SYLLABUS: General Chemistry for Engineers

Instructor: Jerome Fox (Jerome.Fox@colorado.edu)

Advanced TA: Olivia Irvin (Olivia.Irvin@colorado.edu)

Graduate TAs: Yu Hsuan Yang (<u>Yu.Yang@colorado.edu</u>); Jessica McKean (<u>Jessica.McKean@colorado.edu</u>); Anthony Gullion (<u>Anthony.Gullion@colorado.edu</u>)

Undergraduate TAs: William Weise (<u>William.Weise@colorado.edu</u>); Savannah Presson (<u>Savannah.Presson@colorado.edu</u>); Nicole Lollini (<u>Nicole.Lollini@colorado.edu</u>); Audra Rissmeyer (<u>Audra.Rissmeyer@colorado.edu</u>); Caroline Mays (<u>Caroline.Mays@colorado.edu</u>); Cody Campos (<u>Cody.Campos@colorado.edu</u>); Rico Nelson (<u>rine2671@Colorado.edu</u>); Leo Abanov (<u>Leo.Abanov@colorado.edu</u>); Sean Kim (<u>Sean.Kim-1@colorado.edu</u>)

Course email: Routine administrative questions (e.g., excused absences or travel) should go to the course email: <u>chen1201@colorado.edu</u>. Email is not a good way to clarify material; save them for office hours and recitation.

Class Meeting Times:

Lecture: M/W/F 10:10 - 11:00 (CHEM 140). Lectures will not be recorded. Sections: You must attend your assigned section, which appears in your schedule.

Staying on track: We will use Canvas for reading quizzes, assignments, screencasts, and other class info. You are responsible for all the information posted. <u>The weekly modules (e.g., "Week 1") contain pages that list</u> your schedule, reading assignments, and due dates (e.g., "Week 1 To Do").

Office Hours: Office hours and help sessions are most effective if you come prepared with specific questions. Office hours for recitation sections: Details posted on Canvas Office hours for Dr. Fox: Friday at 9:00 AM (location posted on Canvas)

Course Description: General Chemistry for Engineers 1 is designed to meet the general chemistry requirement for many engineering students and serve as part one for students whose academic plans require advanced work in chemistry. A basic knowledge of chemistry is important for understanding how the processes and materials used throughout all fields of engineering work. The intent of this course is to provide an introduction to the structures, properties, and fundamental concepts in chemistry. This course will also teach engineering students how to do problem-solving with chemical concepts and provide a chemistry knowledge base of concepts and experimental techniques that they can carry forward into their future engineering careers. Topics include components of matter, stoichiometry, electron configuration, chemical bonding, molecular shapes, covalent bonding, classes of reactions, thermochemistry, gases, atomic structure, organic compounds, intermolecular forces, and phase equilibria. Examples and problems illustrate the application of chemistry to engineering sub-disciplines.

Daily schedule: Available online at on the last-page of this document.

Course Learning Goals:

- 1. Master basic mathematical skills and fundamental chemical concepts.
- 2. Understand the connection between macroscopic observations, molecular views, and symbolic representations in chemistry.
- 3. Recognize the relationship between molecular structure and chemical and physical properties.
- 4. Understand the basis of and effectively use the periodic table.

