Physical Chemistry Lecture – Second Semester (Quantum Mechanics):

CHE 356 – last updated Sunday 14th January, 2018

Prof. John M Franck office 2-008 CST, jmfranck@syr.edu. Office hours 2-3pm Thursday and by appointment.

CST 1-019 Tu, Th 11:00-12:20

Rebecca Predergast Rebecca volunteers to help with the conceptual aspects of this class. She will schedule office hours (typically no more than 1 hr and never more than 2 hrs) each week during times that she is available on a first-come first-serve basis. Please contact her (rfollmer@syr.edu) to schedule office hours if you are interested.

Alec Beaton (CHE356/357 TA aabeaton@syr.edu) Is accessible during CHE357 laboratory hours, during which he can help with conceptual elements related to this class.

Corey Kroptavich (CHE356/357 TA crkropta@syr.edu) Is accessible during CHE357 laboratory hours, during which he can help with conceptual elements related to this class.

Chemistry Secretary, Elizabeth Molloy 1-014 CST, 443-2851, eemolloy@syr.edu

Course Material

Physical Chemistry, 3rd Edition; Engel and Reid, (Pearson, 2013).

Students should expect to have to read the assigned material and to take notes during class (which will supplement the assigned reading) in order to keep pace with the class.

Course Description

CHE 356 is the second semester of the two-semester physical chemistry sequence intended for undergraduates majoring in various science and engineering disciplines. In this semester we explore the basic ideas of quantum mechanics, spectroscopy, chemical bonding, statistical mechanics (review), chemical kinetics and perhaps a few more topics as time permits. Whereas thermodynamics requires no specific knowledge of the microscopic nature of matter and energy to achieve a quantitatively sound macroscopic picture of our universe, quantum mechanics provides us with a sound microscopic picture of matter and energy.

As you saw last semester, using the methods of statistical mechanics, all the thermodynamic quantities can be calculated from spectroscopic and other physical data. This semester, we will learn about how the microscopic properties of atoms and molecules are manifest in the macroscopic properties and processes that characterize our world.

Prerequisites

As with last semester, we will find that *any realistic means* of expressing physical reality and developing an intuition of the physical world must be rooted in mathematics. Therefore, students are expected to have a basic grasp of algebra, unit conversion, dimensional analysis, as well as multi-variable calculus. The only chemistry prerequisite is successful completion of CHE346 or the equivalent.

Assignments and Lectures

The lectures will not necessarily follow the book's presentation as I will introduce some different subjects and leave out others. Although every effort will be expended to delineate the material of interest in the book, it is inevitable that exams will be based on materials from both the lecture and the book and their overlap may not be complete.

Readings, exercises (in the readings), homework, and lectures are all required; you skip them at your own peril. I strongly recommend taking notes during lecture with pencil and paper, as this has been shown to aid in comprehension and retention.

Struggling through problems is the only known pathway towards understanding and proficiency. Doing problem sets almost every week will improve your grade. Students should do all assigned/recommended problems and then some. You need to be able to solve problems easily and quickly.

What we know about the natural world has all come from the quantitative analysis and interpretation of reproducible experiments and observations. Problem set questions are often supposed to mimic such experiments and observations. You will learn some things this semester that will be useful for the rest of your careers although this may be the only time you will be exposed to them and given some opportunity to learn them in an organized fashion. Dont waste the opportunity! Looking at various texts with alternate presentations of the same material is often useful.

In order to facilitate a friendly and possibly fun group learning environment we have chosen to continue an exercise tried in previous years. At a few points of my choosing, we will divide the students taking this course into an even number of groups, probably 4 groups. Half of the groups will be tasked to produce 3 questions, 1 each of easy, medium, and high degree of difficulty. Each question should comprise 2-3 subsections. The group that produces the questions must also produce the answer key. The TAs and I will examine the questions and the keys and all the students producing the questions/key will get the same grade for that week. The other 2 groups (if there are 4 groups total) will answer those questions and hand them in the following week, along with 3 new questions for the other 2 groups. Those students will get a grade based on their performance on the problem set their colleagues produced. Groups will likely be jumbled regularly. This will proceed most of the semester with the subject matter changing throughout.

Grading

Grading will be averaged from the following components:

10% of the grade will come from online "homework" (Mastering Chemistry) that will be posted near the end of the week, as well as the question exercise described above. Homework will be due every Tuesday morning, before the start of class.

50% Of the grade will come from 3 hourly exams that will be delivered during the standard class time, as indicated in the tentative course schedule.

Your score will be averaged from the best 2 out of 3 of your test grades (*i.e.*, one test grade will be dropped, and the 2 best grades will be counted at 25% each) – **unless** one of your test grades is the subject of an academic integrity hearing/decision. *If a test is failed or reduced in score as a result of an academic integrity decision, that score must be counted as one of the 2 test results used to determine your grade.*

40% Of the grade will come from your final.

