MATHEMATICAL MODELING [MATH-636]

COURSE INFORMATION

Class Days: *Monday and Wednesday*	Office Hours Times (and by appointment):
Class Times: *2:00 – 3:15 pm*	*MoWe 12:45 – 1:45 pm or by appointment*
Class Location: GMCS 405	Office Hours Location: GMCS 579 or by appointment

FACULTY/INSTRUCTOR INFORMATION

Dr. Naveen K. Vaidya, Professor, Department of Mathematics and Statistics (SDSU-DiMoLab)
Office: GMCS 579
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        https://nvaidya.sdsu.edu/DiMoLab.html

COURSE OVERVIEW

- Course Description:
    - From the Official Course Catalog: *Advanced models from the physical, natural, and social sciences. Emphasis on classes of models and corresponding mathematical structures.*
    - This course covers techniques for developing a variety of mathematical models (ordinary differential equations, delay differential equations, partial differential equations, and stochastic differential equations) to address real-world problems in areas such as economics, engineering, biology, and physics. We emphasize qualitative (analytical) and quantitative (numerical) methods for analyzing these models. Interdisciplinary modeling projects are an integral part of this course.
- Student Learning Outcomes: Students will be able to
    - have a clear understanding of critical and creative modeling approaches.
    - acquire numerical and analytical techniques required for model analysis.
    - construct a meaningful model related to a real-world project.
    - analyze the derived model and draw conclusions based on the outcome analysis.
    - validate the model predictions with the experimental data (if available).
- Students will develop knowledge on how mathematical modeling can be used to study diversity, equity, and inclusions in various real-life situations.
- Real Life Relevance: Computational and theoretical techniques learnt in this class have direct applications to many real-life problems in the physical, natural, and social sciences.

ENROLLMENT INFORMATION

- Prerequisites: *Mathematics 254 and 337 or Mathematics 342A and 342B or Aerospace Engineering 280 with grades of C (2.0) or better.*

COURSE MATERIALS

- Textbook: *Lecture notes – N. K. Vaidya*

- References:
  - Leah Edelstein-Keshet, *Mathematical Models in Biology,* SIAM Philadelphia, 2005
  - Nicholas F. Britton*, Essential Mathematical Biology*, Springer-Verlag London Limited, 2003.
  - Sandip Banerjee, *Mathematical Modeling: Models, Analysis and Applications*, Chapman and Hall/CRC, 2014
  - Richard Haberman, *Mathematical Models: Mechanical Vibrations, Population Dynamics, and Traffic Flow*, SIAM Classics in Applied Mathematics.
  - Linda J.S. Allen, *An Introduction to Stochastic Processes with Applications to Biology*, CRC Press, 2010.

COURSE STRUCTURE AND CONDUCT

- Style of the Course: Lecture, Lecture-Discussion, Group-Discussion, Research Activity
- Individual and Group Activities Required: Research Projects (Group Projects), Seminar Presentation
- Technology Utilized in the Course: Canvas and computational software (MATLAB, Python)

COURSE ASSESSMENT AND GRADING

Homework –	45%
Midterm –	15%
Literature review and report –	10%
Modeling Project –	30%
Total:	**100%**

The grading scale will be **no worse** than: A:90-100; A-: 88-90; B+: 86-88; B:80-86; B-: 78-80; C+: 76-78; C:70-76; C-: 65-70; D+:62-65; D: 58-62; D-: 55-58; F<55.

Projects: There will be group projects (Team of maximum 2-3 students). Details will be posted in the SDSU Canvas. In summary, students will identify real-world problems and will develop mathematical models to address those issues. Students will analyze and simulate the models using various techniques learnt in the class. Students will present the results to other groups and submit the final report. I will be acting as mentor throughout your project activities and group discussion. The project will be evaluated based on the following components:

Project proposal:	5% (Presentation and 1 page proposal, September 18, 2024)
Proposal review:	3% (Online submission: October 02, 2024)
Final presentation:	5% (December 09 and 11, 2024, Survey for individual contribution)
Project Report:	17% (December 13, 2024)
Total:	**30%**

Literature review and report: Students will conduct literature survey on the topics of the project they have chosen and prepare a report. The deadline of the report submission is October 30, 2020. The details will be posted on the SDSU Canvas.