- 5. Analyze complex chemical problems, develop critical thinking skills, and logical approaches to problem solving.
- 6. Draw and interpret graphs and analyze data in class, in recitation, and on exams.
- 7. View chemistry as an integrated and logical science.
- 8. Recognize and explain how chemistry concepts apply to everyday phenomena.
- 9. Take personal responsibility for learning and develop/enhance self-regulated learning skills.
- 10. Articulate an understanding of science and develop communication skills.
- 11. Understand in sufficient depth for later coursework:
- 12. The Periodic Table and Atomic Structure
 - a. Understand the concepts of the electromagnetic spectrum (the nature of light), atomic spectra, and the quantum mechanical model of the atom.
 - b. Be able to apply the Pauli Exclusion Principle to the determination of orbital energies and electron configurations.
 - c. Be familiar with the trends of the Periodic Table, and be able to relate these trends to chemical behavior such as bonding and the properties of matter.
- 13. Atoms and Molecules
 - a. Understand the fundamental concepts of the atom, including atomic number, mass number, atomic symbols and atomic masses.
 - b. Be able to discuss ions and their properties.
 - c. Understand the nature of compounds, their formulas and their bonding. Be able to identify and name binary covalent and ionic compounds.
 - d. Be able to discuss inorganic and organic chemical systems, and identify their similarities and differences.
- 14. Molecules, Moles, and Chemical Equations
 - a. Be able to write and balance chemical reactions.
 - b. Understand aqueous solutions, solvents and solutes. Be able to write and balance chemical equations for aqueous reactions, including acid-base and redox reactions.
 - c. Be able to interpret chemical equations, specifically to determine empirical and molecular formulas using moles and molar masses.
- 15. Stoichiometry
 - a. Be able to obtain chemical ratios from a balanced chemical reaction.
 - b. Be able to determine limiting reactants, theoretical and percentage yields and solution stoichiometry.
- 16. Chemical Bonding and Molecular Structure
 - a. Be able to identify and describe ionic and covalent type bonding; understand the similarities and differences between the two types of bonding.
 - b. Be familiar with the concepts of electronegativity, bond polarity, and the use of Lewis structures in predicting chemical structure.
 - c. Be familiar with the model of orbital overlap in chemical bonding, and the use of hybrid orbitals to predict molecular shape.
- 17. Thermochemistry
 - a. Be able to define energy, its forms and the units of energy.
 - b. Understand and apply the concepts of heat capacity, calorimetry, and enthalpy.
 - c. Be able to apply Hess's Law to the interpretation and prediction of enthalpies of reactions.
 - d. Be able to define and use the laws of thermodynamics in characterizing thermochemical reactions.
 - e. Be able to use Gibbs Free energy to characterize reaction spontaneity
- 18. State of Matter: Gases
 - a. Be able to correlate structure with bonding and rationalize the resulting properties.
 - b. Understand the concepts of pressure, partial pressure, and ideal versus real gases.
 - c. Be able to apply the ideal gas law to chemical reactions involving gases.
 - d. Understand the postulates of the kinetic-molecular theory of gases and its limitations.
- 19. States of Matter: Liquid, Solids and Phase Equilibria
 - a. Be able to compare and contrast gases, liquids and solids in terms of bonding, structure and properties.
 - b. Be able to describe bonding in solids, including models for metallic bonding.

- c. Understand the difference between types of solids: conductors, semiconductors and insulators.
- d. Be familiar with the types of intermolecular forces.
- e. Be familiar with the physical properties of liquids, including vapor pressure, boiling point, and surface tension.
- f. Be able to interpret simple phase diagrams.
- g. Be able to apply the Clauisius-Clapeyron equation to changes in phase.

Required Materials:

- **Textbook**: Nivaldo J. Tro, *Chemistry: A Molecular Approach 6th ed.*, Pearson, 2019. (Available as "Day 1 Digital Access" through Canvas site, see posted instructions for access)
- iClicker student response device: Required for in-class participation questions, available at the CU Bookstore. You can register your iClicker in MyCUinfo. Upon logging in, scroll to the bottom of the page where "Schedule" is, and select "CUClicker Registration".
- A non-programmable calculator. These are the simple, \$15 calculators that just do addition, subtraction, multiplication, division, etc. Please bring them to class and <u>exam</u>.

Format: This class uses Concept Tests (iClicker for in-class questions), recitation worksheets, reading quizzes, online homework assignments, and evening exams.

Expectations: The learner is responsible for reading the book, watching the screencasts, participating in recitations, and doing the homework. We will not spend time in class repeating material covered by the text. We will use class time to discuss the most-important concepts, as well as applications and examples.

- Attend all classes.
- Participate in class and recitation. Ask questions and volunteer answers. Stay engaged.
- Complete reading, screencasts, interactive simulations and modules, and quizzes on Canvas prior to class.

