EEE 300
Environmental and Ecological Systems Modeling
Spring 2026

INSTRUCTOR: Dr. Amisha D. Shah

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Office Hours: MWF (11:30 AM – 12:30 PM); other times by appt.

PEER TEACHING ASSISTANT:

Room for Office Hours:
E-mail:
Office Hours:

GRADER:

E-mail:

COURSE TIME AND LOCATION:

Class time: MWF 10:30 **–** 11:20 AM
Class location:

COURSE DESCRIPTION:

This course will serve as an introduction to computation methods using Matlab for describing physical, chemical, and microbiological processes that occur in natural and engineered systems (i.e. rivers, lakes, water treatment plants, indoor air environments). There will be a strong emphasis on understanding and conceptualizing important processes, data analysis, algorithm development, and competency in the use of Matlab programming tools to perform model simulations.

REQUIRED MATERIAL:

You will be required to bring your laptop to each class. The laptop must have the capacity to access Matlab software. Please use the **Purdue University Matlab Portal** to enable access and also gain access to other supplementary tools (e.g. online courses) that we will periodically use throughout the course. *For the Matlab software, you will need to download a version where you can install and have access to: (1) the curve fitting tool, (2) the symbolic toolbox, and (3) access the live editor to create live scripts.*

No textbook is required for this class. All relevant notes and handouts will be provided in class and posted on Brightspace. Please check Brightspace periodically (at least once a week). Additional information will also be provided through your *university e-mail account*. It is advised that you check this e-mail account frequently as well to receive important updates regarding this course.

REFERENCE MATERIALS:

The course will use the following textbooks as references:

1) **PRIMARY REFERENCE:** *Surface Water Quality Modeling,* by Steven C. Chapra, Waveland Press (ISBN: I-57766-605-4)

2) *Environmental Modeling: Fate and Transport of Pollutants in Water, Air, and Soil*, by Jerald L. Schnoor, John Wiley & Sons (ISBN: 0471124362)

3) *Chemical Reaction Engineering*, 3rd edition, by Octave Levenspiel (ISBN: 047125424X)

4) *Environmental Organic Chemistry*, 2nd edition, by Rene Schwarzenbach, Philip Gschwend, and Dieter Imboden (ISBN: 0471357502)

Please note that these textbooks *are not required*, and thus any material taken from them will be provided as class handouts.

COURSE PREREQUISITES:

The following courses are required as prerequisites for the class:

- A course on differential equations including **MA 26600** (Ordinary Differential Equations) or **MA 26200** (Linear Algebra and Ordinary Differential Equations).
- A course teaching the fundamentals of a computer programming language including **ENG 13200**, **ENG 13300**, **ENG 16200**, **CS 15900**, **CS 18000**, or **ENG 13000**.
- **CE/EEE 350** (Introduction to Environmental Engineering) be taken prior to this course where overlapping topics will be discussed (e.g. chemical reaction kinetics, mass balance equations, etc.).

LEARNING OUTCOMES:

After completing this course, students will have learned to:

- Formulate models to analyze the fate and transport of aqueous phase and air-borne contaminants in different reactor types that represent different types of engineered and natural environmental systems.
- Translate analytical and numerical models into common programming language, particularly used in Matlab.
- Integrate experimental data to model results, to enable model fitting of unknown constants.
- Correctly choose and apply models to specific cases studies pertinent to environmental engineers (e.g. chemical spills, specific treatment technologies, pollution in lakes and rivers)

SPECIFIC LEARNING OBJECTIVES:

After completing this course, students will have learned to:

- Formulate models to analyze the fate and transport of aqueous phase and air-borne contaminants in different reactor types that represent different types of engineered and natural environmental systems.

    - Create a schematic discussing how mass moves in an out of a system and identify the boundary conditions involved.
    - Define terms that represent this movement.
    - From this information, construct the fundamental mass balance equation for your environmental system, which should be represented by a differential equation.
    - Identify the type of differential equation it is and how it can be solved using your knowledge of calculus
    - Solve the differential equation to formulate a final equation as the solution, with a clear independent (x) and dependent (y) variable assigned
    - Determine how to modify this equation when the system changes and reevaluate how it can be solved based on this change. An environmental system can go from simple to complex, so we need to know how to make the changes appropriately! =)
- Translate analytical and numerical models into common programming language, particularly used in Matlab.
    - Generate code to define terms and variables in Matlab
    - Create "for" loops in Matlab
    - Create functions using a function handle, using a parent function, or generating a function file.
    - Upload data from excel using two major types of approaches.
    - Plot data in different types of figures (e.g. scatter plots, bar plots, line plots)
    - Use symbolic toolbox to solve for the analytical solution of an ordinary differential equation (ODE)
    - Integrate solution into additional code so that the analytical expression can be plotted as a function of some independent variable.
    - Derive a numerical solution for solving a differential equation using Euler's method. Translate that solution into a Matlab code where a "for" loop is used.
    - Use the embedded functions in Matlab (e.g. ode45) to solve for an ODE. Here the numerical model is embedded into the software so it does not need to be written by scratch.
    - Use the function tool to solve for multiple ODEs simultaneously with embedded functions.

