CHEM35000/CHEM65000: BIOPHYSICAL CHEMISTRY

Syllabus Spring 2021

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COVID-19 DISTANCE LEARNING:

For spring 2021, this course will be taught using a hybrid format including synchronous recitation sessions and asynchronous lectures. For more details please see the document on the Blackboard: 'Distance Learning spring 2021'

Blackboard account: Each student **MUST** have an active Blackboard (Bb) account. Lecture videos, quizzes/exams and other announcement will be posted on the Bb.

TEXTBOOKS

1. ***Required***: «Physical Chemistry: Principles and Applications in Biological Sciences» by I. Tinoco, Jr., K. Sauer, J. C. Wang and J. D. Puglisi. Prentice Hall, 5th Edition, 2014.
2. «Physical Chemistry for the life sciences» by Peter Atkins and J. De Paula, 2nd Edition, Oxford University Press, 2011.

LEARNING OUTCOMES:

Upon completion of this course students are expected to acquire the following skills:

1. Be able to *calculate* thermodynamic parameters of chemical, biochemical and biological processes at a given condition (temperature, volume, pressure, concentration), and *calculate* the changes of these parameters with temperature, pressure, and concentration.
2. Be able to *describe* a system at equilibrium, and *predict* the changes of the equilibrium with the variations of temperature, pressure, and concentration.
3. Be able to *calculate the equilibrium concentration of species in a system*.
4. Be able to *determine* the kinetic order, the rate constant and the thermodynamic parameters of the transition state of a chemical reaction from experimental data.
5. Be able to *interpret* the simple molecular spectra of electron transition based on quantum mechanical principles.

Course Policies (*All contents are subjects to change at the instructor's discretion*.)

- 14% HW and recitations: There will be 14 HW work assignments –Each HW is 1 pt. (total 14 pts). HWs must be submitted on Bd by the indicated due dates. You may find both the assignments and the due dates in document 'Homework Assignments' on Bb.
- 16% Recitation participation. Attending recitation is mandatory. We will take attendance of every session. There will be tests, group problem solving activities etc. Your attendance and participation of the activities will account for 16% of your final grade. *The recitation starts the first week of the semester: Tues Feb 2/Thu Feb 4*.
- 30% quizzes: there will be a quiz associated with each lecture video. The quizzes will be giving on the Bd, and they have to be completed within 48 hr after the lecture is posted.

- 40% exams: two exams during the semester (each is 10 points or 10% of the final grade), plus a final (20 points, or 20% of the total grade). The format of the exams is pending College's policy on in-person exams. You will be updated on the situation.

Please always have a pen/pencil, a paper pad, and a calculator ready during recitation sessions for quizzes and problem solving practice.

Tips on *doing well* in Physical Chemistry

1) *Attend* classes – and read the relevant section of the textbook ***before*** coming to class.
2) *Attend* recitation sessions and ask questions.
3) Homework! Homework!! Homework!!! ***Solve*** the homework problems yourselves. Do not read the solution manual before making your own attempts.
4) ***Review*** relevant materials in Chem104: ideal gas, kinetics, Galvanic cell etc. ***Review/preview*** the material before coming into class and the *Mathematics Needed* at the end of each chapter. ***Review*** each chapter at the end using the *Summary* section at the end of each chapter as a guide.
5) Pay attention to *units* and the conversion of units during calculations.