Resources to help you succeed in this course:

- Materials on <u>www.LearnChemE.com</u>
- Interactive content (linked in the eText)
- Resources on how to study: <u>http://www.learncheme.com/student-resources/how-to-study-resources</u>

Resources on Canvas: Class notes will be posted after class and will contain everything discussed during class; they will also contain explanations of the clicker questions. In general, Canvas will include all course handouts, files, announcements, assignments, reading assignments, reading quizzes, screencasts, and links to interactive simulations. Canvas also contains practice exams for all exams in this class.

Grading: Reading quizzes (Canvas)	5%
Clicker questions (lecture)	5%
Recitation	10%
Homework assignments	15%*
3 evening exams	45%*
Final exam	20%

*It is extremely important for you to stay up to date on material. We will drop your five lowest reading quiz grades, your five lowest conceptual problem grades (i.e., lecture attendance), and your lowest homework grade. If have an excused absence from an exam, we will re-weight your remaining exams to make up the exam grade.

The fixed grading scale for the final course grade is as follows:

 $\begin{array}{l} 90 < A \\ 80 < B < 89 \\ 70 < C < 79 \\ 60 < D < 69 \\ F < 60 \end{array}$

You are guaranteed the indicated letter grade (with a minus) if you have the minimum numerical grade (e.g., if your course average is 79, you are guaranteed at least a grade of B-). Grades may be adjusted, but only in your favor.

Homework Assignments: All homework assignments are available on Mastering Chemistry, which can be accessed directly through Canvas. Once you have registered and enrolled, you can log in at any time to complete or review your homework assignments (see Weekly Modules for due dates). The only make-up homework that will be offered is for medical or emergency reasons. Your lowest homework grades will be dropped. During sign up or throughout the term, if you have any technical problems or grading issues, please contact Pearson support. This support team is almost always faster and better able to resolve technical issues than the TAs.

Support: https://support.pearson.com/getsupport/s/contactsupport

Recitation: Every student is required to attend their scheduled weekly recitation section. The recitation will focus on a worksheet, which will include important topics from the prior three lectures. Students will complete these problems individually, as small group, and as a class; there will be much discussion. The recitation will be graded as follows: attendance (30%) and participation (70%). Please come prepared!

Quizzes: A total of 5% of your course grade will be determined by responses to short quizzes related to the assigned reading and screencasts. Quizzes must be completed independently on Canvas before 9 am the day of each class. The five lowest <u>reading</u> quiz grades will be dropped.

Conceptual problems: Nearly every class will include conceptual problems. To allow for a few missed classes, we will drop the five days with the lowest grades (i.e., missed classes).

Exams: Evening exams are scheduled for <u>6:30-8:00 PM</u> on <u>October 1, October 29, and December 3</u>. Final: **TBD** (scheduled by campus, not me). They will take place in three large classrooms (details online). Please add these dates to your calendars immediately. **NO MAKE-UP EXAMS WILL BE GIVEN.**

Academic Dishonesty: Academic dishonesty of any sort as described on the CU Boulder Honor Code https://www.colorado.edu/osccr/honor-code and repeated below is grounds for failure of the course.

Definition: Any act in which a student gains, or attempts to gain, an unfair academic advantage over other students. These acts may include, but are not limited to:

- i. **<u>Plagiarism</u>**: Portrayal of another's work or ideas as one's own
- ii. <u>Cheating:</u> Using prohibited notes or study aids, allowing another party to do one's work/exam and turning in that work/exam as one's own, copying another student's course work, and collaborating on course work when prohibited
- iii. **Fabrication:** Falsification or creation of data, research, or resources, altering a graded work without the prior consent of the course instructor
- iv. Lying: Deliberate falsification with the intent to deceive in written or verbal form as applied to an academic submission
- v. <u>Bribery:</u> Providing, offering, or taking rewards in exchange for a grade, or, an assignment, or in the aid of Academic Dishonesty
- vi. <u>Threat:</u> An attempt to intimidate a student, staff, or faculty member for the purpose of receiving an unearned grade or in an effort to prevent the reporting of an Honor Code violation, or in connection with any other form of Academic Dishonesty
- vii. <u>Unauthorized Access:</u> Gaining unauthorized access to protected academic information including, but not limited to: the Integrated Student Information System (ISIS); a faculty member's computer, files, and/or office; or secure information on an online server
- viii. <u>Clicker Fraud:</u> Using, or having someone else use, clicker technology fraudulently in an effort to receive academic credit.
- ix. <u>Resubmission:</u> Submitting the same or similar work in more than one course without permission from all course instructors involved
- x. <u>Aiding Academic Dishonesty:</u> Intentionally facilitating any act which may help a student to gain an unfair academic advantage including, but not limited to, any of the aforementioned acts.