- Integrate experimental data to model results, to enable model fitting of unknown constants.
    - Assign data to a type of model curve (e.g. linear, exponential, polynomial, and others)
    - If the model curve is not linear, derive a mathematical approach to modify the model curve so that it can become linear (not all equations can satisfy this)
    - Plot data in accordance to the linearized or non-linearized model such that a independent and dependent variable(s) are clearly identified.
    - Examine four different approaches in Matlab to fit a curve to experimental data (basic fitting on graph, cftool, polyfit(), and fit () function)
    - Identify which approach should be used for a specific model fitting.
    - Explain the output data generated from each approach.
    - Compare and contrast these approaches in terms of ease of use and robustness.
- Correctly choose and apply models to specific cases studies pertinent to environmental engineers (e.g. chemical spills, specific treatment technologies, pollution in lakes and rivers)
    - Identify an environmental engineering-related case study that uses core principles of mass transfer identical to or similar to those discussed in class

- Define the control volume and boundary conditions as it relates to the case study.
- Construct a list of model equations that will be used to characterize the mass transfer occurring within the system
- Write the code in matlab that will be used to solve these model equations over a set of boundary conditions. The equations can be solved analytically, numerically, or using both methods.
- Plot the model curves in one or multiple figures.
- Synthesize in words what the model results show about the mass transfer occurring within your system.
- Illustrate how changes to input variables will alter the output model results. Explain the impacts of the changes to the overall effects of mass transfer.

COURSE CONTENT

In addition, an outline of the course content and how long it will be discussed in class is described in the table below:

Week:	Content Covered:
1	Introduction, Panel Discussion, And Review Of Matlab Basics
2	Creating MAT Files And Plot Data (One Plot And Sub-Plots)
3	Import Data From Excel And Introducing Curve Fitting (Model Fit Data)
4	Curve Fitting
5	Curve Fitting
6	Mass Balance Equation And Batch Reactors
7	Batch Reactor Kinetics (Part 1): Contaminant Loss And By-Product Formation
8	Batch Reactor Kinetics (Part 2): Nutrient Loss And Microbial Growth (Monod Kinetics)
9	Numerical Modeling (Part 1): By Hand
10	Numerical Modeling (Part 2): Using Matlab (Create Loops And Use Imbedded Odes)
11	CSTR Reactor Kinetics (Part 1)
12	CSTR Reactor Kinetics (Part 2)
13	PFR Reactor Kinetics At Steady-State
14	PFR Reactor Kinetics: Biological Oxygen Demand (BOD) and Streeter-Phelps Eqn
15	PFR 2D and Working Days For Group Project

