

# CHBE 410 – Statistics & Design of Experiments

Department of Chemical and Biomolecular Engineering

University of Maryland

Fall 2019

## COURSE INFORMATION

**Pre-requisites:** Pre-requisite: C- or higher in CHBE250, MATH241, and MATH246

**Lectures:** Tuesday & Thursday 2:00 to 3:15 pm ChE 2108

**Discussion:** Friday 11:00 to 11:50 am ChE 2110

**Instructor:** Dr. Deborah S. Goldberg  
Office: ChE 1223D  
Email: [dsgold@umd.edu](mailto:dsgold@umd.edu)  
Phone: 301-405-5575  
Website: [dsgoldberg.weebly.com](http://dsgoldberg.weebly.com)

**Course Description (from testudo):** An introduction to probability, statistics, and design of experiments for chemical engineers.

### **Teaching Team:**

Mete Erdi (TA) Email: [merdi@umd.edu](mailto:merdi@umd.edu)  
Spencer Grissom (UTF) Email: [sgrissom@terpmail.umd.edu](mailto:sgrissom@terpmail.umd.edu)  
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Arthi Vijaykumar (UTF) Email: [arthi.vijaykumar1@gmail.com](mailto:arthi.vijaykumar1@gmail.com)

## LEARNING RESOURCES

### **Office Hours:** (also available by appointment):

Wednesdays	1:00-2:00 pm	Dr. Goldberg	Office ChE 1223D
Fridays	10:00 -11:00 am	Katherine/ Arthi	Room ChE 2118
Mondays	3:00-4:00 pm	Spencer/ Mete	Room CHM 0127

### **410 Learning Community:**

Thursdays	12:30 pm -1:30 pm	Dr. Goldberg	Room ChE 2118
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**Textbook:**

- Montgomery & Runger: Applied Statistics and Probability for Engineers, 7th Edition
- Students are required to purchase WileyPlus access and either an electronic version (ISBN 9781119400226) or printed version (9781119649304) of the textbook.
- A portion of each homework assignment will be submitted online through WileyPLUS

**Supplemental Material:** Will be posted to course website as needed.

## **LEARNING OUTCOMES**

**After successful completion of the course students should be able to:**

1. Identify and apply appropriate statistical tools or models to the analysis of engineering and research data.
2. Read and critically analyze results presented in engineering research papers or technical reports.
3. Design experiments to collect appropriate data to clearly answer a research or process question.
4. Use modern software packages to complete statistical analyses and present results graphically.
5. Appreciate the ethical obligation of an engineer to use statistical tools when presenting data and avoid misinterpretation or over-interpretation of results.

## **COURSE EXPECTATIONS**

**Faculty Expectations of Students:**

- Review prerequisite course materials.
- Complete out of class assignments on time.
- Come to class prepared (having read the assigned textbook material) and on time.
- Participate in the classroom by asking and responding to questions and engaging in group activities.
- Get help and feedback from the instructor and teaching assistants, as needed.
- Treat instructor, teaching assistants and fellow students professionally, and with respect.
- Follow the university code and departmental policy on Academic Integrity.
- Write out and sign the University of Maryland Honor Pledge on all assignments and examinations, as well as abide by its principles.

**Student Expectations of Faculty:**

- Provide written documentation and dialog on what is expected of students, course objectives and content, and performance criteria and evaluation procedures.
- Hold advertised office hours and be available at other times, by appointment.
- Put course material in context by relating it to life experiences, career related problems and applications, contemporary issues in engineering research and practice, and the content of other courses.
- Respect students and be receptive to their questions and opinions.
- Treat students fairly and equitably.
- Come to class prepared and on time.
- Return graded material in a timely fashion.
- Set examinations appropriately for the material being tested.
- Provide continual feedback on student performance.

## COURSE POLICIES

This course will adhere to university policies relevant to Undergraduate Courses are found here: <http://ugst.umd.edu/courserelatedpolicies.html>

In addition, links to full policies on excused absences and academic dishonesty can be found below. Students are expected to read and understand these policies.

