

CBE 612 (3 Cr.) – Transport Phenomena: Momentum

Summer Semester 2019

Department of Chemical and Biological Engineering

South Dakota School of Mines and Technology

2019.05.08

COURSE SYLLABUS

Instructors

Travis Walker

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Dates: 2019.05.06-08.16**Lectures:** TR 0900-1030**Classroom:** CBEC 3305**Course Description:** CBE 612 Transport Phenomena: Momentum

Credits: (3-0) 3

Introduction to momentum transport. Equations of continuity and motion. Velocity distributions. Boundary layer theory. Turbulent transport compressible flow.

Notes: This course is cross listed with ME 612.

CRN: 52650

Course Website:<https://webpages.sdsmt.edu/~twalker/secure/teaching/2019/2/cbe612.html>**Required Textbook:**L.G. Leal, *Advanced Transport Phenomena: Fluid Mechanics and Convective Transport Processes*. Cambridge University Press (2010). ISBN 978-0521179089.É. Guazzelli, J.F. Morris, *A Physical Introduction to Suspension Dynamics*. Cambridge University Press (2012).M.D. Graham, *Microhydrodynamics, Brownian Motion, and Complex Fluids*. Cambridge University Press (2018).**Recommended Textbook:**G.K. Batchelor, *An Introduction to Fluid Dynamics*. Cambridge University Press (2000).J. Happel, H. Brenner, *Low Reynolds Number Hydrodynamics*. Prentice-Hall, Englewood Cliffs, NJ (1965).S. Kim, S.J. Karrila, *Microhydrodynamics: Principles and Selected Applications*. Butterworth-Heinemann, Boston (1991).

J. Mewis, N.J. Wagner. *Colloidal Suspension Rheology*. Cambridge University Press (2013).

Other Textbooks:

J.C. Berg, *An Introduction to Interfaces and Colloids: The Bridge to Nanoscience*. World Scientific (2009).

R.B. Bird, W.E. Stewart, E.N. Lightfoot, *Transport Phenomena*, 2nd ed. John Wiley & Sons, New York (1999). ISBN 0-47011-539-4.

W.E. Boyce, R.C. DiPrima. *Elementary Differential Equations and Boundary Value Problems*. Wiley (2009).

P-G. de Gennes, F. Brochard-Wyar, D. Quere. *Capillarity and Wetting Phenomena: Drops, Bubbles, Pearls, Waves*. Springer (2004).

M.D. Greenberg, *Foundations of Applied Mathematics*. Dover (2013).

E.J. Hinch, *Perturbation Methods*. Cambridge University Press (2002).

J.N. Israelachvili. *Intermolecular and Surface Forces*. Academic Press (2011).

H. Lamb, *Hydrodynamics*, 6th ed. Cambridge University Press (1932).

Course Grading:

Homework	30%
Project	40%
Final Examination	30%

Grade Policy: Work received up to 24 hours late will receive 50% credit. Work received beyond 24 hours late will receive 0% credit. Group work on homework is permitted, but each student must submit his or her own individual assignment with a list of contributors.

Grading: If you determine that a regrade is necessary, the entire assignment will be regraded.

Final performance percentage will be assigned a minimum letter grade by the following scale (implying that the percentage requirements for a particular grade may be decreased at the instructor's sole discretion but will not be increased):

90-100	A
80-90	B
70-80	C
60-70	D
00-60	F

Course Objectives and Rationale: The overall objective of this course is to introduce you to analytic techniques that may be used to solve a variety of advanced problems in momentum transport phenomena.

Course Outcomes: By the end of the course, a student will be able to do the following:

- Develop a fundamental knowledge base for the equations that govern suspension mechanics and polymer solutions.

- Examine the extent of complex fluids (e.g., colloidal systems, emulsions, foams, etc.) in nature and industrial applications.
- Identify experimental microstructural methods for direct characterization and analysis.

Course Structure:***Communication:***

The course website will be used to distribute information, while email to MINES addresses will be used for course communication. I do my best to answer emails as promptly as possible, but I reserve the right to have 24 hours to answer all email inquiries. Under certain circumstances this timeline could be longer.

Lectures:

Lectures will be used for the following:

- content instruction,
- homework feedback and questions, and
- project presentations.

Attendance in lectures is expected. You are expected to be punctual and to minimize disruptions. Cellular devices need to be off during class. Also, no use of laptops or other electronic devices for activity outside of its use in this class will be tolerated. If you miss a class, you are responsible for obtaining lecture notes from other students.

While the Institution is a place where the free exchange of ideas and concepts allows for debate and disagreement, all classroom behavior and discourse should reflect the values of respect and civility. Behaviors that are disruptive to the learning environment will not be tolerated. As your instructor, I am dedicated to establishing a learning environment that promotes diversity of race, culture, gender, sexual orientation, and physical disability. Anyone noticing discriminatory behavior, or who feels discriminated against, should bring it to the attention of the instructor or other institutional personnel as appropriate.

Homework:

To increase efficiency in the grading process, homework will be graded in the following manner.

