UNIVERSITY OF CALIFORNIA at MERCED
SCHOOL of ENGINEERING

BEST 218

Advanced Bio-thermodynamics, Bio-kinetics and Bio-transport.
Number of Units: 4

Fall, 2018

Instructor: Dr. Arvind Gopinath, Dr. Anand Bala Subramaniam

Lecture: TBA (MW preferred)
Office Hours: Monday 3:00 pm - 4:00 pm
Wednesday 3:00 pm - 4:00 pm or by appointment
Office location:

AG SE2 384 agopinath@ucmerced.edu
ABS SE2 291 asubramaniam@ucmerced.edu

DESIGNATION

Biological Thermodynamics, Kinetics and Transport
Number of Units 4

CATALOG DESCRIPTION

A graduate level course specifically designed for emerging engineering disciplines that deal with living systems, the course will focus on graduate level thermodynamic aspects, kinetics and transport within living and biochemical systems. This course aims to provide *theoretical and conceptual* principles underlying biomolecular and biological systems. This course will be of particular value to BEST and BIOE graduate students interested in computational studies and modeling on topics relevant to bioengineering and biophysics, and statistical and thermodynamics based analysis of experimental data.

TEXTBOOKS and other REQUIRED MATERIALS

No required textbook. Materials will include handouts and notes. The following are useful references.

Physical Biology of the cell, Phillips R, Kondev J, Theriot J, Garland-Science
Molecular Driving Forces, K. A. Dill and S. Bromberg

COURSE GOALS

1. Learn the underlying principles related to thermodynamics, chemical kinetics and

transport in biological, biomolecular, biomaterial and biochemical systems.
2. Apply college level calculus and related mathematical principles to understand and reproduce the formulation of the governing equations.
3. Gain knowledge of topics in cutting-edge research by which biomaterial scientists study and apply methods to understand and predict phenomena.
4. Analyze contemporary case studies by reviewing current articles.
5. Be able to communicate knowledge gained to varying audiences.
6. Be able to identify research topics from the recent research papers.

LEARNING OUTCOMES

Course learning outcomes (CLO) are directly connected and relate to the following Program Learning Outcomes (PLO):

PLO 1: Possess a broad foundation in the fundamentals and current topics in either biomaterial science and biological engineering, as well as an in-depth understanding of their chosen research topic area.

PLO 2: Exhibit the quantitative experimental and analytical skills necessary to conduct and lead independent research and contribute to knowledge in their chosen area.

PLO 3: Be able to identify new, important, and interesting research opportunities, and be able to develop effective strategies, including the experimental plan, for pursuing these opportunities.

PLO 4: Communicate both fundamental concepts and details of their own research effectively, both in written and oral form, including in a classroom setting to expert and non-expert audiences.

PLO 5: Be able to critically evaluate the experimental design, data analysis and data interpretation of our peers.

The Course Learning Outcomes (CLOs) support student development of the Program Learning Outcomes (PLOs). The connections between the CLOs are made explicit through the indication of which PLOs are connected to each CLO below. By the end of the course, students will demonstrate

1. An understanding of the principles related to thermodynamics, chemical kinetics and transport in biological, biomolecular and biochemical systems. (PLO 1,2,3)
2. An understanding of the underlying mathematical principles underlying these physical concepts. (PLO 1,2)
3. An understanding of the techniques, skills and modern engineering tools necessary for engineering practice and application of these principles to engineer biomimetic systems. (PLO 1,2,5)
4. An ability to analyze contemporary theoretical and experimental studies to make

connections and decisions based on their scientific merit. (PLO 1,2,3,4,5)

5. An ability to communicate and function effectively on a multi-disciplinary team. (PLO 2,5)
6. An ability to strengthen self-learning methods and organizational skills to enhance problem-solving abilities and efficiency. (PLO 2,5)

Learning Outcomes will be assessed through exams, assignments, and classroom discussion. The course also relates to these following general learning outcomes:

(a)	an ability to apply knowledge of mathematics, science, and engineering	H
(b)	an ability to design and conduct experiments, as well as to analyze and interpret data	M
(c)	an ability to design a system, component, or process to meet desired needs	M
(d)	an ability to function on multi-disciplinary teams	M
(e)	an ability to identify, formulate, and solve engineering problems	H
(f)	an understanding of professional and ethical responsibility	M
(g)	an ability to communicate effectively	M
(h)	a recognition of the need for broad education necessary to understand the impact of engineering solutions in a global and societal context	L
(i)	a recognition of the need for, and an ability to engage in life-long learning	L
(j)	a knowledge of contemporary issues	M
(k)	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	H

H – High, M – Medium, L – Low

PREREQUISITES

Knowledge of thermodynamics (equivalent to ENGR 130), and either fluid mechanics or bio-transport phenomena (equivalent to BioE 104 or ENGR 120) is strongly preferred.

