

COURSE INFORMATION

Instructor: Dr. Peter Howard

Office: BLOC 625B

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Course Time: MWF 3:00 p.m. – 3:50 p.m.

Course Location: BLOC 160

Office Hours: MW 1:00 p.m. – 2:00 p.m.; R 2:00 p.m. – 3:00 p.m.

Course webpage: <http://www.math.tamu.edu/~phoward/M647.html>

COURSE CATALOG DESCRIPTION

The process and techniques of mathematical modeling; covers a variety of application areas and models such as ordinary and partial differential equations, stochastic models, discrete models and problems involving optimization.

PREREQUISITES

The prerequisites for this course are introductory undergraduate courses in linear algebra and ordinary differential equations. The course catalog lists M442 (undergraduate modeling), but that's not assumed. Students unfamiliar with MATLAB will be expected to learn its basic elements very quickly.

COURSE GOAL

The primary goal of the course is to introduce students to techniques useful in the development of mathematical descriptions of physical events and processes. The main topics will be linear and nonlinear regression; dimensional analysis and non-dimensionalization; modeling with ordinary differential equations, parameter estimation with ODE models, and modeling with partial differential equations. We will carry out numerical calculations with MATLAB.

COURSE LEARNING OUTCOMES

Upon successful completion of this course, students will be able to: articulate the major steps associated with using mathematics to model physical events and processes; implement mathematical models in MATLAB; recognize applications for which linear or nonlinear regression is appropriate, and in such cases apply these methods effectively; recognize applications for which dimensional analysis is appropriate, and in such cases apply this method effectively; model dynamical processes with ordinary differential equations; estimate parameter values for ODE models; model static and dynamic continuum processes with partial differential equations.

REQUIRED MATERIALS

TEXTBOOK: No textbook is required for the course. Some course materials will be provided through the course web site.

TECHNOLOGY: Students will need to obtain a (free) copy of MATLAB through the University. For information about obtaining MATLAB, see the document *Accessing MATLAB at Texas A&M University*, available on the course web site.

GRADING

HOMEWORK: Homework assignments will be made on most Fridays, due the following Friday. Work will be accepted up to a week late, though five points will be deducted for each class period by which the assignment is late. (A typical assignment will be worth 40 points.) Homework will be posted through Canvas, and can be submitted either in Canvas or in person.

EXAMS: There will be two exams during the semester, a midterm and a final. The midterm will be an evening exam, Thursday March 9, 7:00 p.m. – 9:00 p.m. According to the University schedule, the final exam will be Monday, May 8, 10:30 a.m. – 12:30 p.m.

GRADES: Final grades will be determined in the following manner: **homework assignments:** 50%; **midterm:** 25%; **final:** 25%. Standard grade ranges will be used: A: 89.5 – 100; B: 79.5 – 89.49; C: 69.5 – 79.49; D: 59.5 – 69.49; F: Below 59.5.

COURSE SCHEDULE

Week of Monday:	Material Covered
Jan. 16	General linear regression. (A&M classes start Tues., Jan. 17.)
Jan. 23	Regression for systems; nonlinear regression. (Mon., Jan. 23 last day for drop/add.)
Jan. 30	Nonlinear regression in neural networks and deep learning.
Feb. 6	Dimensional analysis: method and applications.
Feb. 13	Dimensional analysis: theory.
Feb. 20	Modeling with ODE: reaction kinetics; population dynamics.
Feb. 27	Modeling with ODE: mechanics (Newtonian, Lagrangian, Hamiltonian, Relativistic).
Mar. 6	Modeling with ODE: Hamiltonian systems. (Midterm exam, Thurs., Mar. 9, 7:00 p.m. – 9:00 p.m.)
Mar. 13	SPRING BREAK
Mar. 20	Modeling with PDE in time and one space dimension: conserved quantities; reaction-diffusion equations.
Mar. 27	Modeling with PDE in time and one space dimension: Newtonian mechanics revisited.

Apr. 3	Modeling with PDE in multiple space dimensions: conserved quantities; reaction-diffusion equations. (Fri., Apr. 7 is a reading day; classes don't meet.)
Apr. 10	Modeling with PDE in multiple space dimensions: Maxwell's equations.
Apr. 17	Modeling with PDE in multiple space dimensions: the Navier-Stokes equations I.
Apr. 24	Modeling with PDE in multiple space dimensions: the Navier-Stokes equations II.
May 1	Modeling with PDE in multiple space dimensions: phase-field models. (Tues., May 2 is the last day of spring semester classes; students attend Friday classes.)

UNIVERSITY POLICIES

COPYRIGHT: All printed handouts and web-materials are protected by US Copyright Laws. No multiple copies can be made without written permission by the instructor.

ATTENDANCE: The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments. Please refer to [Student Rule 7](#) in its entirety for information about excused absences, including definitions, and related documentation and timelines.

MAKEUP WORK: Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor. Please refer to [Student Rule 7](#) in its entirety for information about makeup work, including definitions, and related documentation and timelines. Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" ([Student Rule 7, Section 7.4.1](#)). "The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence" ([Student Rule 7, Section 7.4.2](#)). Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See [Student Rule 24](#).)

ACADEMIC INTEGRITY: Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case ([Section 20.1.2.3, Student Rule 20](#)). You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

"An Aggie does not lie, cheat or steal, or tolerate those who do."

AMERICANS WITH DISABILITIES ACT (ADA): Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

TITLE IX AND STATEMENT ON LIMITS TO CONFIDENTIALITY: Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking. With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see [University Rule 08.01.01.M1](#)):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, a person who is subjected to the alleged conduct will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need. Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with [Counseling and Psychological Services \(CAPS\)](#). Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University’s [Title IX webpage](#).

MENTAL HEALTH AND WELLNESS: Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in healthy self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.