.
• You will have **48h** to finish the exam on Feb 20-21 by yourselves.

3. Final Report: 30%
- A final report presented by each student. A very significant portion of your final grade.
- Each report last 15-20mins; Any topics (in the form of further remarks, summary, or new understandings) related to dynamical system can be chosen.

Some examples are
“Summary of fix-point theorems in various space”,
“Smale’s Horseshoe map”,
“Remarks on three body problems”,
“Existence and non-existence of Planar Periodic Orbits” …

4. Class attendance and activity: 10%
• +1% (resp. +2%) for actively answering questions (resp. proposing alternative solutions)
• +2% for sharing typed lecture notes (at least two chapters or more)
• -2% for being absent twice without proper reasons

•Missed course work is officially accommodated in the following three circumstances:
1. Illness or other extraordinary personal circumstance
2. Religious observance
3. Varsity athletic participation
Late work for any other reason will not be accepted.

Grades policy
Students who get at least 97% of the total
points in this course are guaranteed an A+,
93% an A
90% an A-
87% a B+
83% a B
80% a B-
77% a C+
73% a C
70% a C-
67% a D+
63% a D
and 60% a D-

Above is departmental policy for the grade cut-offs. For each of these grades, it's possible that at the end of the semester a lower percentage will be enough to get that grade.

Expectations:
• This is an advanced course with high expectations. Your submitted work should reflect your best effort. Solutions should be complete, legible, and easily understood. Complete sentences expressing well-developed ideas should be used whenever appropriate.
• The goal of the course is to not only learn those classical method in the textbook but also learn the way of thinking. These fundamental ideas will (hopefully) influence the way you think and the way you solve problems. Thus, our goal is to not only teach you the content outlined in the course synopsis, but to also more broadly impact the way you think about problems in your chosen discipline.
• During reading and working out HWs, it is highly encouraged to explain concept, hear it from others in some different angles, and to answer other people's doubts, which will solidify one's own understanding.

Academic Integrity

Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494- 8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace table of contents, under University Policies.

Direct copying from (or too close to) other works or online materials is not allowed. Any form of cheating in exams will automatically lead to an F grade.

All materials, including Projects and HWs posted on the Brightspace of this course subject to my copyright and cannot be bartered.

Academic Guidance in the Event a Student is Quarantined/Isolated
If you must quarantine or isolate at any point in time during the semester, contact the Protect Purdue Health Center at 765-496-4636. Please also reach out to me via email so that we can communicate about how you can continue to learn remotely. Work with the Protect Purdue Health Center (PPHC) to get documentation and support, including access to an Academic Case Manager who can provide you with general guidelines/resources around communicating with your instructors, be available for academic support, and offer suggestions for how to be successful when learning remotely. Your Academic Case Manager can be reached at acmq@purdue.edu. Importantly, if you find yourself too sick for an extended period of time to progress in the course, notify your academic case manager and notify me via email or Brightspace. We will make arrangements based on your particular situation.

Lack of compliance
Students who are not engaging in behaviors established in the standard operating procedures (e.g., properly wearing a mask when required) will be asked to comply and offered any assistance they need in order to comply. If non-compliance continues, possible results include instructors asking students to leave the class, potentially followed by instructors dismissing the whole class. Students who do not comply with the required health and Protect Purdue Pledge behaviors are violating the University Code of Conduct and will be reported to the Dean of Students Office, with sanctions ranging from educational requirements to dismissal from the university. For additional guidance, please see the Dean of Students guidance on Managing Classroom Behavior and Expectations.

Student rights
Any student who has substantial reason to believe that another person in the room is threatening class safety by not wearing a face covering or following other safety guidelines for public health considerations may leave the class without consequence. The student is encouraged to report the observed behavior to the course instructor or to the Office of Student Rights and Responsibilities (OSRR), as well as discuss next steps with the instructor.

Accommodations for Students with Disabilities and Academic Adjustment:

Purdue University strives to make learning experiences accessible to all participants. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone at 765-494-1247.

If you have been certified by the Disability Resource Center (DRC) as eligible for accommodations, you should contact your instructor to discuss your accommodations as soon as possible. Here are instructions for sending your Course Accessibility Letter to your instructor:https://www.purdue.edu/drc/students/course-accessibility-letter.php

Nondiscrimination Statement:

This class, as part of Purdue University's educational endeavor, is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters

tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential.

Mental Health/Wellness Statement

Help-seeking is a life skill rather than an indication of weakness.

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one- on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at evans240@purdue.edu.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Emergency Preparation

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis. A link to Purdue's Emergency Preparedness resources (also located on the Brightspace shell under University Policies) https://www.purdue.edu/ehps/emergency_preparedness/