***Documented excused absences are required to make up any quiz or examination. Self-signed sick notes may only be used for late homework or discussion submissions.***

*Excused Absence Policy:*

<http://www.president.umd.edu/sites/president.umd.edu/files/documents/policies/V-1.00G.pdf>

*Academic Integrity Policy:*

<http://www.president.umd.edu/sites/president.umd.edu/files/documents/policies/III-100A.pdf>

## COURSE FUNDAMENTALS

### Course website

The course website is on ELMS: <https://myelms.umd.edu/login>. The course website will be used for posting course material, announcements, and grades. Ensure the email address you have associated with ELMS is current, as course information will be communicated through the ELMS messaging system.

### Lecture

Lectures will typically be given by the instructor, though occasionally another qualified person may substitute or a recording may be posted on ELMS. Lectures will be the primary means to deliver new information. Lectures will include active learning exercises to enhance learning.

### Discussion

The discussion period is an opportunity to strengthen your understanding of course material. Some discussion sections will include a review of the most important concepts from the week with new practice problems. Other discussions will focus on using software to solve statistical problems, which will be reinforced by software exercises. See schedule for weekly discussion plans.

### 410 Learning Community

Prior to lecture on Thursdays, 410 learning community will provide students with the space and time to start the week's homework assignment peers. Dr. Goldberg will be available to answer questions and facilitate group problem solving.

### Communication with the Instructor

Email is the best way to reach the instructor outside of office hours. A reply to email can be expected within two business days. Email should be used to notify the instructor of planned and/or excused absences and can be used to ask clarifying questions on assignments. **Any in depth questions on course material or homework assignments and any questions regarding student progress or grades should be addressed in person.**

### **Classroom Environment**

Students are expected to contribute to a classroom environment that is conducive to learning. As such, please observe the following during class:

- Interact with all instructors and classmates in a respectful and professional manner. Behaviors and remarks perceived to constitute teasing or harassment will not be tolerated.
- Keep talking to a minimum outside of organized group activities. It is difficult for others to listen if there is background conversation taking place. If there is a question, please ask.
- Refrain from using electronic devices unless specified otherwise. E-mailing, texting, tweeting, and consuming any form of digital media can be distracting to your fellow students. Please leave the classroom if you need to use a device (in emergencies only).

### **Path to Success/ Expected Time Commitment:**

Traditionally, students are expected to devote 2-3 hours of time per week outside of class per credit hour— 6-9 hours per week for a 3 credit class. As a challenging upper level chemical engineering class, you should plan to spend approximately 6-9 hours per week on CHBE410. **The only way to succeed in this class is to put in the time to review notes, work through homework problems (independently first) and think critically about the course material.** If you are overcommitted and do not have sufficient time to spend on the course, you will likely earn a lower grade than you desire.

### **Resources Available:**

If you are struggling to understand and keep up with course material GET HELP EARLY. Many resources are available for extra help including:

- Instructor Office hours
- TA/UTF Office hours
- Learning Community
- LearnChemE and other online videos
- Peer study groups

In addition, the campus's **Learning Assistance Services** offers guidance on building good study habits, time management skills, exam preparation, etc.

<https://counseling.umd.edu/las/>

Finally, the **Counseling Service** in the Counseling Center provides free and confidential therapy to help UMD students manage personal, social, and academic challenges.

<https://www.counseling.umd.edu/cs/>

### **Arrangements for Students with Disabilities**

The University is legally obligated to provide appropriate accommodations for students with disabilities. Please contact Disability Support Service (DSS) Office (301) 314 – 7682 or Dissup@umd.edu or visit their website: <http://www.counseling.umd.edu/DSS/>

If you have an accommodation letter from DSS indicating that you have a disability which requires academic accommodations, please present it by the end of the schedule adjustment period (September 9, 2019) so we can discuss the accommodations that you might need in this class.

### **University Closures or Delays**

If class is affected by a University closure or delay, the instructor will email the class concerning the impact to the missed class meeting and will distribute an updated course schedule.

## Copyright Statement

All materials presented or provided in class and on the course website (e.g., lectures, handouts, videos, slides, assignments) are copyright protected. Students may not copy, record, or distribute these materials without the instructor's permission.

## EVALUATION

### Grading Policy

There will be a total of 1000 points from during the semester. Details on each item follow.

