CBE 605 (3 Cr.) – Applied Engineering Mathematics

Fall Semester 2019
Department of Chemical and Biological Engineering
South Dakota School of Mines and Technology
2020.08.20

COURSE SYLLABUS

Instructor: Travis Walker
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Instructor: Mingyang Tan
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Office Hours: TBD and by appointment

Dates: 2020.08.19–12.08
Lectures: TR 1130-1300
Classroom: CBEC 3305

Course Description: CBE 605 Applied Engineering Mathematics
Credits: (3-0) 3
Application of a broad range of advanced mathematical techniques to engineering analysis, specifically focusing on fundamentals of analytic solutions. Mathematical modeling, scaling, dimensional analysis, regular and singular perturbations, asymptotic analysis, linear and nonlinear ordinary and partial differential equations, linear vectors spaces, tensors analysis, similarity solutions, Fourier and integral transforms, statistics, initial and boundary value problems, data analysis, and curve fitting may be covered.
CRN: 85620

Course Website:
`https://webpages.sdsmt.edu/~twalker/secure/teaching/2020/4/cbe605.html`

Required Textbook:

M.D. Greenberg, *Foundations of Applied Mathematics*. Dover (2013). ISBN 978-0486492797.

Recommended Textbook:

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

Other Textbooks:

M. Abramowitz, I.A. Stegun. *Handbook of Mathematical Functions: with Formulas, Graphs, and Mathematical Tables*. Dover (1965). Web Link.
C.M. Bender, S.A. Orszag. *Advanced Mathematical Methods for Scientists and Engineers I: Asymptotic Methods and Perturbation Theory.* Springer Science & Business Media (2013).

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).
S.J. Farlow, *Partial Differential Equations for Scientists and Engineers*. Dover, New York (1993).
J.B. Fraleigh, R.A. Beauregard, *Linear Algebra*, 3rd ed. Addison-Wesley Publishing Company (1995).
R. Haberman. *Applied Partial Differential Equations*. Pearson, Upper Saddle River, NJ (2012).
E.J. Hinch, *Perturbation Methods*. Cambridge University Press (2002).
A. Varma, M. Morbidelli, *Mathematical Methods in Chemical Engineering*. Oxford University Press (1997).

Course Grading:

Homework	20%
Midterm Examination I	25%
Midterm Examination II	25%
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 chemical engineering problems.

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

- Understand what mathematical models are and how models differ from real systems.
- Simplify differential equations into versions that may be solved using eigenfunction expansions.
- Understand how to make physically-relevant simplifications to complex problems; then,

apply such simplifications to solve chemical/physical phenomena taking place in multi-dimensional systems.
- Develop a fundamental knowledge base for using vectors and tensors while being introduced to Einstein notation.

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,
- homework feedback and questions,
- examinations, and
- examination feedback and questions.

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 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.

Examinations:

Three examinations will exist in this course: two regular examinations and one final examination during finals week. The tentative dates of the examinations are the following:

- Midterm Examination I: 2020.09.11-2020.09.22
  - Distributed Week 04, Friday, 2020.09.11
  - Due Week 06, Tuesday, 2020.09.22 in class
- Midterm Examination II: 2020.10.16-2020.10.27
  - Distributed Week 09, Friday, 2020.10.16
  - Due Week 11, Tuesday, 2020.10.27 in class
- Final Examination: 2020.11.20-2020.12.08
  - Distributed Week 14, Friday, 2020.11.20
  - Due Finals Week Tuesday, 2020.12.08 by 1700 MST

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 exams.

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.

Important Dates:

Midterm Examination I	2020.09.11-2020.09.22
Midterm Examination II	2020.10.16-2020.10.27
Drop	2019.09.05
Final Examination	2020.11.20-2020.12.08

Tentative Course Outline (2020.08.20): 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***
Real Variable Theory	**MDG Part I**
Review	MDG Part I
Vector, Surfaces, and Volumes	MDG Ch 08
Vector Field Theory	MDG Ch 09
The Calculus of Variations	MDG Ch 10
Complex Variables	**MDG Part II**
Complex Numbers	MDG Ch 11
Linear Analysis	**MDG Part III**
Linear Spaces	MDG Ch 17
Linear Operators	MDG Ch 18
The Linear Equation $Lx = c$	MDG Ch 19
The Eigenvalue Problem $Lx = \lambda x$	MDG Ch 20
Ordinary Differential Equations	**MDG Part IV**
First-Order Equations	MDG Ch 21
Higher-Order Systems	MDG Ch 22
Qualitative Methods; The Phase Plane	MDG Ch 23
Quantitative Methods	MDG Ch 24
Perturbation Techniques	MDG Ch 25 EJH Ch 01
Partial Differential Equations	**MDG Part V**
Separation of Variables and Transform Methods	MDG Ch 26
Classification and the Method of Characteristics	MDG Ch 27
Green's Functions and Perturbation Techniques	MDG Ch 28
Tensor Analysis	
Einstein (indicial or index) notation	
Cartesian vectors and tensors	BSL App A

*BSL: Bird, Stewart, Lightfoot; MDG: Michael D. Greenberg; EJH: E. John Hinch

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.

