



Course **BMEN 3315.501:**
Title Thermodynamics and Physical Chemistry in
Biomedical Engineering
Professor Stuart Cogan
Term Fall 2016
Meetings Tuesday & Thursday 5:30 pm – 6:45 pm, FO 3.222

Professor Cogan's Contact Information

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General Course Information

Pre- & Co-requisites; Other restrictions	(CHEM 1301 or (CHEM 1311 and CHEM 1312)) and (MATH 2415 or MATH 2419).
Course Description	An introduction to the fundamentals of thermodynamics and physical chemistry with an emphasis on applications in biomedical engineering. Topics include the four laws of thermodynamics, heat engines, free energy and reaction equilibria, colligative properties, acid-base equilibria, buffers, and chemical kinetics.
ABET CLOs (Course-learning Objectives)	1. Apply the first, second, and third laws of thermodynamics to macroscopic ideal and non-ideal systems, including gases, liquids, and solids. [ABET SO (a)] 2. Use thermodynamic principles to evaluate the operation and performance of engines such as Carnot and internal-combustion engines, and to solve related engineering problems. [ABET SO (e)] 3. Interpret and manipulate thermodynamic identities to mathematically derive quantities of interest and relate these quantities to experimental observables. [ABET SO (e)]
Additional Learning Objectives	4. Apply electrochemical potentials and the Nernst equation to the evaluation of reduction-oxidation reactions in engineered biological interfaces. 5. Apply basic principles of statistical thermodynamics to biomedical systems and molecular structure, recognition, and stability 6. Apply the basic principles of first and second order chemical kinetics to engineered biological systems.
Texts & Materials	Physical Chemistry: Principles and Applications in Biological Sciences (5th Ed) by I. Tinoco Jr., K. Sauer, J. C. Wang, J.D. Puglisi, G. Harbison, D. Rovnyak. ISBN-10: 0321883314; ISBN-13: 978-0321883315 (Textbook required). Other readings assigned as required. This material will be distributed through the eLearning web site. A hand-held calculator will be needed for all quizzes, problem sets and exams. Use of calculator programs on PDAs or similar devices is not permitted. This course will NOT require the use of a "clicker."

Assignments & Academic Calendar

[Topics, Reading Assignments, Due Dates, Exam Dates. T = Tinoco et al.]

Date	Topics	Assigned Reading
Tu 08/23	Course introduction, Introduction to thermodynamics; Zeroth Law, temperature scales, Heat, and Work.	Lecture notes
Th 08/25	Energy, The First Law, State variables.	T. Ch 2. 13-26.
Tu 08/30	The First Law & State variables (cont'd),	T. Ch 2. 26-30.
Th 09/01	Introduction to Enthalpy	T Ch 2, 30-36, Lecture Notes
Tu 09/06	Enthalpy and Phase Changes	T: Ch. 2, pp. 37-47
W 09/07	Last Day to Drop without a "W"	N/A
Th 09/08	Enthalpy and Phase Changes (cont'd)	Lecture notes
Tu 09/13	The Second Law: Spontaneity	T: Ch. 2, pp. 55-62
Th 09/15	The Carnot cycle and Entropy	T: Ch. 3, pp. 62-69
Tu 09/20	The Second Law (cont'd): Phase transitions, Free-energy functions, Maxwell relations.	T: Ch. 3, pp. 70-95.
Th 09/22	Exam No. 1 Review OR additional lecture material	Lecture notes
Tu 09/27	Exam No. 1 (covers material from 08/12 to 09/22)	N/A
Th 09/29	Free-energy Functions and Chemical Equilibria.	T: Ch. 4, pp. 101-126, Lecture notes
Tu 10/04	Free-energy Functions and Chemical Equilibria (cont'd);	T: Ch. 4, pp. 127-138
Th 10/06	Phase Equilibria single component systems	T: Ch. 6, 196-213
Tu 10/11	Phase Equilibria multicomponent systems	Lecture notes
Th 10/13	Electrochemistry, Redox Reactions, Membrane Potentials	T. Ch 6, 238-254
Tu 10/18	Electrochemistry, Redox Reactions, Membrane Potentials (cont'd)	Lecture notes
Th 10/20	Interfacial Thermodynamics and Colligative Properties	T: Ch. 6, 225-233
Tu 10/25	Interfacial Thermodynamics and Colligative Properties (cont'd)	T: Ch. 8, 264-278
Th 10/27	Acid-base Chemistry and Buffers	Lecture notes
Th 10/27	Last Day to Withdraw from an Undergraduate Course with WL	N/A
Tu 11/01	Transport Properties: Fick's laws, Diffusion	T: Ch. 8, pp. 269-274
Th 11/03	Exam No. 2 Review OR additional lecture material	N/A
Tu 11/08	Exam No. 2 (covers material from 09/29 – 11/03)	N/A
Th 11/10	Transport Properties (cont'd): Molecular size and shape, Sedimentation	T: Ch. 8, 272-286
Tu 11/15	Transport Properties (cont'd)	Lecture notes
Th 11/17	Statistical Thermodynamics: Concepts, The Maxwell-Boltzmann distribution, Partition functions	T: Ch. 5, 151-165
	Fall Break and Thanksgiving Holidays – no classes 11/21 to 11/25	
Tu 11/29	Statistical Thermodynamics (cont'd): Applications	T: Ch. 5, 151-165 Lecture notes
Tu 12/01	Chemical Kinetics: Concepts, Rate laws, Kinetic order, Molecularity	T: Ch. 9, 305-326
Tu 12/06	Chemical Kinetics (cont'd): Reaction mechanisms, Transition-state theory, Single-molecule kinetics	T: Ch. 9, 327-341
TBA	Final Exam Review	Lecture notes
TBA	Final Exam (covers material from 08/23 to 12/06)	N/A

Exam Dates and Times

09/27	Exam No. 1, in class
11/08	Exam No. 2, in class
TBA	Final Exam, Time and Location TBD

Course Policies

Grading (credit) Criteria	Homework (30%); in-class exams (2 at 20% each); final exam (cumulative, 30%). Homework may be discussed collaboratively amongst students currently enrolled, but each student must turn in an individual assignment.
Make-up Exams	There will be no make-up for in-class exams except for the most extreme of documented emergencies.
Extra Credit	Extra credit homework assignments are offered periodically
Late Work	No homework assignment will be accepted once an answer key has been posted.
Special Assignments	N/A
Class Attendance	Class attendance is highly recommended. Students are responsible for obtaining all missed lecture material or assignments.
Classroom Citizenship	<i>Cell-phone use:</i> Students are requested to use laptops, tablets and cell phones only for activities directly related to classroom activities at that time and otherwise turn-off or silence their devices during lectures and exams.
Comet Creed	<i>This creed was voted on by the UT Dallas student body in 2014. It is a standard that Comets choose to live by and encourage others to do the same:</i> <i>“As a Comet, I pledge honesty, integrity, and service in all that I do.”</i>
UT Dallas Syllabus Policies and Procedures	<i>The information contained in the following link constitutes the University’s policies and procedures segment of the course syllabus.</i> <i>Please go to http://go.utdallas.edu/syllabus-policies for these policies.</i>

Descriptions and timelines related to course content and scheduling are subject to change at the discretion of the Instructor.