Homework Policy: Students will be given opportunity to re-submit the homework to obtain half of the deducted marks. Late homework will not be accepted. However, because of resubmission policy, students can receive half of the marks.

Missed Midterms: No make-up midterms will be given. If valid medical or supporting documents are provided, marks of missed midterms will be accumulated towards the final presentation and report.

Class Attendance: The students are required to attend all the classes. Daily attendance will be recorded. Students attending regularly will receive up to 2% bonus marks.

Important Dates:
- Proposal due and presentation: September 18, 2024
- Proposal review due: October 02, 2024
- Midterm: October 21, 2024
- Literature review and report due: October 30, 2024
- Final Presentation: December 09 and 11, 2024
- Project report due: December 13, 2024

TECHNICAL SUPPORT FOR CANVAS

Student support for Canvas is provided by the Library Computing Hub, located on the 2nd floor of Love Library. They can be reached at 619-594-3189 or hub@sdsu.edu or via online chat at https://library.sdsu.edu/computers-technology#libchat_hub

We will use the Canvas Inbox and Announcements throughout the semester. Please be sure to check these at least a few times per week and consider leaving Canvas email notifications "on" for these tools.

COURSE SCHEDULE

TABLE 1 – TENTATIVE COURSE SCHEDULE

Chapter	Potential Topics	Discussion Week
1. Modeling - Basics	o Introduction o Classification and Purpose o Formulation and Validation o Procedure of modeling o Basics of qualitative and quantitative analysis o Non-depersonalization o Asymptotic	Week 1-3
2. Modeling with Ordinary Differential Equations	o Initial Value Problems o Parameters and data fitting o Boundary Value Problems o Patchy models	Week 4-6
3. Modeling with Delay Differential Equations	o Formulation o Analysis o Numerical solutions	Week 7-9
4. Modeling with Partial Differential Equations	o Formulations o Analysis o Numerical Solutions	Week 10-12
5. Modeling with Stochastic Differential Equations	o Stochastic processes o Gillespie algorithm o Markov chain o Diffusion processes and SDE	Week 13-15

INTERACTING WITH ME

I'll try to respond within 24-48 hours to emails sent me from within Canvas. For quick questions, the turnaround time may be much shorter. (If Canvas is not working or for non-course-related communications, write to me using my email address: nvaidya@sdsu.edu.)

My regular office hours are MoWe 12:45-1:45pm Pacific Time.

UNIVERSITY POLICIES

Accommodations: If you are a student with a disability and are in need of accommodations for this class, please contact Student Ability Success Center at (619) 594-6473 as soon as possible. Please know accommodations are not retroactive, and I cannot provide accommodations based upon disability until I have received an accommodation letter from Student Ability Success Center.

Student Privacy and Intellectual Property: The Family Educational Rights and Privacy Act (FERPA) mandates the protection of student information, including contact information, grades, and graded assignments. I will not post grades or leave graded assignments in public places. Students will be notified at the time of an assignment if copies of student work will be retained beyond the end of the semester or used as examples for future students or the wider public. Students maintain intellectual property rights to work products they create as part of this course unless they are formally notified otherwise.

Religious observances: According to the University Policy File, students should notify the instructors of affected courses of planned absences for religious observances by the end of the second week of classes.

Medical-related absences: Students are instructed to contact their professor/instructor/coach in the event they need to miss class, etc. due to an illness, injury or emergency. All decisions about the impact of an absence, as well as any arrangements for making up work, rest with the instructors. Student Health Services (SHS) does not provide medical excuses for short-term absences due to illness or injury. When a medical-related absence persists beyond five days, SHS will work with students to provide appropriate documentation. When a student is hospitalized or has a serious, ongoing illness or injury, SHS will, at the student's request and with the student's consent, communicate with the student's instructors via the Vice President for Student Affairs and may communicate with the student's Assistant Dean and/or the Student Ability Success Center.

