BMED 2110 – Conservation Principles in Biomedical Engineering
Fall 2026

Instructional team and their contact information:

Professors:

Dr. Borzin
maysam@bme.gatech.edu
Office Hours: Tuesdays, 3-4 pm; WLC

Head Teaching Assistant:

TBD (Canvas Website, Homework, PSS)
TBD (Demos, Quizzes, Exams, Project)

Teaching assistant (ordered based on first name):

Name:	Email	Office hours:
TBD		
TBD		
TBD		
TBD		
TBD		
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TBD		
TBD		
TBD		
TBD		

Note: "WLC" in the TA Office hours column refers to the "Whitaker Learning Commons"

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Class Structure and meeting times:

Final Exam: TBD. Location will be announced later.
Note: This time is not listed directly in the final exam matrix; but it has been reviewed and approved by the Registrar's Office. If you have another exam scheduled at the same time and date, you must reschedule the final exam for the course with the lower course code. It is the responsibility of each student to see that all possible conflicts are resolved by the instructor, and the proper authorization received no later than 2 weeks before the Monday of exam week. We will be able to accommodate your needs if you inform us in a timely manner. Conflict period is TBD.

Lectures (Demo): Asynchronous virtual, they must be watched before the assigned deadlines
The videos will be available in Canvas, and each video includes an assessment. You must watch the videos and complete the assessments by the assigned deadlines (Tuesdays at 8:00 AM). Each assessment can be attempted a maximum of three times. After the deadlines, the videos will remain accessible for viewing, but the assessments will no longer be available. Please note that these deadlines cannot be extended, as the videos must be completed before the studio sessions.

Problem-Solving Studios:

Section	**A01**	**A02**	**A03**
Instructor	Dr. Babensee	Dr. Leisen	Dr. Wang
When and where	8:10 – 10:05 am TR Whitaker 1214	10:20 am – 12:15 pm TR Whitaker 1214	12:30 – 2:25 pm TR Whitaker 1214
In-class TAs			
Out of class TAs			

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Technology and platforms:
The use of following technologies and platforms are **required** during our class:
Canvas: We will use canvas for official announcements, direct communication, sharing assignment files, quiz files, test files, sharing supplementary materials, posting and submission of all graded assignments, grade reporting, and sharing of links to instructional videos. Please make sure you check the Canvas website and familiarize yourself with all its features.

Point Solutions (Turning point): You are expected to participate in class activities. Often this will include participating in a "Turning Point" quiz or survey. You can access Point Solutions both from your canvas website and the application. You should create an account or activate your existing account in this application, before the first day of classes. When the instructors ask you to participate in a class activity, you should enter the session code in your application, and then participate in the class activities. Please contact the in-class TAs if you have faced any error while you are dealing with the Turning point.

Generative AI: Generative AI is a valuable educational tool that may be used to enhance understanding of course topics, conduct searches, and check grammar and spelling. However, all submitted work must be your own, must follow institutional guidelines, and may not be plagiarized; you are solely responsible for the accuracy and correctness of all content you submit and may not rely on the work of others or on technology to replace your own original effort.

References and prerequisites:

Textbooks:

Required:	Bioengineering Fundamentals, Saterbak, McIntire, and San, Pearson Prentice Hall (2018), **2nd Edition**
Reference:	Basic Principles and Calculations in Chemical Engineering, 8th Edition, D.M. Himmelblau and James B. Riggs, Prentice-Hall (2012) (on reserve at the library)
Prereqs:	(MATH 1501 Minimum Grade of D or MATH 1511 Minimum Grade of D or MATH 1522 Minimum Grade of D) and (CHEM 1211K Minimum Grade of D or Undergraduate Semester level CHEM 1310 Minimum Grade of D)

Course Description:
Engineers seek to create value for others. They do so by finding opportunities, experimenting, mathematical modeling, and prototyping. Biomedical engineers use well-established engineering design practices to create new processes and products that are intended to improve the health and well-being of people. Engineering is an important endeavor since it is almost always done by teams who seek to help people. Because of this, there is a demand for biomedical engineers who are competent in the physical and life sciences who have an entrepreneurial mindset for using their technical skills in combination to create value for others.

