MATH-UA.0251 Intro Math Modeling, Spring 2022

Consider this syllabus as a living document and subject to change. Any significant changes will be announced.

INSTRUCTOR

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TEACHING ASSISTANT

Yuan Chen
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CLASS SESSIONS

(in-person) Mondays & Wednesdays 9:30–10:45 AM, SILV 208

RECITATIONS

(in-person) Sec. 002: Fridays 9:30–10:45AM, CIWW 202
(in-person) Sec. 003: Fridays 11:00–12:15PM, 194M 206

DESCRIPTION

In this course, we mathematically model and analyze a variety of physical systems. The tools include calculus, algebra, probability, ordinary and partial differential equations, numerical analysis, and stochastic processes. Whenever needed, we use python for coding.

RESOURCES

Brightspace

Brightspace is the main course site. It includes the syllabus, class notes, python codes, homework assignments and solutions, projects, announcements, etc. Class notes and python codes will be available via Brightspace prior to class sessions. See NYU Brightspace.

Discussion Forum

I have activated a Discussion Forum on Brightspace with topics *Questions regarding HW assignments*, *Questions regarding project*, and *General questions*. Anonymous posting is enabled. I will be notified of any posting, and will reply there as soon as I can. Please feel free to answer questions for your classmates and get involved in discussions.

Recommended Textbooks

- *Nonlinear Dynamics & Chaos*
  Steven H. Strogatz
- *Transport Phenomena*
  R. Byron Bird, Warren E. Stewart, and Edwin N. Lightfoot

- *An Introduction to Mechanics*
  Daniel Kleppner and Robert Kolenkow
- *Fundamentals of Fluid Mechanics*
  Bruce R. Munson, Donald F. Young, and Theodore H. Okiishi
- *An Introduction to the Numerical Simulation of Stochastic Differential Equations*
  Desmond J. Higham and Peter E. Kloeden

ASSESSMENT CRITERIA

Homework: %60

Homework assignments will be posted weekly each Friday (starting from 01/28/22) at 11:59 PM, and are due to the next Friday at 11:59 PM. 1–2 lowest homework scores will be dropped. Please carefully consider the following **rules**:
Submission: Homework assignments are handled through the Brightspace. For each assignment, upload *one* single pdf file that contains the detail of your work. If applicable, upload your code as well. Incomplete submissions will **NOT** be graded. No late submissions will be accepted. Do not wait until the last minute to upload your solutions; the internet can be unreliable. Do not email your solutions directly to the instructor or the TA. Submit your work electronically to Brightspace only.
Format: Assignments must be neatly written or typed, using words, along with equations, to clearly explain your reasoning. Provide enough information that a reader can understand and replicate your work. We have limited resources. So, make sure that your code runs properly and uses common python packages only. We cannot debug your codes, but will review it. Insert comments in your code.

Project: %40

You will choose from a short list of modeling projects, in which you will mathematically model, simulate, and analyze a real-world problem. The outcome of the project will be a short technical paper. A detailed description of the projects, format of the technical paper, and important deadlines will be provided later.

- **Projects released**: Friday, February 18, 11:59 PM
- **Stage 1 (%5)**: Preliminary report/codes I due Friday, March 18, 11:59 PM
- **Stage 2 (%5)**: Preliminary report/codes II due Friday, April 15, 11:59 PM
- **Stage 3 (%30)**: Finalized report/codes due Final exam date (TBA)

MISCELLANEOUS

Punctuality
Please do not be late for the class. I really appreciate punctuality. I expect to start the class sessions on time and with no interruptions.

Honor Code
We value integrity and do not tolerate academic dishonesty. You are expected to uphold academic integrity as specified by the university. No cheating! Cheating includes, but is not limited to, copying the work of your classmates, or turning in work found on the web or elsewhere. Please consult the STATEMENT ON ACADEMIC INTEGRITY for the NYU College of Arts and Sciences. Honor code violations will be reported to the students Dean and will result in an F for the class and a potential expulsion from the program/university.

TENTATIVE SCHEDULE

Week	Topics
1 (01/24)	Dimensional Analysis, Buckingham π Theorem, Coordinate Systems
2 (01/31)	Differential Form of Transport Equations
3 (02/07)	Modeling of Transport Equations
4 (02/14)	Solution to the Diffusion/Heat/Wave Equations
5 (02/21)	Introduction to Numerical Solutions
6 (02/28)	One-Dimensional Flows, Fixed Points, Stability, Potentials, Bifurcations
7 (03/07)	Two-Dimensional Flows, Phase Plane, Limit Cycles
8 (03/14)	Chaos, Population of Rabbits, Lorenz Map
9 (03/21)	Perturbation Solution
10 (03/28)	Solid-Solid Friction, Mass Spring, Pendulum
11 (04/04)	No Classes (Spring Break)
12 (04/11)	Three-Body Problem
13 (04/18)	Stefan Problem
14 (04/25)	Double Pendulum
15 (05/02)	Brownian Motion