COURSE STRUCTURE

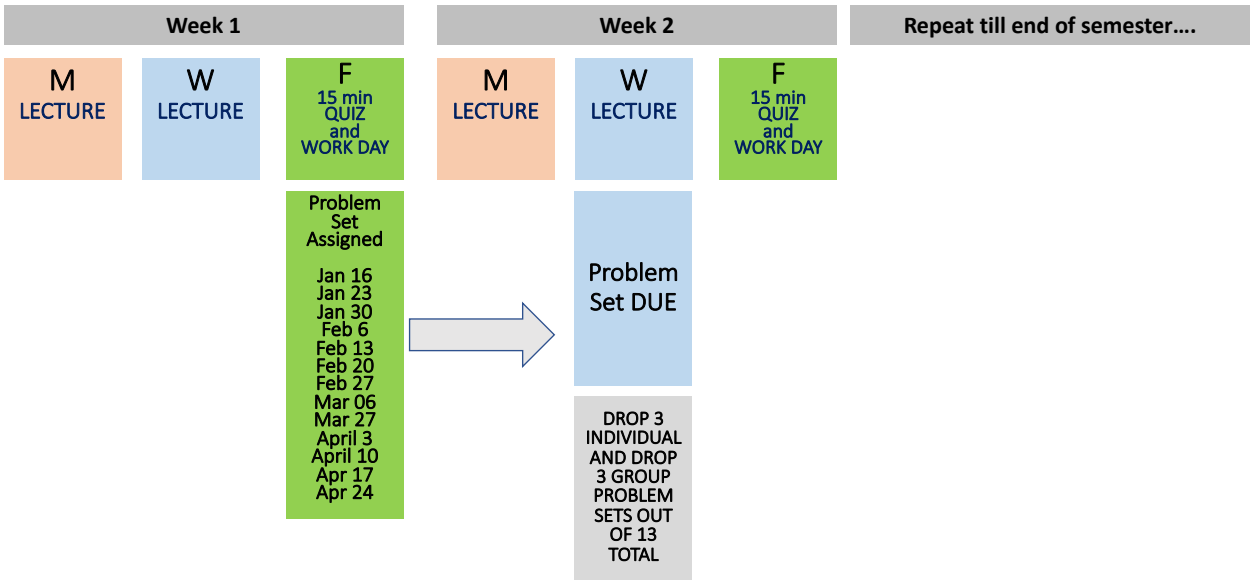
The course will be structured so that that the first two days of the week (MW) include lecture and in-class problems, whereas the third day (F) will be a work day where you will be introduced to and can work on the problem set that will be assigned on this day.

For the entirety of the semester, you will be placed in a group of four but will be specifically paired with one person in this pair. You will work within your pair for all in-class activities but will also turn in a portion of each assignment together. The groups of four will be rearranged midway through the semester but the pairs within them will be rearranged every 3-4 weeks.

For assignments, the course will be comprised of completing a small problem set each week and completing a group project during the second half of the semester. Therefore, you will be assigned **a total of 13 problem sets, but you may drop two of your lowest score problems sets such**

that they do not contribute to your final grade. The problem set will be assigned each Friday and will be due the following Wednesday. **All problem sets will be completed either individually or following a hybrid model where a portion will be completed individually and a portion completed as a pair.** The group project will be due on the final day of the class for the semester (May 01, 2026).

The schematic below provides a figurative summary of the class structure, assignments and due dates.



EVALUATION AND GRADING

Evaluation Item	Contribution to Final Grade (%)
Problem Sets (10 total)	50
Take Home Project	20
Quizzes (~10-11)	15
Participation	15

Problem Assignments: 13 total problem sets will be assigned during the semester. **The problem sets will be broken down into two parts, one part that is to be completed individually and one part that is to be completed together with your peer group (your peer group should only provide one submission). You may drop three of each part of the problem sets that are comprised of the lowest scores. The two parts of the problem sets do not need to be dropped simultaneously (i.e. within the same problem set).** All problem sets should be completed during the Friday workday or outside of the classroom. The problem set will be assigned each Friday and will be due the following Wednesday. Students are encouraged to work on these problem assignments in a collaborative setting, but **copying of each others problem assignments between pair groups is strictly prohibited.**

Quizzes: A small quiz will be given at the beginning of each Friday's class starting on Feb 12, 2026 and ending on May 01, 2026, subsequently totaling 11 small quizzes. The quizzes should be completed within a 15 min time block. The material covered in the quiz will primarily center on all material covered in the prior week and covered by the problem set due two days before; however, it may include prior material if it is needed to understand the material covered in the prior week. You may drop one of your lowest scoring quizzes.

Take Home Project: The take home project will be conducted as a group project where 4 to 5 students will be placed within each group. The project will involve students making a total of four videos (each video being ~ 10 min long) that represents a 4-session "online course". The students will develop videos to teach their fellow peers about one important environmental issue and integrate at least two "learning objectives (see above)" from the class that will need to be "taught" to their peers within the online course.

Participation: This portion of the grade will evaluated by your attendance in class, which is required. **You must attend class for the entirety of the semester (excluding the first day of class) but may miss/drop FOUR (4) classes with no consequences to your overall grade.** It is assumed that you will used these missed classes for any discretionary reason but that will include sick days (minor sickness; not including hospitalization) and professional development activities (e.g. internship interviews, taking the FE exam, etc.). Class attendance will be assessed by signing an attendance sheet that Prof. Shah will have nearby.

AI Policy for Assignments: Each assignment should be constructed using your own thoughts translated into written material. However, it is not possible to ignore that AI tools will play an important part in your professional development moving forward. They along with any other material can help assist in accelerating your learning and product development.

