California State University San Marcos • NEW COURSE • FORM C CHEM 451

ORIGINATOR'S SECTION:

1. College:

☐ CHABSS ☐ CoBA
☐ CoEHHS ☒ CSM

Desired Term and Year of Implementation (e.g., Fall 2008):

Fall 2017

2.Course is to be considered for G.E.? (If yes, also fill out appropriate GE form*) ☐ Yes ☒ No

3. Course will be a variable-topics (generic) course? ☐ Yes ☒ No
("generic" is a placeholder for topics)

4. Course abbreviation and Number:* CHEM 451

5. Title: ***(Titles using jargon, slang, copyrighted names, trade names, or any non-essential punctuation may not be used.)***
Biophysical Chemistry

6. Abbreviated Title for PeopleSoft:
(no more than 25 characters, including spaces)
Biophysical Chemistry

7. Number of Units: 3

8. Catalog Description: ***(Not to exceed 80 words; language should conform to catalog copy. Please consult the catalog for models of style and format; include all necessary information regarding consent for enrollment, pre- and/or corequisites, repeated enrollment, crosslisting, as detailed below. Such information does not count toward the 80-word limit.)***

Applies the principles of physical chemistry to the study of dynamic biomolecular systems and processes. Topics covered will include: a brief review of thermodynamics, chemical kinetics, transport processes, chemical equilibria, and physical equilibria; the use of optical spectroscopy, magnetic resonance spectroscopy, and mass spectrometry to study biomolecular structure and dynamics; protein folding; protein engineering; membrane protein biophysics; and translation. Prerequisites: *This course may be taught together with CHEM 551 by the same instructor. Prerequisite: A minimum grade of C (2.0) in CHEM 341 or 351 and CHEM 401.*

9. Why is this course being proposed?

This course is being proposed as an upper division elective for the Biochemistry degree.

10. Mode of Instruction*
For definitions of the Course Classification Numbers:
http://www.csusm.edu/academic_programs/curriculumscheduling/catalogcurricula/DOCUMENTS/Curricular_Forms_Tab/Instructional%20Mode%20Conventions.pdf

Type of Instruction	Number of Credit Units	Instructional Mode (Course Classification Number)
Lecture	3	C-02
Activity		
Lab		

11. Grading Method:*
☒ Normal (N) *(Allows Letter Grade +/-, and Credit/No Credit)*
☐ Normal Plus Report-in-Progress (NP) *(Allows Letter Grade +/-, Credit/No Credit, and Report-in-Progress)*
☐ Credit/No Credit Only (C)
☐ Credit/No Credit or Report-in-Progress Only (CP)

12. If the (NP) or (CP) grading system was selected, please explain the need for this grade option.

13. Course Requires Consent for Enrollment? ☐ Yes ☒ No

☐ Faculty ☐ Credential Analyst ☐ Dean ☐ Program/Department - Director/Chair

14. Course Can be Taken for Credit More than Once? ☐ Yes ☒ No
If yes, how many times? (including first offering)

15. Is Course Crosslisted: ☐ Yes ☒ No

If yes, indicate which course and check "yes" in item #22 below.

16. Prerequisite(s): ☒ Yes ☐ No CHEM 341 or 351 and 401

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* If Originator is uncertain of this entry, please consult with Program/Department Director/Chair.

18. Documentation attached:
☐ Syllabus ☒ Detailed Course Outline

19. If this course has been offered as a topic, please enter topic abbreviation, number, and suffix:*

20. How often will this course be offered once established?* In a 1,5 to 2-year rotation of elective courses

PROGRAM DIRECTOR/CHAIR - COLLEGE CURRICULUM COMMITTEE SECTION:
(Mandatory information – all items in this section must be completed.)

21. Does this course fulfill a requirement for any major (i.e., core course or elective for a major, majors in other departments, minors in other departments)? ☒ Yes ☐ No

If yes, please specify:
Elective intended for the Biochemistry BS, but also may used for the Chemistry major.

22. Does this course impact other discipline(s)? (*If there is any uncertainty as to whether a particular discipline is affected, check "yes" and obtain signature.*) ☐ Yes ☒ No

If yes, obtain signature(s). Any objections should be stated in writing and attached to this form.