The primary purpose of this course is to develop your skill in using mathematical models as a part of the engineering design process. Mathematical modeling (sometimes called "model-based reasoning"), just like all other aspects of engineering design, is typically conducted collectively with others and in the service of creating value for others. It requires one to be able to work well with others to use modeling to better understand complex systems. And it is subject to human error. We hope this course will foster your interest and abilities for collaboratively building and using mathematical models in the service of engineering design.

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Course learning outcomes:
A year after this course is over you will:

1. Be skilled in several model-based reasoning practices including being able to:
    a. Convert quantities from one set of units to another quickly and accurately
    b. Calculate and estimate system and material properties such as fluid density, flow rate, chemical composition variables (mass and mole fractions, concentrations), fluid pressure, temperature, enthalpy, work, and heat capacity
    c. Construct a diagrammatic representation of complex systems
    d. Carry out a degree of freedom analysis
    e. Perform pressure-volume-temperature calculations for ideal gases
    f. Calculate internal energy and enthalpy changes for fluids undergoing changes in temperature, pressure, phase, and chemical composition
    g. Write and solve conservation equations for single-unit and multi-unit processes, processes with recycle and bypass, and reactive processes
2. Be able to critique, compare, contrast, and use mathematical models in ways that support improving people's healthcare and well-being. For example, you will be able to:
    a. Look at diagrammatic or mathematical models and be able to connect the numbers, parameters, and relationships they depict to the real-world people (or biosystems) they seek to describe.
    b. To compare and contrast models to critique and evaluate their usefulness, including being able to identify shortcomings.
3. Become more aware of, and skilled at overcoming, the challenges of working with others to use model-based reasoning approaches to identify and solve complex biomedical engineering problems
    a. Evaluate and change the level of psychological safety in a team
    b. Prepare for difficult conversations and have such conversations with collaborators

This course's instructional practices
In this course we use instructional practices that help ensure everyone is interacting and feeling included. For example:

- We carry out a set of introductory activities in the first week to help build a sense of community while at the same time introduce key course concepts. In addition, we administer an in-class survey to learn more about students' preferred names and personal pronouns, interests, why they are taking the course, and what they expect to get out of the course.
- We use a straight grading scale so that students are not competing for a limited number of high grades and we assign weekly homework and quizzes so that each assignment is worth a relatively small fraction of the overall grade.
- We use an innovative learning environment called the problem-solving studio (PSS), first developed by our department. PSS is based on the finding that students learn most when they interact with each other, engaging in exploratory talk during which they share relevant knowledge, challenge ideas, evaluate evidence, consider options. PSS improves students' learning and preparedness for follow-on courses.
- We regularly ask you to share your feelings and ideas concerning the course via anonymous end-of-class surveys called critical incident questionnaires (aka CIQs). Your suggestions are encouraged and appreciated. Please let us know how we can improve the effectiveness of the course for you personally or for other students.

Course activities and philosophy
Mastering a new way of thinking requires deliberate practice. That is, to become an expert at something, you need to practice, practice, and practice. But for the practice to work it needs to be *deliberate.* This means it is not how much you practice, it is how you practice, that matters. In other words, the quality of

your practice time is important to your learning. Deliberate practice means you work to actively identify which concepts and skills you are least comfortable with and then focus your efforts on learning them.

Learning takes time and is hard work. We understand that and we're here to help. In this course you will almost certainly be asked to do and learn things that feel hard to master. That's normal. Everyone feels that way. Please, don't panic. Instead, ask for help. And engage in *deliberate* practice. And be optimistic. Being optimistic means being secure in the knowledge that if you carry out enough deliberate practice, you will, in time, become an expert at this stuff. We call these three qualities (deliberate practice, understanding that learning takes time, and optimism) *SCHOLARLY GRIT*. We're going to work together to develop our "scholarly grit".

Learning how to solve engineering problems requires deliberate practice using a logical problem-solving process. It also requires a willingness to deal with ambiguity and uncertainty. Billy Koen says that "the engineering method is the strategy for causing the best change in a poorly understood situation within the available resources". In other words, engineers have a "method" and a "strategy", and they are used to dealing with "poorly understood" situations under a lot of constraints. This is what you will begin to learn to do in BMED 2110.