Therefore, you are welcome to use AI tools for all coding purposes and answering questions for any assignment given to you that is completed during or outside of class. However, I ask that you disclose when you have used AI, in what capacity, and for what specific actions. Please note that we have no way to check whether you are truthfully disclosing the use of AI (I don't have an AI to check the use of an AI in this context =)), so this is really based on the honor system and understanding the value of learning on your own.

However, if you use AI tools in your writing (e.g. a self-reflection of some reading assignment), you must acknowledge or disclose any material that has been assisted by using AI tools. You can disclose this information in a similar manner as you would for giving credit to any other author that you quote directly. If you do use content taken from AI tools, it is also recommended that you document this information separately on your computer, as we may ask you to provide this content later when grading.

Remember that plagiarism where you take words, ideas, and data from someone else without giving them credit, is strictly prohibited. In addition, it is required that you are able to claim intellectual authorship of your work, even if you incorporate AI tools. Therefore, think carefully about how you want to incorporate AI tools into your writing. If your voice is not seen, then the ultimate product is not yours.

To handle any issue of plagiarism in your writing, all assignments will be submitted in Brightspace, and we will use "Turnitin" software via Brightspace to check if any of the written material (related to self-reflections and NOT small answers to questions) is likely taken from ChatGPT or openAI applications. **If any material considered to be taken by AI tools is not correctly acknowledged and/or overwhelms the product such you can no longer claim intellectual**

authorship (> 50% of the final written assignment), you will receive no credit (= 0%) on the written portion of the assignment.

Re-grade Policy

If you believe a grading error has been made on an exam or an assignment, you must notify the instructor via email within 24 hours of receiving the grade. Within this e-mail, please explain why you have requested a re-grade for the assignment. Once the re-grade has been accepted, the instructor reserves the right to carefully re-grade the entire exam or assignment.

Late Policy

Problem assignments will be completed outside of class and will incur a **20% deduction for each business day (24 hrs) it is late**. If the assignment is submitted **more than three (3) business days (72 hrs)** after it is due, **it will not be accepted**. If you plan to submit the assignment after the deadline, please inform the instructor as soon as possible.

Final Course Grade

This class will be graded on a standad grading scale, as shown below. The grading will not be considerably curved in any way. This grading approach is aimed to deter students from competing with each other.

Letter Grade	Percentage Window (%)
A+	97-100
A	93-97
A-	90-93
B+	87-90
B	83-87
B-	80-83
C+	77-80
C	73-77
C-	70-73
D	60-70
F	<60

Attendance

You are expected to attend all lectures (MWF, 10:30 – 11:20 AM) except for four excused absenses that can be missed for any reason. **Unexcused absences from the lectures/lab sessions *will* result in a lower grade for the course.**

This course follows the University Academic Regulations regarding class attendance, which state that students are expected to be present for every meeting of the classes in which they are enrolled. Attendance will be taken at the beginning of each class and lateness will be noted. When conflicts or absences can be anticipated, such as for many University-sponsored activities and religious observations, you should inform me of the situation as far in advance as possible. For unanticipated or emergency absences when advance notification to is not possible, contact me

as soon as possible by Purdue email or phone. For absences that do not fall under excused absence regulations (see below), this course follows the following procedures:

1. Do not come to class if you are feeling ill but DO email me at adshah@purdue.edu, with the subject line: EEE 300 absence. I do not need details about your symptoms. Just let me know you are feeling ill and cannot come to class. If it is an emergency, please follow the University regulations on medical care (see below).
2. Unless it falls under the University excused absence regulations (see below), any work due should be submitted on time via our course Brightspace.
3. If that day's class involves assessed work such as a test or presentation, you and I will plan if and how you can make up the work, following the assignment guidelines. This plan must be done before the next class period, so again, email me immediately when you know that you will miss the class.
4. The most important consideration in any absence is how it will affect your achievement of the assignment objectives and the course learning outcomes.

For cases that fall under **excused absence regulations**, you or your representative should contact or go to the Office of the Dean of Students (ODOS) website to complete appropriate forms for instructor notification. Under academic regulations, excused absences may be granted by ODOS for cases of grief/bereavement, military service, jury duty, parenting leave, or certain types of medical care. The processes are detailed, so plan ahead.

OTHER IMPORTANT ITEMS

Classroom Guidance Regarding Protect Purdue

Any student who has substantial reason to believe that another person is threatening the safety of others by not complying with Protect Purdue protocols is encouraged to report the behavior to and discuss the next steps with their instructor. Students also have the option of reporting the behavior to the Office of the Student Rights and Responsibilities. See also Purdue University Bill of Student Rights and the Violent Behavior Policy under University Resources in Brightspace.