COURSE POLICIES

HOMEWORK ASSIGNMENTS

- Homework assignments are a critical component of this course and are designed to help you learn, understand and practice the material. Homework will be due on the dates indicated in the detailed schedule provided to course participants via CATCOURSES.
- Late homework will not be accepted.
- You are encouraged to work with your peers when doing homework. However, each student must turn in his/her own homework assignment and it must reflect his/her own work. You must explicitly identify all peers with whom you worked.

EXAMS

- There will be a midterm exam as indicated on the detailed schedule. This will comprise an open book part and a closed book part.

- In lieu of the final exam, we will have a final project.
- There will be no make-up exams.

DROPPING THE COURSE

- Please see the UC Merced General Catalog and the Registrar's / Student First website for details.

CATCOURSES

- The CATCOURSES site will be used for periodic course announcements, and for the distribution of class notes, discussion exercises, homework sets, and (some) solutions.
- You can check the scores that you have received on your homework assignments and exams.
- Warning: pay no attention to any letter grade that is reported on CATCOURSES, except for the final grade.

CONDUCT

- Students are expected to complete their own work and to abide by the UC Merced academic honesty policy, which can be found on the Student Life website http://studentlife.ucmerced.edu/ under the "Student Judicial Affairs" link.
- Note that most of the handouts provided in this course are protected by copyright, and are flagged accordingly on UCMCROPS. They are for your personal use only. Re-posting the files or their contents on sites such as (for example) "Course Hero" is an explicit violation of this copyright.
- Students and instructors are expected to honor UC Merced's Founding Principles of community http://www.ucmerced.edu/about-uc-merced/principles-community.

SPECIAL ACCOMMODATION

- The instructor will make every effort to accommodate all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance.
- Please speak with the lead instructor during the first week of class regarding any potential academic adjustments or accommodations that may arise due to religious beliefs.

ACADEMIC DISHONESTY STATEMENT

- Each student in this course is expected to abide by the University of California, Merced's Academic Honesty Policy. Any work submitted by a student in this course for academic credit will be the student's own work.

- Students are encouraged to study together and to discuss information and concepts covered in lecture and the sections with other students. You can give "consulting" help to or receive "consulting" help from such students. However, this permissible

cooperation should never involve one student having possession of a copy of all or part of work done by someone else, in the form of an email, an email attachment file, or a hard copy. Should copying occur, both the student who copied work from another student and the student who gave material to be copied will both automatically receive a zero for the assignment. Penalty for violation of this Policy can also be extended to include failure of the course and University disciplinary action.

- During examinations, you must do your own work. Talking or discussion is not permitted during the examinations, nor may you compare papers, copy from others, or collaborate in any way. Any collaborative behavior during the examinations will result in failure of the exam, and may lead to failure of the course and University disciplinary action.

DISABILITY STATEMENT

Accommodations for Students with Disabilities: The University of California Merced is committed to ensuring equal academic opportunities and inclusion for students with disabilities based on the principles of independent living, accessible universal design and diversity. Instructors are available to discuss appropriate academic accommodations that may be required for student with disabilities. Requests for academic accommodations are to be made during the first three weeks of the semester, except for unusual circumstances. Students are encouraged to register with Disability Services Center to verify their eligibility for appropriate accommodations.

TOPICS AND TENTATIVE WEEKLY SCHEDULE:

Week 1-2	Low Reynolds number flow, Buckingham-Pi theorem,
Week 3	Physical Kinetics: Diffusion & Transport; Permeation & Flow
Week 4	Thermodynamic Laws, Free Energy and Maxwell's Relations, Boltzmann Distribution Law, Onsager reciprocity theory
Week 5-6	Chemical potential, Thermodynamics in active and passive systems
Week 7-8	Chemical kinetics and transition state theory
Week 9-10	Motility and Movement: Biological motors and machines
Week 11-12	Biophysics and Biochemistry at surfaces: Glycans and Lipids
Week 13-14	Assembly and Activity: Protein folding

GRADES AND GRADING POLICY:

Assignments 40%, Final project 60 %

There will be 4 assignments worth 40% of the grade. The final project will be worth 40% of the grade.