Class schedule: Math 4500, Spring 2025

- **Week 1: 1/8–1/10**. No in-person class. Watch the YouTube videos.
  Summary & key ideas. We introduced a variety of simple models from the sciences, with a focus on exponential growth and decay. Then we modified them to get more complicated models such as the logistic model and falling objects with air resistance.

  To do: Read over the hand-written notes and formulate any questions you may have.

- **Week 2: 1/13–1/17**. Difference equations, the logistic model, and chaos. We learned about cobwebbing. We used Matlab to explore the logistic model $\Delta x = r(1-x)$ for various values of r, and saw overdamped and underdamped fixed points, 2-cycles, 4-cycles, 8-cycles, chaos, and even a 3-cycle. We watched a short video connecting bifurication diagrams with the Mandlebrot set. We saw how to linearize a difference equation like the logistic map, and we used to this show that $x = 0$ is an unstable fixed point, whereas $x = 1$ is a stable fixed point.

  To do: Read over the notes and formulate any questions you may have. Look at the website for the Mathematical Contest for Modeling (MCM).

- **Week 3: 1/20–1/24**. We spent some time going over HW 1, which is due Friday. We discussesd modifying Newton's law of cooling to incorporate non-constant ambient temperatures. Then, we moved to linear models of structured populations. We also talked about Lotka-Volterra population models.

  To do: Work on HW 1, due this Friday, Jan 24.

- **Week 4: 1/27–1/31**. We discussed several Lotka-Volterra population models: competing species, and then predator-prey. For both, we found the fixed points, linearized them and analyzed the stability, and sketched phase portraits.

  To do: Work on HW 2 (difference equations, the logist map, population models, and linearization), due next Tuesday.

- **Week 5: 2/5–2/9**. We discussed HW 2 in class. We continued with the predator-prey models, but this time when the prey grows logistically instead of exponentially. We moved onto epidemic models, starting with the SIR model, and introduced the *basic reproductive number*, R_0.

To do: Work on HW 3 (models of structured populations), due next Tuesday, Feb 11. Listen to the RadioLab Patient Zero podcast episode (optional, but fun!).

- **Week 6: 2/10–2/14**. We discussed HW 3 in class. We contined with the SIR model, but incorporating births and deaths. This allows for an *endemic equilibirium*. We analyzed this using the Jacobian matrix, and finding the eigenvalues. We also looked at a number of other disease models, such as the SI, SIS, SIRS, and SEIR model, and how to incorporate infection-induced mortality. We discussed the relationship between R_0 and the average age of infection, which is how R_0 is often estimated.

  To do: Work on HW 4 (models of interacting populations), due next Wednesday.

- **Week 6: 2/17–2/21**. Tuesday: briefly discussed HW 4, and then proposing a COVID model as a class activity. Thursday: modeling biochemical reaction networks.

  To do: Work on HW 5 (infectious disease modeling), due next Wednesday.

- **Week 8: 2/24–2/28**. Tuesday: gene regulation by operons. Thursday: discussion of HW 5 (epidemology), and delay differential equation (DDE) models of gene regulation. We also discussed bistability and hysteresis [Pages 1–8 of the slides].

  To do: Finish HW 5 (infectious disease modeling), extended to Friday.

- **Week 9: 3/7–3/11**. We modeled the *lac* operon with delay differential equations (DDEs), analyzed the fixed point, and showed how it exibited bistability. We discussed a few other operons and showed examples of existing models. We finished on Thursday with a brief overview to Boolean logical and Boolean modeling.

  To do: Finish HW 6 (chemical reaction networks)

- **Week 10: 3/14–3/18**. We proposed several small Boolean models of the *lac* operon, and showed how to use Cyclone and BoolNet in R to analyze their dynamics. We introduced elementary cellular automata, John Conway's *Game of Life*, and agent-based models using NetLogo.

  To do: Enjoy your Spring Break!

- **SPRING BREAK: 3/21–3/25**.

- **Week 11: 3/24–3/28**. Two lectures on Boolean models of the *lac* operon, covering *Advanced features Boolean models* (pp. 1-7).

- **Week 12: 3/31–4/4**. Midterm 1 Tuesday. On Thursday, We finished the *Advanced features of Boolean models* slides, pp. 7-26. HW 7 due Tuesday.

- **Week 13: 4/7–4/11**. Tuesday: we covered the slides on *Reduction of Boolean models*, pp. 1-12. Thursday, I'll be at Georgia Tech, and we'll have an asynchronous class.