EXCUSED ABSENCES

Grief Absence Policy

If a student requires a time of bereavement, Purdue provides the following rights to students facing the loss of a family member through the Grief Absence Policy for Students (GAPS). The GAPS policy states that: students will be excused for funeral leave and given the opportunity to earn equivalent credit and to demonstrate evidence of meeting the learning outcomes for misses assignments or assessments in the event of the death of a member of the student's family. A student must formally submit this request for this bereavement leave through the Office of Students (https://www.purdue.edu/advocacy/students/absence-policies.html).

Other Excused Absences

If a student requires time for other excused reasons including military absence, jury duty, parenting leave, or for medical reasons, the student must for formally submit this request through the Office of Students (https://www.purdue.edu/advocacy/students/absence-policies.html).

Academic Integrity

Every assignment that you turn in under your own name must be completed by you personally. If you turn in homework copied from someone else or allow others to copy your work, this will be considered automatic grounds for failing the course. Therefore, it is of greatest importance that the academic integrity of each student be maintained in order to secure the value of their education and to secure the high quality of learning provided at Purdue. The instructor will take all measures necessary to prevent and report academic violations.

In general, Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, University Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972]

A student's guide for academic integrity is available at: http://www.purdue.edu/odos/aboutodos/academicintegrity.php

Copyrighted Material

Please note that all materials presented by the instructor are protected by copyright unless the instructor has stated otherwise. Copyrighted materials include lectures, notes, and other material presented in class or part of the course. Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally.

Notes taken in class are, however, generally considered to be "derivative works" of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course without the express written permission of the course instructor. To obtain permission to sell or barter notes, the individual wishing to sell or barter the notes must be registered in the course or must be an approved visitor to the class. Course instructors may choose to grant or not grant such permission at their own discretion, and may require a review of the notes prior to their being sold or bartered. If they do grant such permission, they may revoke it at any time, if they so choose.

Violent Behavior Policy

Purdue prohibits violent behavior and is committed to providing a safe and secure campus environment for its community members. Additional information regarding this policy can be found at: http://www.purdue.edu/policies/pages/facilities_lands/i_2_3.shtml

Students with Disabilities:

If you have a disability that requires special academic accommodation, please make an appointment to speak with me within the first three (3) weeks of the semester in order to discuss any adjustments. It is important that we talk about this at the beginning of the semester. It is the student's responsibility to notify the Disability Resource Center (http://www.purdue.edu/drc) of an impairment/condition that may require accommodations and/or classroom modifications.

Mental Health/Wellness Statement:

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try Therapy Assistance Online (TAO), a web and app-based mental health resource available courtesy of Purdue Counseling and Psychological Services (CAPS)**.** TAO is available to all students at any time by creating an account on the TAO Connect website, or downloading the app from the App Store or Google Play. It offers free, confidential well-being resources through a self-guided program informed by psychotherapy research and strategies that may aid in overcoming anxiety, depression and other concerns. It provides accessible and effective resources including short videos, brief exercises, and self-reflection tools.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 a.m.- 5 p.m.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc., sign up for free one-on-one virtual or in-person sessions in West Lafayette with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is free and can be done on BoilerConnect. Students in Indianapolis will find support services curated on the Vice Provost for Student Life website.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS offices in West Lafayette or Indianapolis.

Basic Needs Security:

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8 a.m.-5 p.m. Monday through Friday. Considering the significant disruptions caused by the current global crisis as it relates to COVID-19, students may submit requests for emergency assistance from the Critical Need Fund

Emergency Preparation:

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

Nondiscrimination Policy

The nondiscrimination policy for Purdue is as stated: Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University

believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life.

Purdue University prohibits discrimination against any member of the University community on the basis of race, religion, color, sex, age, national origin or ancestry, genetic information, marital status, parental status, sexual orientation, gender identity and expression, disability, or status as a veteran. The University will conduct its programs, services and activities consistent with applicable federal, state and local laws, regulations and orders and in conformance with the procedures and limitations as set forth in Executive Memorandum No. D-1, which provides specific contractual rights and remedies. Any student who believes they have been discriminated against may visit www.purdue.edu/report-hate to submit a complaint to the Office of Institutional Equity. Information may be reported anonymously.

Syllabus Changes

While the instructor will make every effort to adhere to the syllabus in its current form, specific items of this syllabus may change during the semester. All changes will be posted through Brightspace or will be reported to the student through their university e-mail account.