جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Aquatic Chemistry - EnSE 202

Division	Biological and Environmental Sciences & Engineering Division
Course Number	EnSE 202
Course Title	Aquatic Chemistry
Academic Semester	Fall
Academic Year	2018/2019
Semester Start Date	08/26/2018
Semester End Date	12/11/2018
Class Schedule (Days & Time)	02:30 PM - 04:00 PM | Sun Wed

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Himanshu Mishra	himanshu.mishra@kaust.edu.sa	+966128082110	4276, 4, Al-Jazri (bldg. 4)	Please speak with the instructor after the class

Teaching Assistant(s)

Name	Email
No teaching assistants	

Course Information

Comprehensive Course Description	**EnSE 202** is a core course in the Environmental Science and Engineering program specially designed for students from various backgrounds, such as engineering—chemical, civil, materials, mechanical, and bio—along with hydrology, biosciences, and chemistry. Throughout the course, a special emphasis is laid on developing problem-solving skills, in-depth derivations of theoretical models, quantitative thinking, and back-of-the-envelope calculations. Key topics include: 1. Introduction to aquatic chemistry: Molecular picture of water and its interfaces, ways to express concentrations in liquid- and gas-phases, e.g. molarity, normality, equivalent mass, ppm, ppb, ppt, TDS, TIC, DOC, TOX, and CaCO--3 2. Chemical equilibrium: activity coefficients, Debye-Hückel theory, Davies model 3. Chemical Kinetics: First-, second-, pseudo first- and higher–order reactions; Temperature dependence of rate constants, Opposing reactions, parallel reactions, consecutive reactions, unimolecular decomposition, Oscillating reactions. 4. Acids and Bases: autodissociation of water; dissociation of strong acids/bases, dissociation of weak acids/bases—speciation as a function of pH, multiprotic weak/strong acids/bases, log*C*-pH plots. 5. Gas-Liquid Equilibrium: Henry's law, Gas-dissolution and aqueous phase speciation and equilibrium pH 6. Miscellaneous topics: Ideal gas theory, solubility products, Langmuir adsorption isotherms, transition state theory, surface tension, wetting of rough surfaces… In addition, a significant component of the course is the Individual Term Project, which students are encouraged to pick based on their MS/PhD thesis research. The expected outcome is a concise 2-page report with significant emphasis on scientific writing and a polished 15 minutes talk followed by an intense 15-minute Q&A session, evaluated by the class and the instructor. **Suggested reference book:** Water Chemistry, Mark Benjamin (IInd Edition)
Course Description from Program Guide	Chemistry of processes in aquatic systems. Natural water composition, characteristics and analysis (inorganic and organic composition, ionic balance, pH, conductivity, turbidity), acids and bases, carbonate system, chemistry of metals, precipitation, redox chemistry.
Goals and Objectives	**EnSE 202** is a core-course in the Environmental Science and Engineering program specially designed for students from various backgrounds, such as engineering—chemical, civil, materials, mechanical, and bio—along with hydrology, biosciences, and chemistry. Throughout the course, a special emphasis is laid on developing problem solving skills, in depth derivations of theoretical models, quantitative thinking, and back-of-the-envelope calculations. Key topics include: 1. Introduction to aquatic chemistry: Molecular picture of water and its interfaces, ways to express concentrations in liquid- and gas-phases, e.g. molarity, normality, equivalent mass, ppm, ppb, ppt, TDS, TIC, DOC, TOX, and CaCO--3 2. Chemical equilibrium: activity coefficients, Debye-Hückel theory, Davies model 3. Chemical Kinetics: First-, second-, pseudo first- and higher–order reactions; Temperature dependence of rate constants, Opposing reactions, parallel reactions, consecutive reactions, unimolecular decomposition, Oscillating reactions. 4. Acids and Bases: autodissociation of water; dissociation of strong acids/bases, dissociation of weak acids/bases—speciation as a function of pH, multiprotic weak/strong acids/bases, log*C*-pH plots. 5. Gas-Liquid Equilibrium: Henry's law, Gas-dissolution and aqueous phase speciation and equilibrium pH 6. Miscellaneous topics: Ideal gas theory, solubility products, Langmuir adsorption isotherms, transition state theory, surface tension, wetting of rough surfaces… In addition, a significant component of the course is the individual Term project, which students are encouraged to pick based on their MS/PhD thesis research. The expected outcome is a concise 2-page report with significant emphasis on scientific writing and a polished 15 minutes talk followed by an intense 15-minute Q&A session, evaluated by the class and the instructor. **Suggested reference book:** Water Chemistry, Mark Benjamin (IInd Edition)
Required Knowledge	basic chemistry (concept sof moles, molarity), basic mathematics (calculus, algebra, logarithm scale)
Reference Texts	Water Chemistry, Mark Benjamin (IInd Edition) The instructor will provide additional reading material.

Method of evaluation	**20.00**% - Final exam **20.00**% - Midterm exam **10.00**% - Homework /Assignments **40.00**% - Course Project(s) **10.00**% - Active participation
Nature of the assignments	-Problem sets -Mid-terms -Individual Term Projects: -Reading scientific literature, -Scientific writing (a 2-page concise report) -Class presentation (15 minutes followed by a 10-15 minutes Q&A session) **The Instructor will help the students identify the term projects.**
Course Policies	I do not mind students missing classes as long as they perform well in mid-terms and final presentation/report.
Additional Information	Bring crazy ideas, Ask lots of questions, THINK!!

