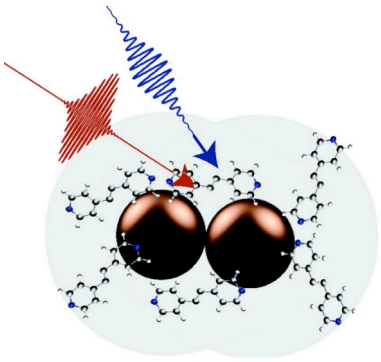
Chem. 401/501: Advanced Physical Chemistry
Spring 2019



Instructor
Prof. Kristin Wustholz, ISC 2041, 1-2675, kwustholz@wm.edu
(email is the best way to contact me)

Class Meetings
TR 2 pm – 3:20 pm, ISC 2280

Office Hours
W 2:00 pm – 3:00 pm (and by appointment**)**

Course Materials
Your physical chemistry and instrumental analysis textbooks may be useful resources for various topics. Other required readings and supplemental resources will be posted on Blackboard.

Course Description
Advanced Physical Chemistry focuses on topics in modern experimental physical chemistry including nanoscience, laser spectroscopy and chemical dynamics, optical and scanning probe microscopy, non-linear optics, and plasmonics. Specific learning goals are to understand fundamentals concepts of light-matter interactions and their applications to current problems in renewable energy, materials science, biology, and atmospheric chemistry. Class meetings will be a mixture of lecture, discussion, in-class exercises, communication workshops, and student presentations.

Assessment
Research Project Portfolio (40%): A major component of this course involves a semester-long research project where you will become an expert in an active research area in one of the top-20 Ph.D. programs in physical chemistry (*U.S. News & World Report*, 2014). The overarching goals of the project are to: learn advanced physical chemistry concepts and the current state of the field, develop problem-solving skills, gain experience in the peer review and response process, and enhance written and oral communication skills. Chem. 401 students may work in pairs. Chem. 501 students must complete a project individually. Projects will culminate in a research paper and class presentation, though there are several scaffolded "deliverables" along the way. These activities include developing writing skills in a "process," evaluating the work of your peers, composing a response to reviewers, and creating effective presentation slides – all of which play an important role in manuscript and grant writing process as well as professional presentations. Over the course of the semester, students will generate a research project portfolio that will be turned in at the end of the semester. A complete description of the research project with point breakdown is included on page 4 of this syllabus.

In-Class Exercises and Problem Sets (10%): To help prepare you for exams and research projects, there will be several in-class exercises and a few problem sets (due dates TBD). Collaboration on in-class exercises is encouraged. However, to facilitate the development of independent problem-solving skills, problem sets must be completed individually.

Exams (20% each): Both the mid-term and final are take-home exams. Exams are open note (in-class handouts, exercises, textbooks, and Blackboard materials), but using additional resources (e.g., the internet, other students, publications, etc.) is not permitted. The take-home final exam is due by the end of the scheduled final exam period: 5 pm on Tuesday, April 30th.

Participation (10%): This course embraces an active learning environment in which your full engagement is vital to the learning experience. Full participation includes coming to class prepared, asking and answering questions, sharing in discussion, collaborating and communicating effectively with your peers, completing in-class exercises, and delivering presentations.

Grades

Grading rubrics for each element of the research project will be posted on Blackboard in advance of the assignment deadline. In general, class scores and grades will be scaled with the following considerations:

A = Excellent performance and mastery of the material
B = Very good understanding of the material
C = Adequate performance
D = Poor performance
F = Unsatisfactory performance

Policies

Late submission of materials is not permitted (except in rare extenuating circumstances). Two class absences for any reason are excused without penalty, but to pass the class, your attendance at the practice and final presentations is mandatory. Additional unexcused class absences will lead to a grade-letter reduction in your participation and/or final grade. Any exceptions to these policies will be at the instructor's discretion in consultation with the Dean of Students Office (757-221-2510, deanofstudents@wm.edu).