Classroom Behavior. Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation, or political philosophy.

For more information, see the <u>classroom behavior policy</u>, the <u>Student Code of Conduct</u>, and the <u>Office of Institutional Equity and Compliance</u>.

Requirements for Infectious Disease. Members of the CU Boulder community and visitors to campus must follow university, department, and building health and safety requirements and all applicable campus policies and public health guidelines to reduce the risk of spreading infectious diseases. If public health conditions require, the university may also invoke related requirements for student conduct and disability accommodation that will apply to this class.

If you feel ill and think you might have COVID-19 or if you have tested positive for COVID-19, please stay home and follow the <u>guidance of the Centers for Disease Control and Prevention (CDC) for isolation and testing</u>. If you have been in close contact with someone who has COVID-19 but do not have any symptoms and have not tested positive for COVID-19, you do not need to stay home but should follow the <u>guidance of the CDC for masking and testing</u>.

Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation. I If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the <u>Disability Services website</u>. Contact Disability Services at 303-492-8671 or <u>dsinfo@colorado.edu</u> for further assistance. If you have a temporary medical condition, see <u>Temporary Medical Conditions</u> on the Disability Services website.

If you have a required medical isolation for which you require adjustment, please notify us over the course email (<u>chen1201@colorado.edu</u>) and CC your recitation section instructor. You do not need to state the nature of your illness, just the anticipated duration so that we can work out a plan to keep you on track with lectures, recitations, and assignments.

Preferred Student Names or Pronouns. CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor code. All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the <u>Honor Code</u>. Violations of the Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: <u>honor@colorado.edu</u>, 303-492-5550. Students found responsible for violating the <u>Honor Code</u> will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Visit <u>Honor Code</u> for more information on the academic integrity policy.

Sexual Misconduct, Discrimination, Harassment, and/or Related Retaliation. CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits protected-class discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. These behaviors harm individuals and our community. The Office of Institutional

Equity and Compliance (OIEC) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email <u>cureport@colorado.edu</u>. Information about university policies, <u>reporting options</u>, and <u>support resources</u> can be found on the <u>OIEC website</u>.

Please know that faculty and graduate instructors must inform OIEC when they are made aware of incidents related to these policies regardless of when or where something occurred. This is to ensure that individuals impacted receive outreach from OIEC about resolution options and support resources. To learn more about reporting and support for a variety of concerns, visit the <u>Don't Ignore It page</u>.

Religious Holidays. Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please communicate the need for a religious accommodation in a timely manner. In this class, please notify us over the course email (<u>chen1201@colorado.edu</u>) and CC your recitation section instructor. Please note the anticipated duration of missed class so that we can work out a plan to keep you on track with lectures, recitations, and assignments.

See the campus policy regarding religious observances for full details.

Mental Health and Wellness. The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact <u>Counseling and Psychiatric Services (CAPS)</u> located in C4C or call (303) 492-2277, 24/7.

Free and unlimited telehealth is also available through <u>Academic Live Care</u>. The Academic Live Care site also provides information about additional wellness services on campus that are available to students.

