CHEM 341—Physical and Analytical Chemistry for Life Sciences, Fall 2019

Instructor: **Tyler Meldrum,** ISC 1060, 221-2561 *tkmeldrum@wm.edu*
Office hours: Mondays 10:00–11:00 am, Tuesdays 1:30–2:15 pm
Class times: Tuesdays, Thursdays 11:00 am – 12:20 pm, ISC 1111 (in ISC 3)

Course Description:
This course explores principles of physical chemistry applied directly to biological systems. Topics include structure of nucleic acids and proteins, thermodynamics, statistical mechanics, quantum mechanics, spectroscopy, and kinetics, as well as many techniques used in biophysical research. Please note: this course does NOT count towards the chemistry major; however, it does count towards the chemistry and biochemistry minors. Prerequisites include two years of chemistry (through Organic II and General II) and integral calculus (MATH 112/132). Students who have taken differential calculus (MATH 111/131) and have some exposure to integrals or are currently enrolled in MATH 112/132 are probably sufficiently prepared for this course—they should see the instructor to discuss their math background and, if appropriate, to receive a course override.

More broadly, I expect students to develop quantitative competency in (bio)physical chemistry, and to learn how physical chemistry and analytical methods apply to biological problems.

Text:
We will not strictly follow a textbook in this course. Broad concepts of thermodynamics are elegantly explained in:
Atkins, P. The Laws of Thermodynamics: A Very Short Introduction; Oxford University Press: 2010. ISBN: 978-0199572199.
Note: This book is available for free online through Swem. It's only ~$10, in case you want a hard copy.

In addition, a textbook that has been used in this course previously addresses some thermodynamic concepts in amore quantitative detail:
(Recommended) Kuriyan, J.; Konforti, B.; Wemmer, D. *The Molecules of Life: Physical and Chemical Principles;* Garland Science: New York, 2013. ISBN: 978-0-8153-4188-8.

I have other related textbooks in my office that you are welcome to look at for additional information.

Course Structure and Grading:

Homework (20% total):	2.5% each, 8 assignments
Midterm exams (45% total):	22.5% each. two midterms
Final project (35% total):	27.5% for individual contribution
	additional 5% for meaningful feedback to other students
	additional 2.5% for participation in the final "poster" session

Homework: Eight homework assignments will be posted to Blackboard. They will be submitted to Blackboard at the specified due date/time. Each is worth 2.5% of the course grade, for a total of 20% of the course grade.

Midterm exams: Two take-home midterm exams will be given. They will be due at the end of class on Tuesday, October 1 and Thursday, November 21. Each midterm will be worth 22.5% of the course grade. We will not have regular class on midterm exam days, so you can use the class time for the exam.

Final project: In lieu of a standard final exam, students will submit an "interactive webpage" created using Microsoft Sway that explains some aspect of the course: a technique, a concept, or a particular example that came up during discussions or reading. Be creative in choosing your topic; your instructor can give guidance as needed. A draft webpage will be required (November 12), and you will provide peer-review feedback to one another (due at 5:00 pm on Monday, November 25). The final webpage is due at the beginning of the final exam period (Tuesday, December 10 at 2:00 pm). We will meet during the final exam period for a "poster session" where we will view others' webpages and provide feedback on the webpage assignment.

CHEM 341—Physical and Analytical Chemistry for Life Sciences, Fall 2019

Grading policy: To receive a grade in the A range in this course, you must have at least 90% of the points; the B range is at least 80%; etc. These thresholds may be lowered (i.e., it may become easier to get a higher grade), but they will not be raised. These absolute thresholds are designed to allow you to collaborate and work with others without fear of getting a lower grade if a peer performs well. Please teach one another and, while submitting only your own work, collaborate with your colleagues.

Student Accessibility Services: William & Mary accommodates students with disabilities in accordance with federal laws and university policy. Any student who feels they may need an accommodation based on the impact of a learning, psychiatric, physical, or chronic health diagnosis should contact Student Accessibility Services staff at 757-221-2512 or at sas@wm.edu to determine if accommodations are warranted and to obtain an official letter of accommodation. For more information, please see www.wm.edu/sas.

CHEM 341—Physical and Analytical Chemistry for Life Sciences, Fall 2019

COURSE SCHEDULE

Tentative Due Dates	Dates	Topics
	R, 8/29	Course intro, forces, and keeping things together
	T, 9/3	Important shapes in biomolecules (proteins, nucleic acids, lipids, water)
	R, 9/5	More shapes and motifs, Energy
	F, 9/6	***ADD/DROP PERIOD ENDS***
HW 1	T, 9/10	Intro to quantum mechanics, de Broglie, and the particle in a box
	R, 9/12	Quantum mechanics continued
HW 2	T, 9/17	Harmonic oscillator, rigid rotor
	R, 9/19	Spectroscopy, retinal and rhodopsin **[FTIR, UV-Vis]**
HW 3	T, 9/24	The Hydrogen Atom
	R, 9/26	Intro to Sway, project planning and rubric design
MT 1	**T, 10/1**	**MIDTERM EXAM 1**
	R, 10/3	**[X-Ray Diffraction]**
	T, 10/8	Single molecules to macroscopic systems—statistical mechanics
	R, 10/10	The First Law of Thermodynamics; work, heat, heat capacity
	T, 10/15	***FALL BREAK—NO CLASS***
HW 5	R, 10/17	The Second Law of Thermodynamics: Classical entropy
	T, 10/22	Statistical entropy
HW 6	R, 10/24	Free energy and ATP
	M, 10/28	***WITHDRAW DEADLINE***
	T, 10/29	**[Nuclear Magnetic Resonance]**
	R, 10/31	Protein stability, folding, and denaturation **[Calorimetry]**
	T, 11/5	Molecular motion and diffusion
HW 7	R, 11/7	**[Chromatography]**
Webpage draft	T, 11/12	**[Mass Spectrometry]**
	R, 11/14	Chemical kinetics, rate laws, activation energy
	T, 11/19	**[Electron Microscopy]**
MT 2	**R, 11/21**	**MIDTERM EXAM 2**
Webpage feedback	*M, 11/25*	*Feedback due at 5 pm*
	T, 11/26	Webpage work period
	R, 11/28	***THANKSGIVING BREAK—NO CLASS***
HW 8	T, 12/3	**[Computers in Structural Biology]**
	R, 12/5	Buffer, review
	T, 12/10	**2–5 pm; FINAL WEBPAGE DUE, PROJECT REVIEWS**