Honor Code

The student Honor Code is an important part of what makes W&M a special community. I expect you to observe the Honor Code fully and faithfully.

Class Climate

This course is designed to give you an opportunity to explore topics in advanced physical chemistry through instruction, discussion, and collaboration. Together we will create and maintain an atmosphere of mutual respect in which everyone's ideas can be heard. Please feel free to inform me of the appropriate name and pronoun to use when addressing you.

Writing Resource Center

The Writing Resources Center, located on the first floor of Swem Library, is a free service provided to W&M students. Trained consultants offer individual assistance with writing, presentation, and other communication assignments across disciplines and at any stage, from generating ideas to polishing a final product. Students are encouraged to make use of this free resource. To make an appointment, visit: www.wm.edu/wrc.

Accommodations

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 757-221-2509 or at sas@wm.edu to determine if accommodations are warranted and to obtain an official letter of accommodation. If you feel that there is anything I can do to ensure a better learning environment for you, please do not hesitate to contact me. As long as these accommodations do not unfairly disadvantage other students, I am more than willing to help out.

Chem 401/501 Tentative Course Schedule:

Week	Topics	Reading	Important Dates
1/17	Welcome & State of the Field: Overview of 401/501 Research Topics		
1/22	Wave Mechanics, Light-Matter Interactions, Dirac Notation, Perturbation Theory	Hecht, Ch.2 Levine, 9.1-9.2	Add/drop ends 2/25
1/29	Fermi's Golden Rule and Spectroscopy, Lasers, Non-Linear Optics	Levine, 9.9 Turro, Ch. 5	*Choose 2 PIs* due 1/31
2/5	Workshop #1: Research	McQuarrie, Ch. 15 Video posts	2/5: Class meets in the Ford Classroom, Swem Library
2/12	Optical and Single-Molecule Microscopy, Single-Photon Counting; Workshop #2: Writing Process	*Science* article	
2/19	Chemical Dynamics	*J. Raman Spec.* article	*Annotated Bibliography Due* due 2/19
2/26	Research Topic Meetings; Exam 1		Exam 1 due 2/28
3/5	*Spring Break*		
3/12	Transient Absorption Spectroscopy	handout	
3/19	Time-Resolved Vibrational Spectroscopy and Imaging; How to Give a Spectacular Presentation	*Phys. Rev. Lett.* article	Revise a slide homework due 3/21
3/26	Nanoscience, Scanning Probe Microscopy	Feynman lecture	*Research Paper "Draft"* due 3/26
4/2	Nanoparticles, Quantum Dots, Plasmonics, Surface-Enhanced Spectroscopy	*Ann. Rev. Phys. Chem.* article	*Peer Review (Paper)* due 4/2
4/9	Workshop #3: Practice Presentations	handout	*Practice presentation & peer feedback* due 4/9 or 4/11
4/16	Student Presentations	Peer review form	*Project Portfolio* due 4/25
4/23	Student Presentations; Advanced Topic: Class Choice	handout	

The final exam can be picked up on Tuesday, 4/23 and is due by Tuesday, 4/30 at 5 pm.

Research Project Guidelines

List of Possible Principal Investigators:

