ChE 103a: Transport Phenomena
Fall 2019

Course Details

Class Schedule:	Monday, Wednesday, Friday 10:00 AM
Classroom:	106 Spalding
Recitations:	TBD, Location: 106 Spalding

Instructor:	Julie Kornfield
Office:	231 Spalding
Contact:	jak@cheme.caltech.edu (cc TAs); ext. 4138

TA Information

Graduate TA:	Jin Mo Koo	Graduate TA:	TBD
Contact:	jkoo@caltech.edu	Contact:	TBD
Office:	120 Schlinger	Office:	TBD
Office Hours:	TBD	Office Hours:	TBD

Undergraduate TA:	Gianmarco G. Terrones
Contact:	gterrone@caltech.edu
Office Hours:	TBD

Please begin every e-mail with "ChE103" in the subject line

To help us scan for messages regarding this class, begin the subject line with "ChE 103a" ***every time.***

Textbooks

Required Text: Transport Phenomena – 1st or 2nd Edition
Bird, R. Byron; Stewart, Warren E. and Lightfoot, Edwin N.
ISBN13: 978-0471410775
ISBN10: 0471410772
*Note: same text will be used for 103a, 103b and 103c

Syllabus:

Week 01 (10/01 – 10/05):	Mechanisms of Energy Transport; Dimensional Analysis
Week 02 (10/08 – 10/12):	Alternate Derivations of Heat Equation: Molecular Basis of Conduction
Week 03 (10/15 – 10/19):	Newton's Law of Cooling: Heat Fins
Week 04 (10/22 – 10/26):	Local and Average Heat Transfer Coefficients: Viscous Dissipation
Week 05 (10/29 – 11/02):	Thermal boundary layer in flow through a tube (Midterms Start)
Week 06 (11/05 – 11/09):	Conduction involving more than one spatial dimension (Midterms Finish)
Week 07 (11/12 – 11/16):	Transient Conduction and Computational Modeling of Heat Transfer
Week 08 (11/19 – 11/23):	Radiative Energy Transport
Week 09 (11/26 – 11/30):	Macroscopic balances for energy transport; Heat Exchangers
Week 10 (12/03 – 12/07):	Special topics (multimode heat transfer, design…)

Grades

Midterm	35%
Final	35%
Homework	30%

Learning Outcomes

Problem-Solving Skills

- Approximation: Apply appropriate approximations to make quick estimates
- Assumptions: Specify assumptions that make problems solvable, while still applicable
- Reasoning: Explain problem solutions using physical and mathematical reasoning
- Reality Check: Assess reasonableness and accuracy of answers

Problem-Solving Toolkit

- Dimensional Analysis: Assess the relative importance of different phenomena based on different values of a dimensionless group
- Differential Equations: Solve ordinary and partial differential equations for scalar dependent variables, using techniques like separation of variables and Fourier analysis to address partial differential equations
- Boundary Conditions: Identify and justify appropriate boundary conditions for physical situations
- Methods of Solution: Implement analytical, numerical, and computational methods to solve governing equations

Transport Phenomena

- Conservation Principles: Use conservation principles to derive governing rate equations, using techniques such as shell and macroscopic balances
- Macroscopic Applications: Apply conservation principles to broad-scale situations, like the Earth's atmosphere, where microscopic details are either unknown or more complex than the desired model requires
- Microscopic Applications: Apply conservation principles to small-scale situations, where microscopic details about the system are desired, including positional information
- Constitutive Equations: Relate fluxes to driving forces for transport through constitutive equations

Heat Transfer

- Conduction: Apply Fourier's "Law" and solve 1D and 2D conduction problems in solid and fluid materials with a variety of sources and sinks of energy
- Convection: Apply Newton's "Law" of Cooling with appropriate heat transfer coefficient correlations to convection problems
- Radiation: Identify roles of absorptivity, emissivity, reflectivity, and view factors in radiative heat transfer problems
- Multimode: Solve problems in which conduction, convection, and/or radiation coexist and "compete" and assess the relative importance of different routes of heat transfer

Inclusion and Accessibility
Caltech values and supports inclusive and accessible classrooms (https://hr.caltech.edu/community/statement_community). We uphold that students have a variety of perspectives and needs as participants in the classroom and as individuals, and recognize that students come into the classroom with different experiences and backgrounds. As instructors and TAs for this course, we are looking for feedback so that we can be responsive to student concerns, and can connect students to resources to address ongoing and/or immediate student needs. If you have documented accommodations or any other accessibility needs, you can contact Dean of Undergraduate Students (deansoffice@caltech.edu) or we are happy to hear directly from students, and we will implement accommodations in consultation with Dean's Office.