Discipline _____ (Signature) _____ (Date) _____Support _____Oppose

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SIGNATURES : (COLLEGE LEVEL) :

K. Hamadani 8/4/2016
1. Originator (please print or type name) Date

8/9/16
2. Program Director/Chair Date

12/14/16
3. College Curriculum Committee Date

12/14/16
4. College Dean (or Designee) Date

(UNIVERSITY LEVEL)

5. UCC Committee Chair Date

6. Vice President for Academic Affairs (or Designee) Date

7. President (or Designee) Date

Office of Academic Programs PS ~~Banner~~ Catalog Revised 3/28/2007

* If Originator is uncertain of this entry, please consult with Program/Department Director/Chair.

RP _____ Tracker ✓

CHEMISTRY 451/551: Biophysical Chemistry

Term: Fall, 2016

Prerequisites: CHEM 341 or 351 and CHEM 401

Class time: TBD

Class location: TBD

Instructor: Kambiz Hamadani

Inst. Office: Science II-331

Inst. Office hours: TBD

Inst. Phone: (760)750-4189

Inst. E-mail: khamadani@csusm.edu

Course Description: This course is intended for upper-division undergraduate or first-year graduate students in Biochemistry and serves to reinforce and apply fundamental principles from physical chemistry toward dynamic biological systems and processes such as protein folding, protein engineering, membrane protein biophysics, and translation. The course provides a brief review of thermodynamics, chemical kinetics, transport processes, chemical/physical equilibria, and electrochemistry as well as an introduction to some of the most-common techniques used to study biomolecular structural transitions, interactions, and conformational dynamics (e.g. calorimetry, optical spectroscopy, magnetic resonance spectroscopy, mass spectrometry, electrophysiology, and perturbation-relaxation methods). CHEM551 students will also read, discuss, and evaluate research articles which employ the methods described to address outstanding biological questions of interest.

Student Learning Outcomes: Upon completion of this course students should:

1. Understand the advantages and limitations of a wide variety of methodologies that are commonly used to study biomolecular structural transitions, interactions, conformational dynamics, and function.
2. Be able to select the most appropriate biophysical tool/method for solving/answering a given biological problem/question.
3. Gain a appreciation for the importance of physical chemistry in biology.
4. Graduate students should also be able to find and critically evaluate research articles by applying their understanding of the limitations of the biophysical tools introduced.

Required Textbook: "Physical Chemistry: Principles and Applications in Biological Sciences" by Ignacio Tinoco Jr., Kenneth Sauer, James C. Wang, Joseph D. Puglisi, Gerard Harbison, and David Rovnyak. **5th Edition**. Pearson, 2013

Supplemental Texts: The following texts are available in Dr. Hamadani's office:
"Biophysical Chemistry, Part I: The Conformation of Biological Macromolecules" by Charles R. Cantor and Paul R. Schimmel, 1st edition. Macmillan, 1980.

"Biophysical Chemistry, Part II: Techniques for the Study of Biological Structure and Function" by Charles R. Cantor and Paul R. Schimmel, 1st edition. Macmillan, 1980.

"Biophysical Chemistry: Part III: The Behavior of Biological Macromolecules" by Charles R. Cantor and Paul R. Schimmel, 1st edition. Macmillan, 1980.

"Physical Chemistry: with Applications to the Life Sciences" by David Eisenberg and Donald Crothers. 1st edition. Benjamin/Cummings Publishing. 1979.

"Frontiers in Molecular Biology: Mechanisms of Protein Folding" edited by Roger H. Pain. 2nd Edition. Oxford University Press. 2000.

"Molecular Driving Forces: Statistical Thermodynamics in Biology, Chemistry, Physics, and Nanoscience" by Ken A. Dill. 2nd Edition. Garland Science. December 3, 2010.

Cougar Courses: The course website can be accessed via cougar courses. The following will be available or done through the site:

- **(i).** Posting of all research articles and additional assignments.
- **(ii).** Public e-mail communication with the instructor, receiving notices from the instructor (make sure you are receiving the "test message" sent at the beginning o the semester).
- **(iii).** The syllabus
- **(iv).** Lecture notes (*also see below*).

If you are not already familiar with the use of Cougar Courses please consult the IITS help desk or the instructor as soon as possible.

