MA 481G (001), 3 credits — Spring 2018
MWF 1:00-1:50pm, Room:CB 343
Differential Equations
URL: www.ms.uky.edu/~ofpr222/spring2018/ma481

Instructor:	Olivia Prosper
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Course Description: It is often impossible to find closed-form analytic solutions to ordinary differential equations that model physical systems. This semester, MA 481G focuses on qualitative analysis of ordinary differential equations, with applications taken from physics, engineering, and biology. The methods developed provide a means to (1) determine whether a system of differential equations is well-posed, and (2) study the behavior of solutions to differential equations for which a closed-form solution is impossible.

Prerequisites: One of MA 432G, MA 471G or equivalent, or consent of the department.

Course Outline: Analysis of first and second order linear differential equations will be reviewed briefly, and techniques for nonlinear ordinary differential equations (ODEs) will be studied. Topics include:
- Preliminary definitions & introduction to existence and uniqueness
- Linear Equations
  - First and second order
  - Higher order
- Planar systems
  - linear
  - nonlinear
  - phase-plane analysis
- Nonlinear systems
  - Equilibria and their stability
  - Global Techniques
  - Closed orbits and limit sets
  - Bifurcation analysis
  - Existence and Uniqueness of solutions revisited
- Chaotic behavior (time permitting)

The schedule of topics may adjust depending on student progress at the discretion of the instructor.

Student Learning Outcomes: After completing this course, students will be able to:
- Categorize a given set of ODEs,
- Derive ODE models for some "simple" physical systems,
- Discover important properties of solutions to differential equations through methods of qualitative analysis,
- In the context of applications, interpret mathematical conclusions in their appropriate physical context, and
- Obtain an appreciation for the complexities arising from these continuous dynamical systems.

Required Materials: The required textbook for this course (freely available through your Link Blue account through ScienceDirect online service) is

Title: *Differential equations, dynamical systems, and an introduction to chaos*
Authors: Morris W. Hirsch, Stephen Smale and Robert L. Devaney
Edition: 3rd
Publisher: Academic Press, Elsevier Inc.
Publication or copyright date: copyright date 2013
ISBN-13: 978-0-12-382010-5

Description of Course Activities and Assignments

Class Participation: Your grade for participation will not only reflect your attendance record and how often you contributed to our class discussions, but the degree to which your contributions were constructive and generative of further response(s) from your fellow classmates.

Midterm Exams: There will be two midterm exams during the regular class time. Each midterm exam is worth 75 points. Midterm exams I and II are tentatively scheduled for Wednesday, February 14th, and Wednesday, March 21st, respectively. Absolutely no cell phone use is allowed during exams.

Final Exam: The final exam will take place on Wednesday, May 02, 2018 at 1:00 pm.

Homework: 10 homework sets will be assigned throughout the semester. Assignments will be collected at least one week after they have been assigned. Students are encouraged to brainstorm solutions to homework problems together, but solutions must be written in their own words and independently.

Course Grading: Students will obtain a maximum of 500 points in this class, divided as follows:

	Points	Percent
Homework	200	40%
Class participation	50	10%
Midterm I	75	15%
Midterm II	75	15%
Final exam	100	20%
Total	500	100%

Please note that the grades will be assigned differently depending on whether the student is receiving graduate course credit or not. The assignment of grades is described below.

To receive credit for MA 481, an <u>undergraduate</u> student's final grade for the course will be based on the total points earned as follows:

Grade	Points	Percent
A	450-500	90%-100%
B	400-449.9	80%-89.9%
C	350-399.9	70%-79.9%
D	300-349.9	60%-69.9%
E	0-299.9	0%-59.9%

To receive credit for MA481G, a <u>graduate</u> student's final grade will include a 3-5 page paper, written in LaTeX, due on the last day of class. Instructions for this assignment will be provided. A grade of *satisfactory (S)* or *unsatisfactory (U)* will be assigned to the paper (a rubric for grading will be provided). Those receiving a satisfactory grade will be graded as follows, according to the student's

points earned on all other assignments. Those receiving an unsatisfactory grade on the paper will earn one letter grade lower than indicated by their points earned.

Grade	Points	Percent
A	450-500	90%-100%
B	400-449.9	80%-89.9%
C	350-399.9	70%-79.9%
E	< 350	$< 70\%$

Note: The grading scale might be adjusted at the end of the semester. You will be guaranteed the above letter grade if your score falls within the given range (and for graduate students enrolled in MA 481G, a satisfactory grade earned on the paper assignment), but the minimum score for each letter grade might be lowered.

Software: Students will be permitted to write their code in R, Octave, or MATLAB. Tutorials for each will be given in class or through Canvas as needed. Computers will not be permitted on exams, but will be allowed for homework for select problems.

Tentative Course Schedule: This the tentative schedule of the course

Week	Topic
1 – 2	Preliminary definitions & intro to Existence and Uniqueness
2 – 3	Review of linear first and second order systems. Intro to higher order linear systems
4 – 5	Planar systems: linear & nonlinear
6 – 7	Equilibria & their stability
8 – 9	Global methods (ex: Liapunov functions)
10–11	Closed orbits and limit sets
12 – 13	Bifurcation analysis
14–15	Existence & Uniqueness revisited
16	(*Dead week*) Review

Mid-term Grade: Mid-term grades will be posted in myUK by the deadline established in the Academic Calendar: March 5, 2018.

Tutoring Resources: If you find that you are having difficulty with any aspect of the course, you should seek help immediately. Please talk to your instructor as soon as possible. Take full advantage of your instructor's scheduled office hours. If you have conflicts with these office hours, your Instructor will be happy to schedule an alternative time to meet with you.