Exams
This course will have two exams. These exams will be take-home exams, comprising of a short closed book section and a longer open book section, unless otherwise specified prior to the exam. When the exams are distributed, the time for each exam will be announced and usually is between 3-4 hours in total. During the open book portion of the exam, you are allowed to use the required text, your own class notes (including any handouts), and problem sets. You are allowed to use a calculator – but only for numerical calculations. No other resources are allowed unless otherwise stated on the exam.

The specific policy for each exam will be detailed on its cover.

Midterm – Covers first four weeks of material (i.e. Problem Sets 1-4)
Final – Emphasizes last six weeks of material (i.e. Problem Sets 5-7)

Homework
Problem Sets will be assigned every Monday and will be due at the beginning of class the following Monday unless otherwise specified. Extensions may be granted for extenuating circumstances if **prior (>24 hour notice)** arrangement is made with the instructor and TAs or as a part of appropriate accommodations through the Dean's office for accessibility and/or emergency situations (i.e. physical and mental health concerns, family emergencies, or other additional burdens on students). The Dean's office will not reveal confidential information to either the instructor or the TAs.

Late Policy without extension/prior arrangement
To encourage students to keep up with course material and to allow the timely release of solution keys and graded sets, we will remove credit from assignments that are turned in late without prior arrangements or accommodations. Our advice is to work on problems until the point that you are stuck because 80-90% of the credit for the process and the work, while 10-20% is reserved for the final answer. If you are unable to find a reasonable final answer, evaluating the validity of the answer may regain credit lost for mathematical or conceptual mistakes. If you are unable to finish a problem due to being stuck, turning the set in on time may be worth more points and the process of being stuck is still helpful for learning the material.

Between 10:00 AM Monday – 10:00 AM Tuesday = 75% of grade.
Between 10:00 AM Tuesday – 10:00 AM Wednesday = 50% of grade.
After 10:00 AM Wednesday = **NO CREDIT** (TA will correct it for you).

Collaboration Policy
Students are expected to follow the Caltech Honor Code. Please work on the problems alone before working with other students. If you get stuck on a specific point and you have made a reasonable effort to figure it out by yourself, you may discuss it with others. Do not look at your classmates' solutions. **Do not** refer to previous years' solutions. We expect each student to produce their own solutions to the problems. Until you have turned in an assignment, do not look at the solution key for that assignment.

You may use a variety of references to solve homework problems (any text, fluid mechanics journals, etc.). However, your solution **must** represent **your** understanding in your own words and you must *cite your references*. Simply copying a solution from a more advanced text or article without understanding is plagiarism, which is clearly an Honor Code violation.

You may use Mathematica or similar software packages to check your work, but you may not use Mathematica to do the work. You cannot use Mathematica or similar software packages on an exam, and you should not rely on it as a tool for homework. You will never be expected to use plotting software on an exam.

Your homework represents a written communication of your solutions to the TA and the instructor. It should be presented neatly and clearly, using words and diagrams as well as equations. All non-obvious assumptions should be clearly stated and justified.

Expectations for each homework and exam problem:
These expectations are designed to prepare you to work in teams, prepare reports for future use, and document processes and procedures so that someone else (or even you) can look back at what you prepared and replicate your work.

- Restate the problem
    - Write down any given information
    - Sketch a picture or diagram
    - Label/define all variables/symbols used
- State your assumptions
- Articulate your solution in words in addition to equations
    - Include helpful notes about your steps, especially if you tried multiple tactics to a problem or if you made new assumptions during a problem
    - Usually more than just equations is needed—show the flow between different steps and explain why
- Evaluate whether your answer is reasonable
    - If numerical, is the order of magnitude in the right range?
    - If numerical, how many significant digits? (How precise is your answer?)
    - If symbolic, does the dependence on the different variables make sense?
    - If numerical or symbolic, what are the units/dimensions? (You know something is wrong when a length has units of meter/second!)
- Box your final answer
- Cite your sources (if sources outside of the problem set are used, including the textbook)
- Unless otherwise stated, software packages such as Mathematica should only be used to CHECK your work, and should not replace your own solution to a problem.

An example problem is provided on Moodle demonstrating expectations for homework problems.