Luis Campos (Columbia) – single-molecule spectroscopy, materials, organic
Fleming Crim (Wisconsin) – reaction dynamics, transient absorption spectroscopy
Jillian Dempsey (UNC) – solar energy, proton coupled electron transfer, inorganic
Gordana Dukovic (Colorado) – quantum dots, nanoscience, ultrafast spectroscopy
Graham Fleming (UC Berkeley) – energy transfer, photosynthesis, ultrafast spectroscopy
Renee Frontiera (Minnesota) – ultrafast spectroscopy, plasmonics, biological sensing
Daniel Gamelin (Washington) – inorganic, luminescence, plasmonics, quantum dots
Naomi Ginsburg (UC Berkeley) – single-molecule spectroscopy, organic photovoltaics
Naomi Halas (Rice University) – plasmonics, nanoscience, catalysis
Marsha Lester (UPenn) – atmospheric chemistry, vibrational spectroscopy
Amanda Morris (Virginia Tech) – spectroscopy, catalysis, metal organic frameworks
Cathy Murphy (Illinois) – nanoscience, inorganic, nanomedicine, plasmonics
Eric Potma (UC Irvine) – nonlinear microscopy, tissue imaging
Ben Schwartz (UCLA) – resonance Raman, ultrafast spectroscopy, hydrated electron, theory
Gregory Scholes (Princeton) - solar energy conversion, ultrafast spectroscopy
Claudia Turro (Ohio State) - ultrafast spectroscopy, inorganic complexes, photodynamic therapy
Richard Van Duyne (Northwestern) – plasmonics, surface-enhanced Raman spectroscopy
Haw Yang (Princeton) – protein dynamics, quantum dots, single-molecule spectroscopy

Note: All paper assignments should have a unique title, 1" paper margins, page numbers, 1.5 line spacing, 11- or 12-pt. font (Times New Roman/Arial or similar). Figures (when necessary for clarity) must be legible and not exceedingly large. Grading rubrics for major components will be posted to Blackboard in advance of the assignment deadline.

Timeline of Events:

1. *Choose 2 PIs (~1 page):* Investigate the PIs listed above (**and others if you wish**). Browse publications on their website and use Google Scholar or the Web of Science to find "hot" articles. Students (individuals or teams as appropriate) will submit a ranked list of their top 2 choices along with the citation (use ACS format) of one article from each PI on which they plan to focus. Topics must be relevant to the course material and not too closely related to your current research. Include a brief justification of your choices (career plans, relationship to course material, research interests/experience, etc.). (Due in class on Thursday, 1/31)

2. *Annotated Bibliography (~3 pages):* Once PI assignments are finalized, you will have 2 weeks to pursue more in-depth study of the their publications. There are hundreds, if not thousands, of manuscripts related to your topic – careful thought must be devoted to focusing on 3 related papers that can be combined to tell a compelling story. One of these papers should be a high-quality review – a "primer" article that covers the fundamentals/theory/applications of the research area. You may choose letters/communications, but at least one article must be a full-length manuscript in a high-quality peer-reviewed journal (e.g., *J. Phys. Chem.*). You will need additional literature sources to successfully complete the paper, which will be the focus of a Research Workshop at Swem Library. Submit an annotated bibliography (~3 pages) that describes the proposed topic, summarizes, assesses, and reflects the sources, and explains the interrelatedness/storyline of the articles (ACS citation format). A useful resource on annotated bibliographies can be found here: https://owl.english.purdue.edu/owl/resource/614/1/. Although a working thesis statement is not required at this stage, including it in this assignment

will be helpful to you and is recommended. Please note: this may require revision at the instructor's discretion – I strongly encourage you to meet with me before submitting this assignment. (Due in class on Tuesday, 2/19)

3. *In-Class Workshop #1 (Research):* In this workshop we will be working toward gathering salient, high-quality, reputable sources for your research paper. We will review how to format citations in ACS format. (In class at Swem Library on Tuesday, 2/5)

4. *Research Paper "Draft":* Submit two copies of a "draft" of the 6-8 page (not including references) research paper. One copy should not contain your name. The draft must not be a first draft. Have someone else read and thoughtfully edit it before submission or make an appointment with the Writing Resource Center (WRC). Submit the name of one or more of your peers in Chem. 401/501 who has already reviewed this paper or indicate that it was reviewed at the WRC. Frequent grammatical and spelling errors in a draft are unacceptable – they will lead to a poor evaluation from your peers and me. A grading rubric for the draft will be posted in advance of the deadline. (Due in class on Tuesday, 3/26)