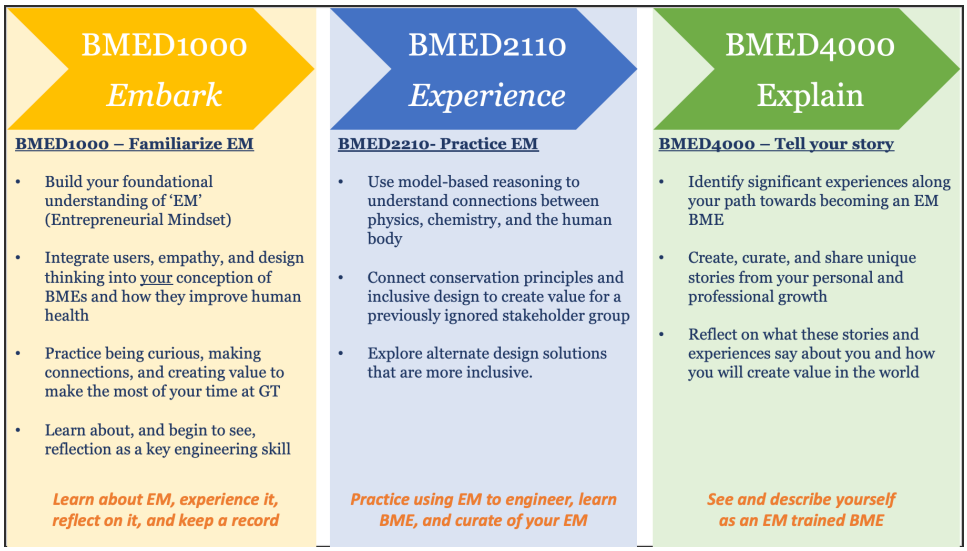
Entrepreneurial mindset (EM)

BME2110 is one of several courses in our curriculum that focus on developing students' **entrepreneurial mindset (EM).** When faculty in BME talk about 'EM' they don't just mean starting a company. Instead, when we talk about EM, we want students to develop several elements that we call the 3Cs:

- Be **Curious –** we want our graduates to understand the broader world, look towards the future, and explore multiple perspectives when solving problems.
- Make **Connections –** we want our graduates to think outside the box, put old ideas into new contexts, and connect information together in novel ways to generate insights.
- **Create value –** we want our graduates to seek out opportunities, understand the impact of their work on all stakeholders, and work in ways to maximize their impact on society

While this can happen in ANY course, this course is designed to create specific opportunities to develop your EM. You will likely find the 3Cs most obvious in the value sensitive design project.

You may also notice a focus on stories in these EM courses. Whether from the value sensitive design project or another experience you have in this class, I strongly encourage you to think about things that have a good story attached. Those stories are a way of helping you reflect on and communicate your own growth, and share what you can do with others. They are also useful as you look for your first job, prepare for grad school admissions, or take whatever your next step is. We have a class at the end of the BME curriculum, BMED 4000, where we help you develop those stories to make them impactful both on your sense of yourself and how others understand you. In the following figure you can see where our course stands in your journey in the BME program.



The Problem-Solving Studio

People learn best when they are actively engaged in applying new material together with other people, listening to and building on each other's ideas. To help this happen we have created a learning environment called the Problem-Solving Studio (or PSS for short). As a participant in PSS, you will spend most of your time in class working problems as part of a team of four. This is your "table group". You will have a partner that you will work most closely with as you solve problems, but you are encouraged to work with all the members of your table group as needed. From time-to-time we may ask you to hold focused discussions or carry out exercises with your partner or table group that are intended to help you get to know each other better, to help you work better together, and to build your interpersonal and small group engineering work skills.

The undergraduate teaching assistants and your professor will coach you, but they typically will not (except when demonstrating a problem for the entire class) work the problems for you. Solution keys will generally not be provided for problems worked during class, although the final numerical answers may be provided. We encourage you to ask your professor and the undergraduate teaching assistants questions that will help you progress through a problem. But before doing that, challenge yourself to see how much you can figure out with your partner and tablemates. You may be surprised by how much you can accomplish when you are open to each other's ideas and working to support each other's learning.

