Ordinary Differential Equations
MATH-UA 262 (section 3) — Spring 2019

Instructor: Shafer Smith, WWH 916, kss3@nyu.edu
Lectures: Monday & Wednesday 2:00-3:15pm in WWH 317
Office hours: Monday 3:30-4:30pm & Tuesday 4-5pm (or by appointment)
TA: Wenjun Zhao, wenjun.zhao@nyu.edu
Recitation: Friday 2:00-3:15pm in WWH 517
Textbook: Braun, *Differential Equations and their Applications*, 4th edition, Springer (1993)
        [**free!** https://link.springer.com/book/10.1007%2F978-1-4612-4360-1]

Description: Differential equations are the language in which most models of the physical world are expressed. They link calculus and linear algebra, and are a necessary prerequisite to understand partial differential equations. In this course we'll cover elementary methods for solving the few types of linear first and second order equations that can be solved exactly; methods for proving existence and uniqueness of solutions; series solutions for equations with singular points; systems of linear equations; nonlinear dynamical systems and phase plane analysis; boundary value problems; Green's functions and Fourier series. Examples and connections to real-world models will be pointed out along the way.

References

- Boyce & DiPrima: *Elementary Differential Equations and Boundary Value Problems,* Wiley
- Strogatz: *Nonlinear Dynamics and Chaos,* Addison-Wesley

Assessment

[30%] Weekly homework, due Wednesdays at the beginning of class (lowest score dropped)
[20%] Midterm exams (2)
[30%] Final exam

Conduct, attendance, lateness

- I aim for an environment of mutual respect, as adults in a professional relationship. I am sympathetic to the issues you may face, as students and young adults, and I can be flexible when appropriate. But I do not react well to entitlement, manipulation or dishonesty.
- "Can I reschedule my exam?" Only in the case of medical emergencies
- "Will you accept late homework?" You have a 24 hour grace period, following the due date. After that, it won't be accepted. Lowest score is dropped to account for issues. **Never place homework in my mailbox — it must be brought to my office.**
- "Is attendance required?" No, but I make an effort to learn student's names and faces, and after a few weeks I will know who's coming and who's not. Good faith efforts to attend lectures and learn the material will garner my sympathy and extra time. Failing to attend lectures will result in an extreme lack of sympathy in the case of difficulties with homework or exams.

Schedule

Week	Dates	Topic	Reading (Braun)
1	Jan 28, 30	Introduction, classification of ODEs. First-order linear equations. Separation of variables. Autonomous equations, logistic model.	1.1, 1.2, 1.4, 1.5
2	Feb 4, 6	Exact equations. Existence of solutions.	1.9, 1.10
3	Feb 11, 13	Uniqueness of solutions. Numerical solutions (Euler and Runge-Kutta)	1.10, 1.13, 1.16
4	Feb 20 (Pres day)	Second order linear equations — general solution	2.1
5	Feb 25, 27	Second order linear equations with constant coefficients, homogeneous and inhomogeneous. Damped oscillator and resonance.	2.2, 2.3, 2.5, 2.6
6	Mar 4, 6	Second order linear equations with *non*constant coefficients. Variation of parameters. Series solutions	2.4, 2.5, 2.8
7	Mar 11, 13	Singular points, method of Froebenius, special functions. Discussion of what we won't do (Laplace, etc.)	2.8 + other reading
8		Spring break	
9	Mar 25, 27	Systems of linear equations (linear algebra review). Eigenvector methods.	3.1, 3.8
10	Apr 1, 3	Systems continued. Complex roots, equal roots. Fundamental solution. Matrix exponentiation. Mention inhomogeneous problem	3.9-12
11	Apr 8, 10	Nonlinear autonomous equations. Fixed points and linearization. Stability of linear systems.	4.1, 4.2
12	Apr 15, 17	Stability of equilibrium solutions. Phase plane analysis. Predator-prey and SIR models	4.3-7, 4.10, 4.12
13	Apr 22, 24	Boundary value problems, simple Sturm-Liouville.	5.1, 6.3, 6.4
14	Apr 29, May 1	Heat equation and Fourier series	5.2-6
15	May 6, 8	Dirac delta-functions and Green's functions	2.12-13
16	May 13	Review	