

**SABANCI UNIVERSITY**  
**MATH 307/578 DYNAMICAL SYSTEMS**  
**FALL 2024-2025**

*This syllabus may be subject to update and change.*

**Instructor:** Nilay Duruk Mutlubas

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**Office Hours:** By appointment.

**Lectures:**

Day / Time	Classroom
Tuesday 09.40-10.30	FENS L063
Wednesday 11.40-13.30	FENS L035

**Attendance:** Students are expected to attend all class meetings on time. Even though attendance is not compulsory keep in mind that you will not be able to learn the lecture entirely and have a high grade unless you attend the classes properly.

**You are responsible for every announcement made in class or in SUCourse+. Not attending the class or not following SUCourse+ regularly is not an excuse, in case you miss something.**

**Textbook:** Arrowsmith D.K., Place C.M., Dynamical Systems- Differential Equations, maps and chaotic behavior, Chapman & Hall, 1992.

**Recommended Textbooks:**

Glendinning P.A., Stability, Instability and Chaos, Cambridge University Press, 1994.

Alligood, K.T., Sauer T.D., and Yorke J.A., An Introduction to Dynamical Systems, Springer-Verlag, 1996.

Palais R.A., Palais R.S., Differential Equations, Mechanics and Computation, AMS, 2009.

Strogatz S.H., Nonlinear Dynamics and Chaos, CRC Press, 2014.

**Condensed guideline of the present syllabus:**

- Read this syllabus from top to bottom.
- Follow the announcements on SUCourse+.
- Attend the lectures.
- Prepare for the midterm and the final exams.
- Take advantage of the Office Hours, to ask your questions.

**Course Objective:** To teach the fundamental theory of ODE's; the fundamentals of dynamical systems and their connections with problems from a wide variety of areas.

### **Course Content**

Qualitative theory of ordinary differential equations (ODEs). Existence and uniqueness, geometrical representation of ODEs. Construction of phase portraits. Nonlinear systems, local and global behavior, the linearization theorem. Periodic orbits and limit sets, Poincare-Bendixson theory.

### **Course Description:**

This course covers the following subjects:

- i. Introduction: ODEs, geometrical representation;
- ii. Linear systems in one-dimension
- iii. Linear systems in the plane
- iv. Nonlinear systems in the plane

### **Learning Outcomes**

- i. Draw phase portraits in the plane
- ii. Construct proofs for existence and uniqueness for linear systems
- iii. Identify fixed/equilibrium points, determine their stability, and analyze local and global behavior
- iv. Rule out closed orbits for gradient systems and construct Lyapunov functions
- v. Utilize theorems to establish the existence of closed orbits, such as Poincare-Bendixson theorem
- vi. Investigate fixed points and their stability for one-dimensional maps

### **Exams:**

- There will be **two** midterm exams and **one** final exam. Exam subjects will be announced for each during the class hours before the exam. These are tests performed in person on campus.
- During the exams, the use of books, notes, electronic devices (including cell phones, smart watches, calculators, computers etc.), or any other kind of supporting learning material is NOT allowed. A student violating this rule will receive 0 points for that exam.
- However weeks of the midterm exams are announced in the tentative schedule, it may change according to special situations. The university will later announce the final exam date. The final may be given on any day between 02.01.2025 and 12.01.2025. Student Resources will determine the dates and times for all final exams, and instructors cannot change it. So, do not plan to leave Istanbul before the exam period ends.
- Unless you have a serious excuse, such as health problem, it is not allowed to make up any exam. In such a case, you must contact the instructor Nilay Duruk Mutlubaş **as soon as possible** and explain your situation. If it is a health problem you need to bring a medical report, that must be given or checked by SU Health Center within 3 days of the date of the report. Make-up for the midterm or the final will be at the end of the

semester (after the finals period). Only students that had contacted the instructor with a valid excuse will be informed about the time and format. The make-up exam will contain all topics and counted for only one of the missed exams. If a student miss both (Final and Midterm) exams even with a valid excuse, then (s)he will be allowed to take make-up for Final exam only and receive 0 (zero) point for Midterm exam.

### **Grading:**

- Midterm Exam 1: %30
- Midterm Exam 2: %30
- Final Exam: %40

### **NA Policy:**

Students missing both the midterm and the final exams, without a valid excuse, will receive NA if they also miss the make-up. In general, if you will have serious issues preventing you from regularly following the course, you are required to contact Nilay Duruk Mutlubaş. Please see also Class Discipline below.

### **Academic Integrity:**

All university policies on academic integrity apply to our course, and they will be enforced. (more information on <http://www.sabanciuniv.edu/en/academic-integrity-statement>). In general, to ensure Academic Integrity, any student might be asked to validate any activity contributing to their grade in an interview (recorded, with audio and video). A student failing to explain the submitted work, or refusing/missing the interview, will receive zero from that work. In particular, no form of cheating is welcome in the exams such as copying whole or part of each other's answers, using cheat-sheets etc. The action against such violations could range from getting a zero on the particular assignment to explaining the case in front of the Disciplinary Committee.

### **Class Discipline:**

It is our responsibility to provide students with excellent teaching and learning environments. We are therefore asking you to respect both our responsibility to teach and the right of other students to learn. Any action that disturbs your classmates or disrupts the activities is unacceptable. Repeated violations of the above rules may cause a student to be counted as absent for a lecture.

### **Registration Overrides**

Time conflict requests will be accepted if you do not exceed one hour. However, any and all negative outcomes that may result are solely the student's responsibility.

**GOOD LUCK ☺**

## Tentative Weekly Schedule

Week	Topic
1	Introduction; qualitative theory of ordinary differential equations; existence and uniqueness; geometrical representation
2	Introduction; qualitative theory of ordinary differential equations; existence and uniqueness; geometrical representation
3	Autonomous equations, phase portraits and dynamics; applications
4	Autonomous equations, phase portraits and dynamics; applications
5	Construction of phase portraits in the plane; isoclines; flows and evolution
6	Construction of phase portraits in the plane; isoclines; flows and evolution <b>MIDTERM EXAM 1 (30.10.2024)</b>
7	Linear systems; similarity types for real matrices in two dimensions; phase portraits for canonical systems; difference equations
8	Linear systems; similarity types for real matrices in two dimensions; phase portraits for canonical systems; difference equations
9	The evolution operator; affine systems; linear systems of dimension greater than two; applications
10	Nonlinear systems in the plane; maps; local and global behavior; the linearization theorem
11	Fixed points, stability of fixed points; ordinary points and global behavior
12	First integrals, limit cycles; Lotka-Volterra models; Poincare-Bendixson theory <b>MIDTERM EXAM 2 (11.12.2024)</b>
13	First integrals, limit cycles; Lotka-Volterra models; Poincare-Bendixson theory
14	Review