If you do feel stuck, that's normal. You can simply ask those questions from your professor or in class mentors.

Please remember to bring your textbook, calculator, and writing materials to every PSS session. It's tempting to start working the problem on your own notebook paper but please don't. It's much more beneficial to your learning if you work on the large paper pad with your partner. We want you to enjoy yourself in PSS but try not to get too caught up in prolonged conversations with your friends about topics that are not related to BMED 2110. We want you to take maximum advantage of your time with us in PSS. And in that spirit, If you finish a problem – ask for another. We have a bottomless cup of problems here in Café PSS.

As part of the PSS sessions, we will often use the Turning Point app to run survey or so-called "clicker questions". Your participation in these surveys is expected and will be used to determine your participation grade. If the instructors or TAs visit the table group and you are not there, you will not get participation credit

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for that PSS session, even if you did complete the Turning Point questions. If you can't make PSS for any reason, contact your instructor in advance or as soon as possible after you miss PSS to explain why.

Lectures Demo sessions
Every week one lecture video will be uploaded in Canvas site about the topic of that specific week. The videos will feature the instructor demonstrating how to solve problems. The main purpose of these sessions is to demonstrate the problem-solving approaches you will learn in that week's PSS sessions. All demo sessions end with a graded exercise that you will carry out on your own. The videos will be posted one week in advance to give students enough time to watch them as many times as they wish. All students are expected to watch the lectures and take the participation assessment before the assigned deadline.

Table groups
Your instructor will assign you to a team of three to four students to work with during PSS. Your responsibility as a member of your group is to 1) provide each other with support, encouragement, and assistance in completing assignments, 2) hold each other accountable for striving to learn, 3) ensure all members are making good progress. Generally new teams are established two times, once at the beginning of the semester and a second time a few weeks into the course.

Class expectations

The Student-Faculty Expectations Agreement is considered part of this syllabus. We reserve the right to include a question on the contents of this agreement as part of one or more quizzes or other graded assignments, so we strongly encourage you to read it: http://catalog.gatech.edu/rules/22/

Expectations for student work: This is a three-credit course. Accordingly, expect the average workload for this course to be about 6 to 9 hours per week outside of class. Spend this time working example problems from the text, reviewing your notes, working homework problems, discussing material with your colleagues, and thinking. Complete all of your assignments on time without referring to solutions prepared by someone else, and continuously self-evaluate your skills and proactively seek help.

Reading assignments and extra practice videos: Please, try to complete the reading assignments before PSS. This will help you get the maximum benefit of your time in PSS. Readiness pop quizzes on the readings may be given from time to time during a demo session or in PSS. Pop quizzes, if given, will be graded and become part of your overall participation grade. We have also prepared a number of extra videos that can help you better understand the material. Links to these videos can be found in Canvas.

Homework. All assignments should be submitted virtually (via Gradescope) before the deadlines indicated in Canvas. Problem sets will be assigned weekly, based on a combination of problems from the book and/or created by the professor or TAs. Typically, the homework assignment will be posted on CANVAS one week in advance of the due date and is due on Mondays at 8 pm. Solution sets will be posted shortly after the homework is due so late submission will not be accepted after that. Students may collaborate to help each other to understand the material, but each student is responsible for completing their own solutions for the homework. Please do not use another person's solutions to homework problems, or solutions that you may find on the internet or on campus. You will not learn that way. Turning in homework that you did not complete yourself is also a violation of the Honor Code.

Homework format. Use plain white paper, engineering paper, or a tablet (such as ipad). Write on only one side of each page. Begin each problem on a new page (unless the problems that are assigned are short answer, as often occurs early in the course). Use black ink (ball point) or medium-weight pencil. Don't crowd your work. The margin on the left side of the paper should be at least 1". Clearly mark the final

answers by boxing them. Staple the pages together (in case you were asked to submit a hard copy, for canvas submission this will not be required). At the top of the first page write your name, the problem set number and date, and the course number. **Scan and submit your assignment via assignment tab (Gradescope) which can be found both in modules section of Canvas and also in assignment section of canvas. You can also use your pen tablets and create the electronic version of your homework and save that as pdf.** Note: by writing your name on a solution set, you are certifying that you personally solved the problems. The purpose of these formatting standards is to help our homework graders do their jobs well. It is important that you follow them. Therefore, we will deduct a small number of points (see "Homework grading" section below) if your homework does not meet these standards.