✓+	excellent
✓	satisfactory
✓-	unsatisfactory
0	not submitted

To aid in the understanding of the information, complete solutions will be posted to the course website following the submission of the homework. Inquiries will be directed to

these solutions for comparison to the returned homework, while further discussion will be saved for office hours.

Project:

A course project will be completed. The project will be used as an overall assessment of the student's understanding of key concepts that are described throughout the course. The deliverable will consist of a written report and an oral presentation. Further information will be distributed in a separate document that is entitled Project Description.

Examinations:

One final examination will exist in this course. The tentative date of the examination is the following.

- Final Examination: 2019.04.18-2019.05.03
 - Distributed Week 12, Thursday, 2019.07.25 in class
 - Due Week 15, Thursday, 2019.08.15 in class

Unless otherwise stated, during examinations you may only use your copy of the required textbook and any materials provided during the course. You cannot “share” a textbook during an examination or use copies of pages from the book. You may write notes in your textbook about topics that are covered in class but not included in the textbook. Laptops, calculators, or phones are not allowed during examinations.

Make-up examinations will only be allowed in the case of documented emergencies or with prior authorization (i.e., prior to the examination time) from the instructor. If you must miss one of the examinations for an emergency situation, please let me know as soon as possible (travis.walker@sdsmt.edu). You will not have an opportunity to make up the examination without an approved reason.

Tentative Dates:

- **Classes:**
 - May 07, 14, 16, 21, 23, 28, 30
 - June 04, 06, 11, 13, 18, 20, 25, 27
 - July 02, 09, 11, 16, 18, 23, 25, 30
 - August 01, 06, 08, 13, 15
- **No Classes:**
 - May 09 (ABET Meeting)
 - July 04 (Independence Day)

Tentative Course Outline (2019.05.08): This tentative list is subject to change depending on class needs. All topics in the chapters may not be covered, and some topics may be covered to a greater depth than others. Additional reading material might be provided as well.

Topic	Reading*
Microhydrodynamics	LGL Ch 07-08 G&M Part I Ch 01-04 MDG Ch 01-04
From the Microscopic to the Macroscopic	G&M Interlude Ch 05
Toward a Description of Macroscopic Phenomena in Suspensions	G&M Part II Ch 06-07
First Effects of Inertia	MDG Ch 05 G&M Ch 08
Thermal Fluctuations and Brownian Motion	MDG Ch 06
Stochastic differential Equations	MDG Ch 07
Coarse-Grained Models of Polymers in Dilute Solution	MDG Ch 08
Rheology and Viscoelastic Flow Phenomena	MDG Ch 09
Final Examination	

*LGL: Leal; G&M: Guazzelli & Morris; MDG: Graham

Academic Integrity: Students are expected to abide by the SDSM&T policies of academic integrity (with regard to cheating, plagiarism, etc.), as outlined in the Course Catalog.

ADA Statement: *Students with special needs or requiring special accommodations should contact the instructor, (Travis Walker, at travis.walker@sdsmt.edu or 605.394.2543) and/or the Title IX and Disability Coordinator, Ms. Nancy Sprynczynatyk, at Nancy.Sprynczynatyk@sdsmt.edu or 605.394.2533 at the earliest opportunity.*

Freedom in Learning Statement: *Under Board of Regents and University policy student academic performance may be evaluated solely on an academic basis, not on opinions or conduct in matters unrelated to academic standards. Students should be free to take reasoned exception to the data or views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled. Students who believe that an academic evaluation reflects prejudiced or capricious consideration of student opinions or conduct unrelated to academic standards should contact the Provost and Vice President for Academic Affairs to initiate a review of the evaluation.*

Additional Support

- The Student Success Center is a hub for learning support, resources, and help in identifying sources of assistance or support on campus. Go to <http://www.sdsmt.edu/Academics/Student-Success-Center/> for more information or stop by the office in the Surbeck Center (across from the Dean of Students office) to visit with Lisa.Carlson@sdsmt.edu. The phone number is 605.394.5261.
- Student Resource List:
<http://www.sdsmt.edu/Campus-Life/Student-Resources/Student-Resources-List/>
- Information about how to use or access ITS resources (e.g., computer, Internet, email):
<http://www.sdsmt.edu/Campus-Services/ITS/How-Do-I/>
- Title IX of the Educational Amendments Act of 1972 is the federal law prohibiting discrimination based on sex under any education program and/or activity operated by an institution receiving and/or benefiting from federal financial assistance. Behaviors that can be considered “sexual discrimination” include sexual assault, sexual harassment, stalking, relationship abuse (dating violence and domestic violence), sexual misconduct, and gender discrimination. You are encouraged to report these behaviors. Reporting: SD Mines can better support students in trouble if we know about what is happening. Reporting also helps us to identify patterns that might arise – for example, if more than one complainant reports having been assaulted or harassed by the same individual.

SDSM&T is committed to providing a safe and positive learning experience. To report a violation of sexual misconduct or gender discrimination, please contact the Title IX Coordinator at 605.394.1203. Please note that as your professor, I am required to report any incidences to the Title IX Coordinator. Confidential support for students is available by contacting the Student Counseling Center at 605.394.1924.