Policies
Attendance and excused absences: Attendance in MA481G is mandatory. Be on time and remain until dismissed. Do not leave in the middle of class. Whenever possible, please notify your instructor of absences prior to class. S.R. 5.2.4.2 defines the following as acceptable reasons for excused absences: (a) serious illness, (b) illness or death of family member, (c) University-related trips, (d) major religious holidays, and (e) other circumstances found to fit as reasonable cause for nonattendance by the professor. You may be asked to verify absences in order for them to be considered excused. Senate Rule 5.2.4.2 states that faculty have the right to request appropriate verification when students claim an excused absence because of illness or death in the family. Appropriate notification of absences due to university-related trips is required prior to the absence. If you anticipate an absence for a major religious holiday please notify your instructor (in writing) of anticipated absences due to your observance of such holidays no later than the last day in the semester to add a class. Two weeks prior to the absence is reasonable, but should not be given any later. Information regarding major religious holidays may be obtained through the Ombud (859) 257-3737,

`http://www.uky.edu/Ombud/ForStudents_ExcusedAbsences.php`

You are expected to withdraw from the class if more than 20% of the classes scheduled for the semester are missed (excused or unexcused) per university policy.

Classroom behavior: Electronic devices such as mobile phones, laptops and tablets should be put away or used only as part of class activities during lectures. Mobile phones, laptops, and computers may not be used during exams.

Make-up policies: Per Senate Rule 5.2.4.2, if you are missing any graded work due to an excused absence you are responsible for informing the Instructor about your excused absence within one week following the period of the excused absence (except where prior notification is required); and for making up the missed work. The instructor will give you an opportunity to make up the work and/or the exams missed due to an excused absence, and shall do so, if feasible, during the semester in which the absence occurred. In particular, if you have university excused absences or have university-scheduled class conflicts with uniform examinations you may arrange with their instructor to take the exam at an alternate time. Generally these make-up exams will be scheduled on the day of or on the day after the regularly scheduled exam. Work-related conflicts are neither university excused absences nor university-scheduled absences.

Students needing accomodations: If you have a documented disability that requires academic accommodations, please see your instructor as soon as possible. In order to receive accommodations in this course, you must provide your instructor with a Letter of Accommodation from the Disability Resource Center (DRC). The DRC coordinates campus disability services available to students with disabilities. It is located on the corner of Rose Street and Huguelet Drive in the Multidisciplinary Science Building, Suite 407. You can reach them via phone at (859) 257-2754 and via email at drc@uky.edu. Their web address is

`http://www.uky.edu/StudentAffairs/DisabilityResourceCenter/`

Accommodations for victims of violence: By federal law, any student who is a victim of dating violence, domestic/intimate partner violence, sexual assault, or stalking (whether on or off campus) is entitled to appropriate accommodations for his or her coursework. To get help getting accommodations and other support, students who are assaulted can do any of the following:

- Tell your instructor who can assist you in accessing resources appropriate to your situation;
- Call the UK VIP Center (Violence Intervention and Prevention Center) at 257-3574 or vipcenter@uky.edu or

  `http://www.uky.edu/StudentAffairs/VIPCenter/about_contact.php`

  or walk in to the Center in Frazee Hall, lower level, between 8:30 and 5:00;
- Call the University Counseling Center at 257-8701; 2nd floor, Frazee Hall;
- Call Ms. Patty Bender from the UK Institutional Equity and Equal Opportunity at 257-8927 or patty.bender@uky.edu;
- In the case of an emergency, contact the UK Police Department at 911.
- Students may also contact community resources 24-hours a day, including:
  (a) Bluegrass Rape Crisis Center at 800.656.4673 or http://bluegrassrapecrisis.org/
  (b) Greenhouse17 (formerly Bluegrass Domestic Violence Program) at 800.544.2022 or http://greenhouse17.org/

Non-Discrimination Statement and Title IX Information: The University of Kentucky faculty are committed to supporting students and upholding the University's non-discrimination policy.

Discrimination is prohibited at UK. If you experience an incident of discrimination we encourage you to report it to Institutional Equity & Equal Opportunity (IEEO) Office, 13 Main Building, (859) 257-8927.

Acts of Sex- and Gender-Based Discrimination or Interpersonal Violence.
If you experience an incident of sex- or gender-based discrimination or interpersonal violence, we encourage you to report it. While you may talk to a faculty member or TA/RA/GA, understand that as a "Responsible Employee" of the University these individuals MUST report any acts of violence (including verbal bullying and sexual harassment) to the University's Title IX Coordinator in the IEEO Office. If you would like to speak with someone who may be able to afford you confidentiality, the Violence Intervention and Prevention (VIP) program (Frazee Hall - Lower Level; http://www.uky.edu/StudentAffairs/VIPCenter/), the Counseling Center (106 Frazee Hall, http://www.uky.edu/StudentAffairs/Counseling/), and the University Health Services (http://ukhealthcare.uky.edu/uhs/student-health/) are confidential resources on campus.

Academic Honesty: Cheating or plagiarism is a serious offense and will not be tolerated. It will be thoroughly investigated, and might lead to failure in the course or even to expulsion from the university. See http://www.uky.edu/StudentAffairs/Code/part2.html (Sections 6.3.1 and 6.3.2) for information on cheating, plagiarism, and penalties. A summary of recent changes to rules on cheating can be found at the Academic Ombud website: http://www.uky.edu/Ombud