COVID-19 Attendance Policy for classes with face-to-face elements
(see https://www.sdsmt.edu/Rockers-Return/COVID-19-FAQ/#If for more detail)

Out of an abundance of caution, you should contact the Dean of Students office at deanofstudents@sdmst.edu and not come to class if you experience any symptoms associated with COVID-19 (fever or chills, cough, shortness of breath or difficulty breathing, fatigue, muscle or body aches, headache, new loss of taste or smell, sore throat, congestion or runny nose, nausea or vomiting, diarrhea). The Dean of Students will contact your instructor(s). Any make-up of course requirements missed shall be worked out between you and your instructor(s). Your responsibility is to follow up with your instructor(s) quickly. Instructor(s) will respond with the aim of being flexible while retaining the integrity of your academic experience. To facilitate this process, you should do any or all of the following if you are able:

- Join scheduled synchronous remote class sessions;
- Participate in remote class activities, whether synchronous or asynchronous;
- Keep up with classwork;
- Submit assignments digitally;
- Work with your instructor(s) to try to reschedule exams, labs, and other critical academic activities.

Even if your absence has not been validated by the Dean of Students, instructors are required to allow for such make-up in a timely manner. You, on the other hand, are required to remain in timely contact with your instructor(s) to the greatest degree possible. Failure to communicate quickly and follow up my result in your inability to complete your semester.

COVID-19 Attendance Policy for Online Classes
(see https://www.sdsmt.edu/Rockers-Return/COVID-19-FAQ/#If for more detail)

Out of an abundance of caution, you should contact the Dean of Students office at deanofstudents@sdmst.edu if you are ill or injured and are not able to engage in course work. The Dean of Students will contact your instructor(s). Any make-up of course requirements missed shall be worked out between you and your instructor(s). Your responsibility is to follow up with your instructor(s) quickly. Instructor(s) will respond with the aim of being flexible while retaining the integrity of your academic experience. Even if your absence has not been validated by the Dean of Students, instructors are required to allow for such make-up in a timely manner. You, on the other hand, are required to remain in timely contact with your instructor(s) to the greatest degree possible. Failure to communicate quickly and follow up my result in your inability to complete your semester.

COVID-19 Statement
(see https://www.sdsmt.edu/Rockers-Return/COVID-19-FAQ/#Health-and-Prevention for more detail)

Mitigating the spread of COVID-19 is everyone?s responsibility. In order to ensure your health and safety and that of the entire campus community, please monitor your health daily and abide by the following protocols: If you are exposed to COVID-19, develop COVID-19 symptoms, or antic-

ipate being absent for more than two weeks due to COVID-19, communicate your circumstances immediately via deanofstudents@sdmst.edu. The Dean of Students office will communicate with your instructor(s) and provide appropriate University communication to impacted parties while also preserving privacy. If you miss class due to medical reason, please inform your instructor(s) in a timely fashion. If you have been told to isolate or quarantine, you cannot attend classes in person. You should ask your instructor(s) about options for remote participation. Your instructor(s) will work with you to determine whether remote participation, an incomplete grade, or withdrawal is most appropriate. Thank you for following these important measures to keep our community healthy and safe.

COVID-19 Face Covering Policy

Under the COVID-19 Face Covering Protocol approved by the South Dakota Board of Regents, SD Mines begins the fall term at Level 3, which requires face coverings in all public indoor spaces on campus. If you come to class not wearing an appropriate face covering, you will be asked to put one on. If supplies exist, a disposable mask will be provided if you do not have one. If no mask is available, you will be advised about virtual education options under the Informal Correction process in the COVID-19 Face Covering Protocol. If you decline to wear a face covering and do not leave the classroom, you will be referred to the Dean of Students for Formal Correction under the COVID-19 Face Covering Protocol, which may include noncompliance with the Student Code of Conduct. Your instructor(s) may be required to provide virtual options for you to continue to participate in the course until the allegations against you of non-compliance are resolved. Students who repeatedly come to class without a face covering will be subject to the consequences outlined in the COVID-19 Face Covering Protocol.

Copyright and Terms of Use of Course Materials

Lectures, presentations, and other course materials are protected intellectual property under South Dakota Board of Regents Policy. Accordingly, recording and/or disseminating lectures, presentations or course materials is strictly prohibited without the express permission of the faculty member. Violation of this prohibition may result in the student being subject to Student Conduct proceedings under SDBOR Policy 3:4.