Lecture Notes: PDF files of the slides that I use during the lecture will be available online via the campus Cougar Courses system. It is highly recommended that you print a copy of these files and bring it to class with you and take your own notes on them during lecture.

Topic Schedule: Given below is the topic list. Although every attempt will be made to adhere to this list the instructor reserves the right to adjust the time spent on each topic as well as the order of the topics.

Week	Physical Chemistry Topics	Biophysical Tools/Applications/Examples	Readings
1.	1st Law of thermo: E, w, & q	Molecular-Force Spectroscopy	Chp.1-2
2.	2nd/3rd Laws of Thermo: S, H, and G	Ratchets, Demons, & the F_1F_0-ATP Synthase	Chp. 3
3.	Chemical Equilibria: K_{eq}, Q, and G	Protein Folding, LFER's, Isothermal Calorimetry, Circular Dichroism, Trp Fluorescence	Chp. 4
4.	Statistical Thermodynamics	States, Distributions, Ensembles, & Averages	Chp. 5
5.	Physical Equilibria	Equilibrium Dialysis, Ligand Binding, Differential Scanning Calorimetry, Surface-Plasmon Resonance	Chp. 6
6.	Electrochemistry	Membrane transport, Na^+-K^+ ATPase, Nernst Eq, Voltage-gated ion channels, patch clamp methods	Chp.7
7.	Biomolecular Motion/Separations	Translational diffusion, friction, velocity and equilibrium sedimentation, viscosity, particle tracking, Fluorescence Correlation Spectroscopy, Dynamic Light Scattering, electrophoresis	Chp. 8

8.	Chemical Kinetics	Rate laws, steady-state, deducing mechanism, ligand-accelerated CuAAC, energy landscapes, Arrhenius theory, Transition-State theory, diffusion-limited reactions.	Chp. 9
9-10.	Biochemical Kinetics (no enzymology)	Intramolecular chain diffusion, Kramers' Theory, Hammond's Postulate, non-equilibrium relaxation, fluctuation-based methods, chemical/exchange-based approaches, protein/TS engineering, T-dependence, stochasticity and single-molecule kinetics, stop-flow, quench-flow. Phi-value analysis, isotope effects	Chp 9
Optnl.	Molecular Structure/Interaction (part I)	Brief intro to and history of quantum mechanics. particle-in-a-box and beta-carotene absorption, harmonic oscillator and IR absorption, hydrogen atom (exact solutions) versus many-electron systems (approximate solutions), hybrid orbitals.	Chp 11
Optnl.	Molecular Structure/Interaction (part II)	Molecular orbitals, delocalization, HOMO/LUMO. Classical approximations for 1). intramolecular bond stretching, bending, and rotation; and 2). Intermolecular non-covalent interactions. Energy Minimization. Molecular dynamics, Monte Carlo, & distributed computing. Folding@Home vs. Anton.	Chp 12
11-12.	Optical Spectroscopy	Vision, photosynthesis, light, refractive index, absorption/emission, transition dipoles, excited-state, lifetime/linewidth trade-off, quantum yield, fluorescence, phosphorescence, quenching, energy-transfer, polarization, anisotropy, polarizability nsFCS, PET/contact quenching, Circular Dichroism, IR absorption, Raman Scattering, smFluorescence, smFRET, surface-enhanced Raman	Chp 13
13-14.	Optical Imaging/Microscopy	Ensemble vs. single-molecule, confocal vs. wide-field, time-resolved vs. frequency-resolved, diffraction-limited vs. super-resolution, live cell imaging vs. *in-vitro* imaging, freely-diffusing vs. surface immobilized target, single-photon vs. multiphoton excitation, limitations imposed by aberrations and sample scattering. CARS, TIRF, FLIM, scanning-FCS, 2-photon microscopy, super-resolution approaches (STED, single molecule localization, structured illumination)	
Optnl.	Magnetic Resonance Spectroscopy	NMR, EPR, PRE, RDCs, restraints for MD sims,	Chp 14
Optnl	Mass Spectrometry	Mass Spec applications to biochemistry. Applications towards protein folding and drug-target interactions.	
15.	Research Project Presentations	Student-led discussions of research papers related to the course material.	