<u>Homework:</u>	11% (Highest 11 @ 10 points each)
<u>Quizzes:</u>	9% (3 @ 30 points each)
<u>Discussion submissions:</u>	4% (8 @ 5 points each)
<u>Literature pre-work</u>	3% (3 @ 10 points each)
<u>Reflections:</u>	3% (3 @ 10 points each)
<u>Semester Exams:</u>	40% (2 @ 200 points each)
<u>Final Exam:</u>	30% (1 @ 300 points)

### Grading Scale

This course will use a +/- grading system with letter grades equivalent to the following point values:

895-1000 points (90-100%): A-/A/A+; 795-894 points (80-89%): B-/B/B+; 695-794 point (70-79%): C-/C/C+; 595-694 points (60-69%): D-/D/D+; <595 points (<60%) = F

The instructor shall reserve the right to lower the cut-off points at the end of the semester.

### Homework Assignments

Twelve homework exercises will be assigned during the semester. Only the highest eleven scores will be counted towards the final grade. Assignments will be posted to Canvas on Tuesdays and due the following Monday by midnight. Homework assignments will include automatically graded problems on WileyPlus and free-response questions to be submitted on ELMS. **Late homework will not be accepted except in the case of a university excused absence.**

#### **Follow these guidelines for homework assignments.**

- Include a cover page with your name, student ID number, date, course number, assignment number and honor pledge.
- Start each problem on a new page.
- **Homework will be submitted through canvas as a single pdf and must either be typed or neatly written and scanned. Free scanning is available in all university libraries or you may use the scanning app, provided it produces results comparable to document scanning quality. Photographs of written solutions are not acceptable.** Combining digital and scanned PDFs into one document is easy and free (<https://www.sejda.com/visually-combine-reorder-pdf>)
- Submit analysis files to support your PDF solutions.
- Write out a reasonable amount of work to address the problem. Graders are not obligated to giving full credit if large gaps are present and the thought process is not clear.
- Homework assignments will be graded partially for completion and partially for accuracy. Problems that are only partially completed or do not show sufficient work will not earn any points.

Note that while you are encouraged to discuss your homework with classmates, you must turn in (and understand) your own solutions. Turning in solutions that are not your own is a violation of department and university academic integrity policies, and violations will be referred to the Honor Council.

Additionally, you are not permitted to view homework solutions from the web or from other students who took this course previously (e.g., homework from previous students). Note that any version of the solution manual that is posted online has been posted illegally and that the solution manual contains errors.

### **Reading Assignments**

Reading assignments will be posted on ELMS prior to each lecture. Reading the textbook before class will make lecture much more valuable. On occasion, additional references may be provided.

### **Quizzes**

Three short (25 minute) quizzes will be given in lecture. Quiz dates are given on the tentative schedule, but are subject to change if inclement weather closures disrupt the course schedule. Quiz problems will be based on (but not identical to) homework problems assigned since the last quiz or exam. Quizzes are closed book and closed notes. Relevant equations will be provided. Department calculators will be provided if calculations are required. You may also use your own scientific calculator up to TI-36x Pro. In order to receive full credit, students must show all work.

Students will have the opportunity to make up a missed quiz in case of an excused absence (with appropriate documentation). Note that a self-signed sick note is not acceptable for a missed quiz. Students must contact the instructor within 2 business days of the absence to schedule the makeup unless there are extenuating circumstances. For planned absences (ie interview, religious holiday), students should contact the instructor prior to the missed quiz. Students may also elect to use their “drop” for a missed quiz.

### **Exams**

There will be two in-class exams (75 min) and one comprehensive final exam (2 hrs). Exams must be promptly turned in at the end of each class/exam period. For each exam, you may prepare and use one 8½ in. x 11 in. sheet for reference (one side only for semester exams, two sides for the final exam). This reference sheet must be turned in along with your exam and will be returned to you after the exam is graded. Department calculators will be provided if calculations are required. You may also use your own scientific calculator up to TI-36x Pro. No unauthorized materials or tools may be visible during exams, and students must stop working on the exam promptly when informed the exam is over; violation of these policies is a violation of the Code of Academic Integrity.

Exam Dates are as follows. Exam dates are subject to change due to inclement weather. Material covered on the exam will be confirmed 1 week prior to the exam. The exam may be moved to a different room or split into multiple rooms. This will be communicated at least 1 week prior to the exam.