Week	Class	Date	Day	Торіс	Chapter
1	Class 1	26-Aug	М	Course Intro: Matter and Measurement	1.1 - 1.6
1	Class 2	28-Aug	W	Measurement and Data, Atomic Structure	1.7-1.8, 2.1-2.6
1	Class 3	30-Aug	F	Atomic Mass, Molar Mass	2.7-2.9
2	N/A	2-Sep	М	No Class: Labor Day	
2	Class 4	4-Sep	W	Chemical Bonds, Ionic Compounds	3.1-3.5
2	Class 5	6-Sep	F	Molecular Compounds, Combustion	3.6-3.10
3	Class 6	9-Sep	М	Organic Compounds, Balancing Equations	3.11, 4.1 - 4.2
3	Class 7	11-Sep	W	Stoichiometric Relationships	4.3-4.4
3	Class 8	13-Sep	F	Chemical Reactions, Intro to Solutions	4.4-4.5, 5.2
4	Class 9	16-Sep	М	Solution Chemistry	5.2-5.4
4	Class 10	18-Sep	W	Solution reactions: ions and net ionic equation	5.5-5.8
4	Class 11	20-Sep	F	Redox Reactions	5.9
5	Class 12	23-Sep	М	Balancing redox reactions	20.2
5	Class 13	25-Sep	W	Ideal Gases	6.1-6.4
5	Class 14	27-Sep	F	Partial Pressure and Gas Mixtures, Intro KMT	6.5-6.7
6	Class 15	30-Sep	М	Catch up, Review	Chapters 1-5, 20
6	EXAM 1	1-Oct	Т	Location: CHEM 140/142, 6:30 - 8:00 PM	Chapters 1-5, 20
6	Class 16	2-Oct	W	Kinetic Molecular Theory and Real Gases	6.8-6.10
6	Class 17	4-Oct	F	Energy, work, and heat	7.1-7.3
7	Class 18	7-Oct	М	Quantifying Heat and Work	7.4
7	Class 19	9-Oct	W	Calorimetry and Enthalpy	7.5 – 7.7
7		11-Oct	F	No class: time back for exam	
8	Class 20	14-Oct	М	Hess's Law, Std. Enthalpy of Formation	7.8-7.9
8	Class 21	16-Oct	W	The nature of light	8.1-8.2
8	Class 22	18-Oct	F	Bohr Model, de Broglie Wavelength	8.3-8.4
9	Class 23	21-Oct	М	Quantum Numbers, Atomic Orbitals	8.5-8.6
9	Class 24	23-Oct	W	Electron Configurations, Valence Electrons	9.1-9.4
9	Class 25	25-Oct	F	Electron configurations and periodic trends	9.5, 9.6
10	Class 26	28-Oct	М	Review	Chapters 6-8
10	EXAM 2	29-Oct	Т	Location: CHEM 140/142, 6:30 - 8:00 PM	Chapters 6-8
10	Class 27	30-Oct	W	Periodic Trends	9.7-9.9
10	Class 28	1-Nov	F	Lewis Model, ionic bonding	10.1-10.4
11		4-Nov	М	No class: time back for exam	
11	Class 29	6-Nov	W	Covalent bonding, electronegativity	10.5, 10.6
11	Class 30	8-Nov	F	Resonance, formal charge	10.7, 10.8
12	Class 31	11-Nov	М	Bond Energies and Bond Lengths	10.9-10.11
12	Class 32	13-Nov	W	VSEPR Model	11.1-11.3
12	Class 33	15-Nov	F	Molecular Shape and Polarity	11.4-11.6
13	Class 34	18-Nov	М	Orbital hybridization (no sp3d or sp3d2)	11.7
13	Class 35	20-Nov	W	MO Theory	11.8
13	Class 36	22-Nov	F	Phases, Intermolecular Forces	12.1-12.3
14		25-Nov		Fall Break	
14		27-Nov		Fall Break	
14		29-Nov		Fall Break	
15	Class 37	2-Dec	M	Review	Chapters 9-11
15	EXAM 3	3-Dec	Т	Location: CHEM 140/142, 6:30 - 8:00 PM	Chapters 9-11
15	Class 38	4-Dec	W	Vaporization and Vapor Pressure	12.4, 12.5
15	Class 39	6-Dec	F	Phase Changes and Phase Diagrams	12.5-12-9
16	Class 40	9-Dec	М	Catch Up, Review	Chapters 1-12
16	Class 41	11-Dec	W	Catch Up, Review	Chapters 1-12

Tentative Schedule: General Chemistry for Engineers