SDSU Economic Crisis Response Team: If you or a friend are experiencing food or housing insecurity, or any unforeseen financial crisis, visit sdsu.edu/ecrt, email ecrt@sdsu.edu, or walk-in to Well-being & Health Promotion on the 3rd floor of Calpulli Center.

Resources for students: A complete list of all academic support services--including the Writing Center and Math Learning Center--is available on the Student Affairs' Academic Success website. Counseling and Psychological Services (619-594-5220) offers confidential counseling services by licensed therapists; you can Live Chat with a counselor at http://go.sdsu.edu/student_affairs/cps/therapist-consultation.aspx between 4:00pm and 10:00pm, or call San Diego Access and Crisis 24-hour Hotline at (888) 724-7240.

Academic Honesty: The University adheres to a strict policy prohibiting cheating and plagiarism. Examples of academic dishonesty include but are not limited to:
- copying, in part or in whole, from another's test or other examination;
- obtaining copies of a test, an examination, or other course material without the permission of the instructor;
- collaborating with another or others in work to be presented without the permission of the instructor;
- falsifying records, laboratory work, or other course data;
- submitting work previously presented in another course, if contrary to the rules of the course;
- altering or interfering with grading procedures;
- assisting another student in any of the above;
- using sources verbatim or paraphrasing without giving proper attribution (this can include phrases, sentences, paragraphs and/or pages of work);
- copying and pasting work from an online or offline source directly and calling it your own;
- using information you find from an online or offline source without giving the author credit;
- replacing words or phrases from another source and inserting your own words or phrases.

The California State University system requires instructors to report all instances of academic misconduct to the Center for Student Rights and Responsibilities. Academic dishonesty will result in disciplinary review by the University and may lead to probation, suspension, or expulsion. Instructors may also, at their discretion, penalize

student grades on any assignment or assessment discovered to have been produced in an academically dishonest manner.

Further on Cheating: There will be **absolute zero tolerance** towards cheating. All work that you complete in this class **should be your own and only your own**. This applies to ALL assignment types: homeworks, quizzes, lab reports, Mini-Exams, Final, etc. Any form of cheating will automatically result in an "F" for the **whole** course and direct disciplinary action with the Center for Students Rights and Responsibilities (which may include punitive sanctions such as probation, suspension, or even expulsion). Note that helping a fellow student during a test is cheating (both students involved will be given an "F"). Using any electronic device/software/website/etc during tests/exams is cheating. This statement is a reminder to uphold your obligation as a student at SDSU and to be honest in all work submitted for all your courses.

AI policy: Students should not use generative AI applications in this course except as approved by the instructor. Any use of generative AI outside of instructor-approved guidelines constitutes misuse. Misuse of generative AI is a violation of the course policy on academic honesty and will be reported to the Center for Student Rights and Responsibilities.

Posting course materials: Do **NOT** send or post online any course material (HomeWorks, quizzes, worksheets, tests, etc) without the prior consent of the instructor. Doing so will be treated as cheating and strict disciplinary action will be taken. This applies to uploading questions into Chegg (see point above about cheating and our partnership with Chegg).

Classroom Conduct Standards: SDSU students are expected to abide by the terms of the [Student Conduct Code](#) in classrooms and other instructional settings. Prohibited conduct includes:
- Willful, material and substantial disruption or obstruction of a University-related activity, or any on-campus activity.
- Participating in an activity that substantially and materially disrupts the normal operations of the University, or infringes on the rights of members of the University community.
- Unauthorized recording, dissemination, or publication (including on websites or social media) of lectures or other course materials.
- Conduct that threatens or endangers the health or safety of any person within or related to the University community, including
  1. physical abuse, threats, intimidation, or harassment.
  2. sexual misconduct.

Violation of these standards will result in referral to appropriate campus authorities.