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Sun 08/26/2018 Wed 08/29/2018	[{"DayId":8262018,"Details":" Introduction to Phreeqc ","Id":1},{"DayId":8292018,"Details":" Space inside the lattice of water; Various ways to express concentrations: molarity, normality, ppm, ppb, ppt Examples ","Id":1}]
2	Sun 09/02/2018 Wed 09/05/2018	[{"DayId":9022018,"Details":" Various ways to express concentrations: TOC, DIC, TDS, TOX ","Id":2},{"DayId":9052018,"Details":" Various ways to express concentrations: TOC, DIC, TDS, TOX ","Id":2}]
3	Sun 09/09/2018 Wed 09/12/2018	[{"DayId":9092018,"Details":" Examples on Conductivity and mole fraction; Activity and activity Coefficients; Relative Humidity--water concentrations? Standard States, Examples on calculating activities ","Id":3},{"DayId":9122018,"Details":" Refresher on electrostatics: basics of electrostatics-electrical fields, electrical potentials ","Id":3}]
4	Sun 09/16/2018 Wed 09/19/2018	[{"DayId":9162018,"Details":" Refresher on electrostatics: basics of electrostatics-Gauss's law, Poisson-Boltzman eqn. ","Id":4},{"DayId":9192018,"Details":" Poisson-Boltzman equation and its solution leading to Debye length + Derivation of the Debye-Huckel model ","Id":4}]
5	Sun 09/23/2018 Wed 09/26/2018	[{"DayId":9232018,"Details":" No Class (Saudi National Day) ","Id":5},{"DayId":9262018,"Details":" Energy and Mass Balances: mass conservation ","Id":5}]
6	Sun 09/30/2018 Wed 10/03/2018	[{"DayId":9302018,"Details":" Energy and Mass Balances: first and second law of thermodynamics ","Id":6},{"DayId":10032018,"Details":" Reaction Kinetics: Rates of reactions; Orders of Zeroth, 1st, 2nd, 3rd, oscillating reactions; Rate limiting steps, catalysts ","Id":6}]
7	Sun 10/07/2018 Wed 10/10/2018	[{"DayId":10072018,"Details":" Reaction Kinetics: Rates of reactions; Orders of Zeroth, 1st, 2nd, 3rd, oscillating reactions; Rate limiting steps, catalysts ","Id":7},{"DayId":10102018,"Details":" Acid-salt equilibria#1(i) Autoionzation of water; Strong acids and bases; Weak acids and bases: pKa - pH dependence; Weak acids + salts: concentrations ","Id":7}]
8	Sun 10/14/2018 Wed 10/17/2018	[{"DayId":10142018,"Details":" Acid-salt equilibria#1(i) Autoionzation of water; Strong acids and bases; Weak acids and bases: pKa - pH dependence; Weak acids + salts: concentrations ","Id":8},{"DayId":10172018,"Details":" Introduction to Phreeqc ","Id":8}]

9	Sun 10/21/2018 Wed 10/24/2018	[{"DayId":10212018,"Details":" Review of concepts prior to the Exam ","Id":9},{"DayId":10242018,"Details":" Midterm (Concentrations, Activity, Kineics, Acid-Base equilibria, Gas-liquid equlibrium, Energy & Mass Balances) ","Id":9}]
10	Sun 10/28/2018 Wed 10/31/2018	[{"DayId":10282018,"Details":" No class (break) ","Id":10},{"DayId":10312018,"Details":" Midterm solution, Clinic for the Final Presentations (Reports due a week before the talk) ","Id":10}]
11	Sun 11/04/2018 Wed 11/07/2018	[{"DayId":11042018,"Details":" Water thermodynamics: Cp, sensible and latent heat, intro to thermal desalination ","Id":11},{"DayId":11072018,"Details":" Gas-liquid equilibrium: Henry's constants, Gas-liquid-pH equilibrium ","Id":11}]
12	Sun 11/11/2018 Wed 11/14/2018	[{"DayId":11112018,"Details":" Misc. Lecture: Pollutants and water treatment ","Id":12},{"DayId":11142018,"Details":" Misc. Lecture: (i) Suface Tension, (ii) Contact angles, (iii) Laplace Pressure, (iv) Wetting of rough surfaces ","Id":12}]
13	Sun 11/18/2018 Wed 11/21/2018	[{"DayId":11182018,"Details":" Misc. Lecture: (i) Suface Tension, (ii) Contact angles, (iii) Laplace Pressure, (iv) Wetting of rough surfaces ","Id":13},{"DayId":11212018,"Details":" Misc. Lecture ","Id":13}]
14	Sun 11/25/2018 Wed 11/28/2018	[{"DayId":11252018,"Details":" Final Exam ","Id":14},{"DayId":11282018,"Details":" FINAL PRESENTATIONS ","Id":14}]
15	Sun 12/02/2018 Wed 12/05/2018	[{"DayId":12022018,"Details":" Final Presentations (if any) Course over. ","Id":15},{"DayId":12052018,"Details":" Misc. Lecture ","Id":15}]
16	Sun 12/09/2018	[{"DayId":12092018,"Details":" Misc. Lecture ","Id":16}]

Note

The instructor reserves the right to make changes to this syllabus as necessary.