Homework grading. We use Gradescope and Canvas Speed Grader to grade your work. The homework will be graded for solution correctness, completeness, and format as follows:

Format: 10% (e.g., if you don't scan your HW properly you will earn a 0 for 10% of your HW)
Completeness: 40% (did you do all of the assigned problems?)
Spot check: 50% (≥ 1 problems will be chosen at random and graded for correctness, if your submission does not include the spot check problem, you will miss the whole points for the spot check, also you don't get the complete points for completeness)

Attendance policy and Classroom etiquette. Participation in problem solving studios and watching the online lectures is required. This is contributing to the final grade under participation and assessment category. In class, you are expected to be fully engaged in the challenging job of learning the concepts and skills that are taught in this course. Unless you are sick or are dealing with a personal emergency, please arrive on time and stay in class until the end of the period. Please do not use your cell phone or laptop unless it is required for the work you are doing in PSS. Cell phones often prove to be a real distraction to students, and not just to the student who is using it. Using a cell phone can easily distract your partner and your tablemates from their work and it can suggest that you are not focused on the work that you are doing together. So please do not use them during class. We reserve the right to count you as absent use of electronic media, which is unrelated to the class content. This will affect your participation grade. The reason for these rules is that it is our experience that when someone is texting or otherwise distracted from the work at hand, they reduce the ability of their partner to learn and damage the feeling of productive engagement that usually characterizes PSS.

Academic integrity. Students are expected to abide by the Honor Code (http://honor.gatech.edu/). The objective of the honor code is "to prevent any students from gaining an unfair advantage over other students through academic misconduct". It is the instructor's understanding and expectation that the student's name when written on any assignment, quiz, or test signals that the student contributed to the assignment in question (if a group assignment) and that they neither gave nor received unauthorized aid (if an individual assignment). Unauthorized aid includes, for example, using someone else's solutions as your own or sharing information with another student during an exam without the instructor's permission. Examples of authorized aid – things that are perfectly fine to do and that we encourage – include working with others to discuss the interpretation of problem statements, share ideas or approaches for solving problems, and explain concepts. Please ask your instructor if you are not sure what is authorized or unauthorized aid. All cases of potential academic misconduct will be reported to the Dean of Students.

Examples of honor code violations:

- Using unauthorized notes or "cheat sheets" during an exam or quiz.
- Looking at another individual's quiz or exam while the test is in progress.
- Communicating electronically (e.g., texting or surfing the web) during any quiz or exam.

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- Uploading to, or using course material from, content sharing websites such as Course Hero or Chegg.
- Completing a problem (HW or any other kind of problem) using a solution key prepared by someone else, regardless of where the solution key is acquired: from the publisher's website, from the course's CANVAS website, from a previous student, from content sharing websites, or from a textbook. Homework should be your original work.

Academic accommodations. If you need teaching or learning accommodations, you must register with the Office of Disability Services (http://disabilityservices.gatech.edu/). According to their guidelines, you must make an appointment to talk with your professor one-on-one to alert us to your needs. We are very happy to make approved accommodations because we want every student to be successful in this course. If you have any questions, please contact the Office of Disability Services (disabilityservices.gatech.edu), 353 Ferst Drive, Suite 123, Smithgall Student Services Building, Atlanta, GA 30332-0285. Phone: 404-894-2563. Fax: 404-385-5429. Email: dsinfo@gatech.edu.

Office hours. It is important to us that you have a positive learning experience during this course. Your regular and active participation in office hours is a great way to help make sure this happens. Office hours are a scheduled opportunity for you to meet with your professor or teaching assistants one-on-one, or in a small group setting, to discuss course topics and concepts. In fact, feel free to chat with us about *anything* that interests you or concerns you. We want to help you have a good experience in this course and as a student at Tech – please give us the opportunity to do so by attending office hours.