**Exam 1:** Thursday, October 3, 2019, 2-3:15 pm

**Exam 2:** Thursday, November 7, 2019, 2-3:15 pm

**Final Exam:** Saturday, December 14, 2019, 10:30 am- 12:30 pm

### **Re-grade Requests**

Any questions (or complaints) regarding grading of homework, quizzes or exams must be brought up within one week of the graded item being returned. Requests for reconsideration after this time will not be accepted. Questions (or complaints) regarding homework should be directed to the teaching assistant, quizzes to the undergraduate teaching fellows and those regarding exams should be directed to the instructor. Homework or quiz regrades should be submitted via email with a picture of the item of concern. Exam regrades should be submitted on paper with a written note explaining the regrade request stapled to the exam.

## TOPICS & TENTATIVE COURSE OUTLINE

Date	Day	Topic	HW	HW due*	Assessment
8/27/2019	Tu	Course intro, Statistics in Engineering & Science	HW1		
8/29/2019	Th	Theory of Probability			
8/30/2019	F	Discussion- Statistical Ethics			
9/3/2019	Tu	Discrete random variables and distributions	HW2	HW1	
9/5/2019	Th	Continuous random variables and the normal distribution			
9/6/2019	F	Discussion- Practice Problems			
9/10/2019	Tu	<b>Quiz 1</b> , Joint probability distributions	HW3	HW2	Quiz 1
9/12/2019	Th	Conditional probability, Covariance/ correlations and propagation of error			
9/13/2019	F	Discussion- Practice Problems			
9/17/2019	Tu	Data Description/ Plots	HW4	HW3	
9/19/2019	Th	Plots continued, Graphical data representation in scientific journals (literature discussion)			
9/20/2019	F	Generation of plots using software			
9/24/2019	Tu	Confidence intervals	HW5	HW4	
9/26/2019	Th	Confidence intervals			
9/27/2019	F	Discussion- Practice Problems			
10/1/2019	Tu	Exam review			
10/3/2019	Th	<b>EXAM</b>			Exam 1 (Ch 1-6)
10/4/2019	F	Confidence intervals using software			
10/8/2019	Tu	Hypothesis testing		HW5	
10/10/2019	Th	Hypothesis testing			
10/11/2019	F	Statistical tests using software			
10/15/2019	Tu	<b>Quiz 2</b> , Statistical inference- two samples	HW7	HW6	Quiz 2
10/17/2019	Th	Statistical inference- two samples			
10/18/2019	F	Statistical tests using software			
10/22/2019	Tu	Linear regression	HW8	HW7	
10/24/2019	Th	Confidence intervals, prediction, adequacy and correlation			
10/25/2019	F	Linear regression using software			
10/29/2019	Tu	Non-linear regression models	HW9	HW8	
10/31/2019	Th	Stat and regression in the literature, Multiple regression models			
11/1/2019	F	Discussion- Practice Problems			
11/5/2019	Tu	Exam review/ multiple regression models, con't			
11/7/2019	Th	<b>EXAM</b>			Exam 2 (CH7-11)
11/8/2019	F	Non-linear and multiple regression using software			
11/12/2019	Tu	Design of single factor experiments & ANOVA	HW10	HW9	
11/14/2019	Th	Design of single factor experiments & ANOVA			
11/15/2019	F	ANOVA using software			
11/19/2019	Tu	<b>Quiz 3</b> , Design of multifactor experiments	HW11	HW10	Quiz 3
11/21/2019	Th	Design of multifactor experiments			
11/22/2019	F	DOE analysis using software			
11/26/2019	Tu	Design of multifactor experiments			
11/28/2019	Th	NO CLASS- THANKSGIVING HOLIDAY			
11/29/2019	F	NO CLASS- THANKSGIVING HOLIDAY			
12/3/2019	Tu	DOE in the literature (literature discussion), Statistics in quality control	HW12	HW11	
12/5/2019	Th	Statistics in quality control			
12/6/2019	F	Final exam review			
12/9/2019	M	Final homework due		HW12	
12/14/2019	Sa	<b>FINAL EXAM 10:30-12:30</b>			Final Exam

\*HW Due Monday night prior to date at 11:59 pm on ELMS/ WileyPlus