Exams: There will be 2 mid-term exams and a final examination. The two mid-term exams are scheduled as follows:

1st mid-semester exam – XX
2nd mid-semester exam – XX

This is a tentative exam schedule and may change.

The final exam is scheduled for XX from XX (note the time of the final is different from the normal class time) in room XX

Make up examinations will only be given if the student has a valid excuse (e.g. severe illness, death in the family) and notifies the instructor prior to test time (if possible). No make-up examination will be given unless the instructor is notified of the emergency within two (2) days of the test.

Please bring a green scantron and a scientific calculator without wireless communication capabilities to each examination.

Pop Quizzes: There will be a series of 5 in-class pop quizzes throughout the semester on material that was recently covered in lecture. You will have 15 minutes to complete each quiz. Your lowest score on one of the quizzes will be dropped.

Literature Project: At the end of the semester, students will submit a written presentation/analysis of a research article which they find interesting and which is related to a topic discussed in class. Students will select articles together in small groups and must get the approval of the instructor for the research article they choose. Graduate students will serve as peer-reviewers for the undergraduate papers and for their peers as well. Graduate students will also present their research to the class at the end of the semester.

Homework: Homework problems will be assigned from the textbook for each chapter covered. 4 of these assignments will be collected randomly and graded for credit.

Class participation: Students will be expected to actively participate in class discussions and will be graded on the quality and regularity of their participation.

Grading (points):

	Pts.	**% of grade**
Pop Quizzes (10 points each)	40	8%
Literature Project/Presentation	100	20%
Homework	80	16%
Midterm I	70	14%
Midterm II	70	14%
Class Participation	40	8%
Final Examination	100	20%
Total	500	100%

Letter grades: Letter grades will be assigned based on the following cutoff values:

Percentage	**Grade**
92% and above	A
90 - 91.9%	A-
88 – 89.9%	B+
82 – 87.9%	B
80 – 82.9%	B-
78 – 79.9%	C+

70 – 77.9%	C
68 – 69.9%	D+
62 – 67.9%	D
60 – 62.9%	D-
59.9% and below	F

Writing Requirement: The University Writing Requirement will be satisfied by the written assignments.

Use of Electronic Devices:

The use of cell phones, PDAs, or any other electronic device during exams is not allowed. Scientific calculators are permitted.

Use of Cellular Phones:

All cellular phones must be set to the silent mode. Please refrain from using your cellular phone during class. If you **must** answer your phone, due to an emergency, please leave the classroom.

Students with Disabilities:

Students with disabilities who require accommodation must be approved by the Office of Disabled Student Services (DSS). Please contact this office as soon as possible and meet with the instructor during office hours (or at some other mutually agreeable time). The DSS office is located in Craven hall 5205. Their telephone number is (760) 750-4905 or TTY (760) 750-4909.

Academic Honesty: All students are expected to maintain academic honesty. This is especially true with regards to the completion of assignments and homework. **All submitted work must be your own and must be written in your own words.**

All students should be familiar with the university policies and procedures concerning academic honesty as detailed in the university catalog. An online version of these polices and procedures can also be found at: http://lynx.csusm.edu/policies/procedure_online.asp?ID=187

Cheating, plagiarism, and other forms of academic dishonesty will not be tolerated. If you are caught cheating on an exam you will receive a grade of zero. All cases of academic dishonesty will be reported to the dean of students for appropriate action.

Use of Plagiarism Detection Software:

Where appropriate the instructor will use software (TURNITIN) for the detection of plagiarism. Plagiarized work will not be graded (see above).

Classroom Behavior and Student Code of Conduct:

Students are expected to respect and follow standards of student conduct while in class and on the campus. As your instructor, I have the following expectations concerning your behavior in this class:

1. Promote a courteous learning atmosphere by exhibiting mutual respect and consideration of the feelings, ideas, and contributions of others.
2. Practice consideration for others by maintaining a clean and orderly classroom.
3. Recognize everyone's opportunity to contribute information in a relevant and meaningful manner by not monopolizing discussions, interrupting, interjecting irrelevant, illogical or inappropriate questions or comments.
4. Do not dominate class discussion—give others a chance to contribute!
5. If you must eat in class do so discreetly.