Syllabus CHEM350/650, Spring 2021

WEEK	SUBJECTS	HW assignment
1. *Feb 2* *Feb 4*	Introduction. Review: ideal gas law, potential energy, work and heat, *p*13-21 **Chapter 2** *Internal Energy and Enthalpy*: The 1st law, the heat capacity of ideal gas, *w*, *q*, and ΔU of ideal *p*21-36	**HW 1** **Chapter 2**: 3, 5 (a and c), 17, 18
2. *Feb 9* *Feb 11*	**Chapter 2** *Internal Energy and Enthalpy*: *the* $\boldsymbol{\Delta H}$ of ideal gas, state functions, *w*, *q*, ΔU, ΔH of pure substances **Chapter 2** *Internal Energy and Enthalpy*: $\Delta_* U$, $\Delta_* H$ of phase change, *p36-39*	**HW 2** **Chapter 2**: 1, 6. 7, 9, 10, 11, 13, 15, 20
3. *Feb 16* *Feb 18*	**Chapter 2** *Internal Energy and Enthalpy*: $\Delta_r U$, $\Delta_r H$ of chemical reactions, the *T* dependence of $\Delta_R U$, $\Delta_R H$ *p39-47* **Chapter 3** *Entropy and Free Energy*: Introduction of entropy, the 2nd law of thermodynamics, calculations of entropy – dependence on *T* and *P* of ideal gas *p55-65*	**HW 3** **Chapter 2:** 26, 27, 28, 29 **Chapter 3:** 3, 7
4. *Feb 23* *Feb. 25*	**(*Supplemental*) The second law of thermodynamics** : the spontaneous process of an isolated system, Clausius Inequality**.** **Chapter 3** *Entropy and Free Energy***:** and the absolute entropy - the 3rd law of thermodynamics, the $\Delta_r S$ *and* $\Delta_* S$, p65-72 **Chapter 3** *Entropy and Free Energy*: ΔG and the directionality of a chemical reaction, *p72-75*	**HW 4** **Chapter 3**: 24, 10, 11, 13, 14
5. *March 2* *March 4*	**Chapter 3** *Entropy and Free Energy*: ΔG, ΔS of phase change, of chemical reactions, *p70, p75-80* **Chapter 3** *Entropy and Free Energy*: the *T* and *P* dependence – the thermodynamic cycle, *p87-93*	**HW5** **Chapter 3**: 16, 17, 21, 30
6. *March 9* *March 11*	**Chapter 4** *Chemical Equilibria*: chemical potential (μ) and the reactions of ideal gas, $\Delta_r G^0$ *and* $\Delta_r G$*, equilibrium constant K and the quotation of a reaction Q. p101-108* **Chapter 4** *Chemical Equilibria*: the reactions of solids and liquids, the standard states and activity. $\Delta_r G^0$, $\Delta_r G$ and $\Delta_r G'$*, p108-121*	**HW 6** **Chapter 4**: 1, 3, 5
7. *Mar 16,* *March 18*	**Exam I: Tuesday, March 16 on Chapter 2 and chapter 3** **Chapter 4** *Chemical Equilibria*: *P* and *T* dependence of *K,* pH of water at different temperature, the binding equilibrium of biomolecules *p121-143*	**HW 7** **Chapter 4**: 6, 12, 15, 16, 19
8. *Mar 23,* *March 25*	**Chapter 6** *Physical Equilibria*: phase equilibria of a pure substance at different *P* and *T*, the phase diagram and the phase rule, physical equilibria of a solution, *p196-203* **Chapter 6** *Physical Equilibria*: vapor pressure of solvent, Henry's law, the content of gases in water *p202-208*, the colligative properties *p225-230*	**HW 8** Chapter 6: 2, 3, 8, 23 10, 16, 20, 23

March 27 – April 4	***Spring Break***	
9. *April 6* *April 8*	**Chapter 7** *Electrochemistry*: the electrochemical potential, the ε^0 and ε, the biological redox reactions, *p238-247, p254-257* **Chapter 7** *Electrochemistry*: the transmembrane equilibria, the membrane potential and the Nernst equation *p247-254*	**HW 9** Chapter 7: 2, 3, 5, 9, 13
10. *April 13* *April 15*	**Exam II: Tuesday, April 13 on Chapters 4, 6 and 7** **Chapter 9**: Introduction to chemical kinetics – a review of CHEM104 the rate of a reaction, the 1st order reaction, *p305-317*	**HW 10** Chapter 9: 5 (a-d), 1 (a-c), 8
11. *Apr 20* *April 22*	**Chapter 9** *Kinetics*: the order of a reaction, the reaction mechanism, *p317-337* **Chapter 9** *Kinetics*: the *T* dependence of reaction rate, the transition state theory, *p338-344*	**HW 11** Chapter 9: 9, 12, 18, 19, 21
12. *Apr 27* *April 29*	**Chapter 11** *Quantum Theory*: the black body radiation, the Schrodinger's equation, *p408-415* **Chapter 11** *Quantum Theory*: Particle in a box, energy levels and the molecular spectroscopy *p423-430*	**HW 12** Chapter 11: 1, 5, 6,
13. *May 4* *May 6*	**Chapter 11** *Quantum Theory*: Harmonic oscillator, rigid rotator, the line spectrum of H-atom *p430-440* **Chapter 5** *Statistical Thermodynamics*: Boltzmann distribution, statistical mechanics entropy, *p151-164*	**HW 13** Chapter 11: 7, 10, 14, 19
14. *May 11,* *May 13*	**Chapter 5** *Statistical Thermodynamics*: the partition function, *p158-166* **Review of chapter 11 and Chapter 5**	Chapter 5: 2, 8, 19, 20
	Final Exam: Tuesday, May 25, 5:20-7:20 PM	

"Hunter College regards acts of academic dishonesty (e.g., plagiarism, cheating on examinations, obtaining unfair advantage, and falsification of records and official documents) as serious offenses against the values of intellectual honesty. The college is committed to enforcing the CUNY Policy on Academic Integrity and will pursue cases of academic dishonesty according to the Hunter College Academic Integrity Procedures."

ACCOMODATIONS FOR STUDENTS WITH DISABILITIES

In compliance with the ADA and with Section 504 of the Rehabilitation Act, Hunter is committed to ensuring educational access and accommodations of all its registered students. Hunter College's students with disabilities and medical conditions are encouraged to register with the Office of AccessABILIY for assistance and accommodation. For information and appointment contact the ***Office of AccessABILITY located in Room E1214 or call (212) 772-4857 /or TTY (212) 650-3230***