Tentative Course Schedule

Date	Day	Lecture #	Topic	Reading Assignment
1/16/2018	T	1	Syllabus, History	Chap 12
1/18/2018	Th	2	Schrodinger Eqn., Postulates	Chap 13
1/23/2018	T	3	Free Particle, Particle in Box	Chap 15
1/25/2018	Th	4	Particle Box examples	Chap 16
1/30/2018	T	5	Heisenberg Uncertainty	Chap 17
2/1/2018	Th	6	Harmonic Osc. - Rigid Rotor	Chap 18
2/6/2018	T	7	Vibrational Spectroscopy	Chap 19
2/8/2018	Th	8	Rotational Spectroscopy	Chap 19
2/13/2018	T	9	Hydrogen Atom	Chap 20
2/15/2018	Th		**Exam 1** (Lec 1-8)	Chap 21
2/20/2018	T	10	Many Electron Atoms	
2/22/2018	Th	11	Atomic Spectroscopy	Chap 22
2/27/2018	T	12	Molecular Orbitals	Chap 23
3/1/2018	Th	13	Bond Diagrams	Chap 24
3/6/2018	T	14	Orbital Hybridization	Chap 24
3/8/2018	Th	15	Hückel Theory	Handout
3/13/2018	T		**No Class Spring Break**	
3/15/2018	Th		**No Class Spring Break**	
3/20/2018	T	16	Elec. Abs. Spectroscopy	Chap 25
3/22/2018	Th	17	Elec. Emiss. Spectroscopy	Chap 25
3/27/2018	T		**Exam 2** (Lec 9-17)	
3/29/2018	Th	18	Stat. Mech. Probability	Chap 29
4/3/2018	T	19	Boltzmann Distribution	Chap 30
4/5/2018	Th	20	Partition Functions	Chap 31
4/10/2018	T	21	Statistical Thermodynamics	Chap 32
4/12/2018	Th	22	Kinetic theory of gases	Chap 33
4/17/2018	T	23	Reaction rates	Chap 35
4/19/2018	Th	24	Reaction mechanisms	Chap 35
4/24/2018	T	25	Catalysis	Chap 36
4/26/2018	Th	26	Photochemistry	Chap 36
5/1/2018	T		**Exam 3** (Lec 18-26)	
5/4/2018	Th		**Final Exam** 5:15–7:15 PM 1-019	

Important Note

The Table above lists the *approximate* topics that will be covered including dates and relevant readings. Each exam covers the all preceding Chapters including the new material (which is given in parentheses).

Both the grading scheme and the Course Schedule are subject to change **at any time and for any reason**.

General Information

If you have a required absence due to faith-based observances or other reasons, please inform the instructor within the first week of class. If you believe that you need accommodations for a disability, please contact the Office of Disability Services (ODS) located at 804 University Avenue, third floor or go to the ODS website at `disabilityservices.syr.edu` and click current students tab to register on-line. You may also call 315.443.4498 to speak to someone regarding specific access needs. ODS is responsible for coordinating disability-related accommodations and will issue 'Accommodation Letters' to students as appropriate. Since accommodations may require early planning and are not provided retroactively, please contact ODS as soon as possible.

Syracuse University's Academic Integrity Policy reflects the high value that we, as a university community, place on honesty in academic work. The policy defines our expectations for academic honesty and holds students accountable for the integrity of all work they submit. Students should understand that it is their responsibility to learn about course-specific expectations, as well as about university-wide academic integrity expectations. The policy governs appropriate citation and use of sources, the integrity of work submitted in exams and assignments, and the veracity of signatures on attendance sheets and other verification of participation in class activities. The policy also prohibits students from submitting the same work in more than one class without receiving written authorization in advance from both instructors. Under the policy, students found in violation are subject to grade sanctions determined by the course instructor and non-grade sanctions determined by the School or College where the course is offered as described in the Violation and Sanction Classification Rubric. Syracuse University students are required to read an online summary of the University's academic integrity expectations and provide an electronic signature agreeing to abide by them twice a year during pre-term checkin on MySlice. The Violation and Sanction Classification Rubric establishes recommended guidelines for the determination of grade penalties by faculty and instructors, while also giving them discretion to select the grade penalty they believe most suitable, including course failure, regardless of violation level. **Any established violation in this course may result in course failure regardless of violation level.**

Students must notify instructors by the end of the second week of classes for regular session classes (such as this one) when they will be observing their religious holiday(s).

Educational use of student work: I intend to use academic work that you complete this semester for educational purposes in this course during this semester. Your registration and continued enrollment constitute your permission.

In the event of an emergency

- Phone emergency line from on-campus: 711
- Phone emergency line from off-campus: 315.443.2224
- Phone emergency line from cell phone providers ATT/Verizon/Nextel: #78

For complete details on emergency procedures, visit: `http://emergencyguide.syr.edu/`.