MATH 487 Continuous Dynamical Systems
Sections 0101 Fall 2013

- Instructor: Dr. Jinglai Shen
- E-mail: shenj@umbc.edu
- Office: Math/Psyc 417
- Phone: (410) 455–2402
- Lectures: Tue and Thu, 1:00–2:15 pm, at SOND 208
- Office hours: Tue and Thu, 12:00–1:00 pm or by appointment
- Course web-page: http://www.math.umbc.edu/~shenj
- Prerequisites: Math 221, 251 and 301
- Recommended course preparation: Math 302
- Text: *Differential Dynamical Systems* by James D. Meiss, SIAM Press, 2007
- Other references:
  - *Differential Equations, Dynamical Systems and an Introduction to Chaos*, by Hirsch, Smale and Devaney
  - *Nonlinear Dynamics and Chaos*, by Steve Strogatz
  - *Chaos: An Introduction to Dynamical Systems*, by Alligood, Sauer and Yorke

Course Description This course will focus on the qualitative aspects of dynamical systems modeled by systems of ordinary differential equations. Most differential equations arising from applications cannot be solved in closed form, however, fundamental questions such as existence and uniqueness of solutions, continuous dependence of solutions on initial conditions, and local and global stability can be investigated for a large class of dynamical systems. This course aims to develop an understanding of the theory behind the rich qualitative behavior of dynamical systems. Topics covered include existence and uniqueness, linear systems, local and global stability, Lyapunov functions, Poincare-Bendixson theory, bifurcations and chaos.

We will cover most of Chapters 2–5 and part of Chapters 6–8 of the textbook. Specific topics are:

- Introduction and review (Chapter 1)
- Linear Systems (Chapter 2)
  - Linear ODE systems, and planar systems ($\S 2.1 - 2.2$)
  - Solutions of linear ODEs ($\S 2.3 - 2.6$)
  - Stability of linear ODEs ($\S 2.7$)
- Existence and Uniqueness of ODEs (Chapter 3)
- Dynamical Systems (Chapter 4)
  - Flows, equilibria and notions of stability ($\S 4.2, 4.5$)
  - Linearization and linear stability analysis ($\S 4.4$)
  - Lyapunov stability analysis, topological conjugacy ($\S 4.6, 4.7$)
  - Hartman-Grobman Theorem, classification of orbits ($\S 4.8 - 4.10$)
- Invariant Manifolds (Chapter 5)
- Qualitative Behavior of Planar Systems (Chapter 6)
  - Two dimensional systems and their behavior ($\S 6.1 - 6.3$)
  - Poincare-Bendixson Theorem and its applications ($\S 6.6$)
- Bifurcation Theory (Chapter 8)
  - Bifurcations of equilibria, saddle-node bifurcation ($\S 8.1, 8.4, 8.6$)
- Chaos (Chapter 7)
  - Sensitivity dependence on initial conditions and transitivity ($\S 7.1$)

Please note that these topics are subject to change, depending on class progress.

Homework Biweekly homework will be assigned. Homework is usually collected in Tuesday's class unless a due date change is announced. *No late homework will be accepted.* Please present your answers neatly and show all your work; answers without supporting work may not receive full credit. And please staple your homework if it has multiple pages.

Exams There will be two (2) in-class mid-term exams and one (1) final exam. The time of each exam will be announced at least one week before it is held. A mid-term exam mainly focuses on topics covered by that month, and the final exam will be comprehensive but with more emphasis on the latter part of the course. Please note that there will be *no* optional final exam, and all the exams are closed book.

Grading Policy The grading scheme is as follows:

- homework: 30%
- mid-term exams: 40% (20% for each)
- final exam: 30% (the final is comprehensive)

The letter grade will be computed based upon the numerical grade:

$$A : \geq 90; \quad B : 89 - 80; \quad C : 79 - 65; \quad D : 64 - 50; \quad F :< 50$$

Academic Integrity

- The UMBC Academic Integrity Statement:

  "*By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal. To read the full Student Academic Conduct Policy, consult the UMBC Student Handbook, the Faculty Handbook, or the UMBC Policies section of the UMBC Directory*".

- All work in a homework or an exam must be your own; collaborating on an exam is *not* permitted. Discussions with other students on homework problems are allowed, but you should present your own work in the final turn-in; simply copying other people's work is violation of academic integrity code.

- If you wish to contest a graded exam, you must make an appeal within *one week* of the return date to the class. All appeals should be made in writing to the instructor with a signed and dated note on the exam. End of the semester appeals for earlier exams will be ignored.

- Regarding make-up tests: if you must miss an exam due to a prior obligation, you must speak to the instructor *in advance* of the exam. If you must miss an exam due to an unforseen but valid reason (e.g. illness), you must submit a written excuse. Failing to do so may result in loss of substantial points in your make-up.