5. *Peer Review a Paper:* Individuals will complete an anonymous peer review of a randomly-selected paper. You will submit a copy of the paper with your editorial comments and the completed evaluation rubric. (Due in class on Tuesday, 4/2)

6. *In-Class Workshop #2 (Practice Presentation & Peer Feedback):* Students will create slides and deliver a practice presentation to a group of peers. A rubric will be posted to Blackboard to guide the design and creation of your materials and delivery. Peer review forms from the workshop are due at the end of class. (In class on Tuesday, 4/9 and Thursday, 4/10)

7. *Class Presentation and Discussion:* Present a 20-min. talk on your research topic, followed by a 5-minute discussion period. Students will be evaluated on the quality, style, and content of their talk as well as the level of class participation during peer presentations. Students must email me the .pptx or .pdf file no later than 8 am the day of your presentation so that I can print class handouts. (In class between Tuesday, 4/16 and Tuesday, 4/23)

8. *Project Portfolio:* Submit the complete research project portfolio (organized in one binder or folder) that contains all materials previously submitted, the peer reviews of your paper, a final version of the research paper, a 1-page “Response to Reviewers” that explains how the reviewer comments (made by me and your peers) were specifically addressed (example format will be presented in class), and a list of 2 possible final exam **questions with answers** based on your project. Also submit a digital copy of the final paper and presentation via email. Finally, for students who elected to work in teams, a self & peer evaluation form must be completed and sent to me via email. For students who worked individually, a self-evaluation form must be completed and turned in with the portfolio. (Due Thursday, 4/25)

Points Breakdown:

1. Choose Two PIs (10 pts)
2. Propose a Research Topic with Annotated Bibliography (30 pts)
3. Research Paper "Draft" (30 pts)
4. Peer Review a Paper (20 pts)
5. In-Class Workshop #2 (Practice Presentations & Peer Feedback) (30 pts)
6. Class Presentations and Discussion (50 pts)

7. Response to Reviewers (10 pts)
8. Final Research Paper (50 pts)
9. Final Exam Questions (10 pts)
10. Self & Peer Evaluation (10 pts)
    Total = 250 pts

Tips for Success from Previous Students:

1. Start early and meet with me to discuss specific resources for your project.
2. If you realize after a few weeks that you would like to change research topics or groups, we can do that. Talk to me ASAP about making a change and I will try to accommodate your request.
3. For Chem. 401 students: teamwork is key – you will be wrestling with advanced topics and will benefit from collaboration. For Chem. 501 students or those wishing to pursue a project independently: your peers are still a resource! Develop a cohort to discuss papers, read your work, listen to practice talks, etc.
4. The ability to communicate effectively is critical to your success in the professional world – whether that be as a physician, researcher, teacher, chef, etc. Together we will build and develop your written and oral communication skills. That said, it is your responsibility to make use of writing resources that are available outside of class. I strongly encourage you to make appointments at the WRC. Strunk and White's *The Elements of Style* is an outstanding writing resource (it's also brief, somewhat entertaining, and cheap). A terrific (free) online resource on writing and giving presentations can be found at: https://www.nature.com/scitable/ebooks/english-communication-for-scientists-14053993/contents.
5. When writing a research paper about advanced topics (some that are new to you) it can be challenging to put ideas from the literature into your own words. If you are concerned about plagiarism, please visit the WRC or talk with me.
6. Some students have reported that the exercise of making and practicing the talk is incredibly useful for paper writing. Consider preparing the talk first to help construct a thoughtful and effective narrative.
7. Easy points: use correct ACS citation format. Format in-text citations using superscript numbers and reference lists appropriately. See: https://libguides.williams.edu/citing/acs
8. Practice your talk, focusing on transitions between slides. You might consider writing them down. Practice the talk again. And again. When delivering the talk in class it should definitely not be the first time through and it should not be read from note cards, slides, etc. Polished talks that clearly, concisely tell a good story will be the most successful (and earn the most credit).