Quizzes:
Quiz 1-8 : Weekly quizzes will be given throughout the semester on material covered in the most recent lectures, reading assignments, homework sets, and PSS sessions. The quizzes will start as soon as the Thursday/Friday problem solving session starts. You will have 30-45 minutes to complete the quiz. **Extra time will not be given to students who show up late** – so be on time! A missed quiz will be graded as a **zero** unless you have excused letter due to illness or a family emergency from dean of students living office or communicated that with your professor in a timely manner. No more than two make-up quizzes can be made each semester. Note: Dr's **appointment letter** is not an excuse letter, the excuse letter should have an specific date on it showing the period of time student is excused from class participation.

Tests. There will be two tests during the semester and a comprehensive final exam. Make-up exams will not be given unless you have approved excused absence by the dean of students living or the professor of your section. The final exam is mandatory. The final exam date and time are scheduled by the Registrars' office and cannot be changed. You may not request to take the final exam at an alternative time or date unless you have 3 final exams back-to-back.
***Good news:** if the grade on your final exam is higher than one of your mid-term exams; one of the mid-term exams will be substituted by the final exam's grade. The grade substitution cannot be applied to an unexcused absence in the mid-term exams.

Regrades. The number of points awarded for each part of an assignment is decided by the instructors. However, if you believe, using the grading rubric designed by the instructors, that you should have been awarded more points than you were, please submit a typed regrade request to the person who graded the assignment via Canvas within one week after receiving the graded assignment. Please do not discuss regrade requests orally with your TA or instructor. Instead, take the time to carefully compare your graded work to the published solutions and grading rubric. Then, if you find that mistake has been made and your overall grade is lower than it should be, please by all means write up your observations and submit the typed written request. Please know that ***whenever an assignment is regraded, the entire assignment is regraded.*** These processes are to help ensure the regrade process results in a fair grade.
NOTE: For HW, please submit regrades through Gradescope using their regrade button/function.

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Communication: All communication with students will be conducted through announcements in Canvas. If you need to contact the instructional team, you must use your GATECH email, as non-GT emails may be filtered by Outlook. When sending an email to the instructional team, include the course code "BMED 2110" and a brief description of your inquiry in the subject line. Please use professional and formal language in all correspondence with the instructional team. Address course instructors by their professional titles, such as Dr. or Prof. Our students are our top priority, and we strive to maintain clear and effective communication while fostering an environment of mutual respect.

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Grading policy and weighting. A weighted average grade will be calculated as follows:

Assignment	Weight toward final grade
Course project	7.5%
Quizzes (8 weekly quizzes)	30%
Homework	10%
Class participation and assessments	7.5%
Mid-term test (2 tests, each worth 15%)	30%
Final Exam	15%; cumulative; *could be worth 30%

The minimum grades that will be assigned for a given course average are:

>83%	A
>74%-83%	B
>65%-74%	C
60%-65%	D
<60%	F

Miscellaneous.

- Parental inquiries. Based on the Family Educational Rights and Privacy Act (FERPA) (http://www.ed.gov/policy/gen/guid/fpco/ferpa/index.html), the performance of students in class and their grades cannot be legally discussed with the parents of undergraduate students.
- Email etiquette. Please only use your official Georgia Tech e-mail account. To help ensure a speedy response to your email, please use a subject line with the below format: BMED2110- *your name - reason why you are writing*.
- If any class meetings conflict with a religious event, please let us know during the first week of classes
- We reserve the right to revise the course content and expectations (i.e. grading schemes, the amount of homework and examinations etc.) if deemed necessary due to the ongoing pandemic or other unforeseen circumstances.
- The grade drops cannot be applied to an unexcused absence or no submission grades.

Education research.

You may be asked to participate in educational research while enrolled in this course in the form of interviews, observations, questionnaires, or surveys, helping the BME department gain a deeper understanding of learning process within the classroom. Participation in this project in completely voluntary, anonymous, and has minimum to no risk. Participation in this research will not affect your grade in any way, and you may withdraw from the research at any point. If you agree to participate, you will need to read, sign, and return a consent form to the research scientist conducting the study. The research scientist will introduce the project and share a printed consent form with you during a demo or PSS session early in the course. The consent form will also be posted on Canvas.

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