CBE 692 (3 Cr.) – Special Topics – Advanced Colloids and Interfaces
Summer Semester 2020
Department of Chemical and Biological Engineering
South Dakota School of Mines & Technology
2020.05.11
COURSE SYLLABUS

Instructor: Travis Walker
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Office Hours: By appointment

Dates: 2020.05.11-2020.08.21
Lectures: TBA
Classroom: Remote Delivery

Course Description: CBE 692 TP: ADVANCED COLLOIDS & INTERFACES (3). Fundamentals of fluid dynamics with an emphasis on transport phenomena at interfaces. Possible topics include fluid interfaces and capillarity, thermodynamics of interfacial systems, solid-liquid interactions, colloidal systems, rheology of dispersions, emulsions and foams, interfacial hydrodynamics. Permission of Instructor required. CRN: 52864

CBE 692 is an elective course for graduate students at SD Mines. The course content focuses on the fundamentals of colloids and interfaces. Tentative major lecture topics are detailed below.

Students are expected to have completed graduate coursework in transport phenomena (e.g., CBE 611) and in thermodynamics (e.g., CBE 621). Students are also expected to be proficient in calculus and differential equations, particularly analytical solution of ordinary differential equations (e.g., MTH 321), and to have successfully completed CBE 605 or equivalent.

Course Website:
`https://webpages.sdsmt.edu/~twalker/secure/teaching/2020/2/cbe692.html`

Required Textbook:

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

Recommended Textbooks:

R.B. Bird, W.E. Stewart, E.N. Lightfoot, *Transport Phenomena*, 2nd ed. John Wiley & Sons, New York (1999). ISBN 0-47011-539-4.
P-G. de Gennes, F. Brochard-Wyar, D. Quere, *Capillarity and Wetting Phenomena: Drops, Bubbles, Pearls, Waves.* Springer (2004).
G.R. Fowles, *Introduction to Modern Optics.* Dover (1989).
L.G. Leal, *Advanced Transport Phenomena: Fluid Mechanics and Convective Transport Processes*. Cambridge University Press (2010). ISBN 978-0521179089.

Other Textbooks:

M. Abramowitz, I.A. Stegun, *Handbook of Mathematical Functions: with Formulas, Graphs, and Mathematical Tables.* Dover (1965). Web Link.
G.K. Batchelor, *An Introduction to Fluid Dynamics.* Cambridge University Press (2000).
W.E. Boyce, R.C. DiPrima, *Elementary Differential Equations and Boundary Value Problems.* Wiley (2009).
G.G. Fuller, J. Vermant, *Complex Fluid Interfaces: Structure, Dynamics, and Interfacial Rheology. in progress.*
E.M. Furst, T.M. Squires, *Microrheology.* Oxford University Press (2017).
M.D. Graham, *Microhydrodynamics, Brownian Motion, and Complex Fluids.* Cambridge University Press (2018).
M.D. Greenberg, *Foundations of Applied Mathematics*. Dover (2013).
É. Guazzelli, J.F. Morris, *A Physical Introduction to Suspension Dynamics*. Cambridge University Press (2012).
J. Happel, H. Brenner, *Low Reynolds Number Hydrodynamics*. Prentice-Hall, Englewood Cliffs, NJ (1965).
E.J. Hinch, *Perturbation Methods*. Cambridge University Press (2002).
H. Lamb, *Hydrodynamics*, 6th ed. Cambridge University Press (1932).
J.N. Israelachvili, *Intermolecular and Surface Forces.* Academic Press (2011).
S. Kim, S.J. Karrila, *Microhydrodynamics: Principles and Selected Applications*. Buttersworth-Heinemann, Boston (1991).
J. Mewis, N.J. Wagner, *Colloidal Suspension Rheology.* Cambridge University Press (2013).
A. Varma, M. Morbidelli, *Mathematical Methods in Chemical Engineering*. Oxford University Press (1997).

Course Grading:

Homework	50%
Project	20%
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 Overview & Objectives: 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 fluid interfaces and capillarity.
- 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 inquires. Under certain circumstances this timeline could be longer.

Lectures:

Lectures will be used for the following:

- content instruction and
- workshop introduction.

Attendance in lectures is expected. You are expected to be punctual and to minimize disruptions. Cell-phones 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 University 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 students' understanding of key concepts described throughout the course. The deliverable will consist of an oral presentation. Further information will be distributed in a separate document entitled Project Description.

Final Exam:

One take-home final will exist during finals week.

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 Course Outline (2020.05.11):

Lecture Topic	**Reading***
Introduction	JCB Ch. 01
Fluid Interfaces and Capillarity	JCB Ch. 02 dGBWQ
Introduction to Modern Optics	GRF Ch. 1-2
Thermodynamics of Interfacial Systems	JCB Ch. 03
Solid-Liquid Interactions	JCB Ch. 04
The Thin-Gap Approximation – Films with a Free Surfaces	LGL Ch. 06
Colloidal Systems: Phenomenology and Characterization	JCB Ch. 05
Light Scattering	Wyatt
Electrical Properties of Interfaces	JCB Ch. 06
Interactions Between Colloidal Particles	JCB Ch. 07
Rheology of Dispersions	JCB Ch. 08
Emulsions and Foams	JCB Ch. 09
Interfacial Hydrodynamics	JCB Ch. 10
Final Exam due 2020.08.21	

*dGBWQ: de Gennes, Brochard-Wyar, Quere; GRF: Fowles; JCB: Berg; LGL: Leal

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: *SD Mines strives to ensure that physical resources, as well as information and communication technologies, are accessible to users in order to provide equal access to all. If you encounter any accessibility issues, you are encouraged to immediately contact the instructor of the course and the Title IX and Disability Coordinator, Ms. Amanda Lopez at disabilityservices@sdsmt.edu or 605.394.2533. Students with special needs or requiring special accommodations should also contact the instructor and the Title IX and Disability Coordinator. More information can be found at* `https://www.sdsmt.edu/Campus-Life/Student-Support/Disability-Services/`.

Freedom in Learning Statement: Freedom in learning. *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 to visit with Lisa Carlson (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.
  SD Mines 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.