UNIVERSITY OF CALIFORNIA, MERCED
ES 280 – Natural Treatment Systems (3 units)
Fall 2017
SSM 150, MW 10:30-11:45 pm

Instructor: Marc Beutel; SE1 210; mbeutel@ucmerced.edu
Office Hours: M 12-1:30 pm SE1 210, or by appointment

I. Course Description: This course presents a comprehensive introduction to the emerging field of natural treatment systems, focusing on nutrient removal in free water surface treatment wetlands. The course consists of lectures on types of wetland treatment systems, wetland structure and function, modeling wetland pollutant removal, and treatment wetland case studies. Particular emphasis will be placed on nitrogen and phosphorus biogeochemistry. The course also includes quantitative homework sets, in-class student presentations, and field trips related to pollutant removal in treatment wetlands.

II. Course Goal and Outcomes:

a. ***Course Goal:*** The overarching goal of this course is for students to gain a qualitative and quantitative understanding of pollutant removal in natural treatment systems. Students will achieve this goal through a rigorous program of lectures, reading, in-class student presentations, homework sets, exams, and field trips.

b. ***Learning Outcomes:*** Select learning outcomes for this course include:
- Describe the advantages and disadvantages of the three categories of treatment wetlands.
- Develop a water budget for a free water surface (FWS) treatment wetland.
- Perform hydraulic and water surface profile calculations for a FWS treatment wetland.
- Calculate an energy balance and calculate water temperature in a FWS treatment wetland.
- Develop a dissolved oxygen mass balance for a FWS treatment wetland.
- Describe wetland microbial processes including aerobic respiration, anaerobic respiration, heterotrophy, autotrophy, lithotrohy, and phototrophy.
- Explain the key ways in which vegetation affects chemical cycling in wetlands.
- Describe the concept of redox zonation and give examples of common biogeochemical redox transformations in treatment wetlands.
- Develop and apply the P-k-C* model to predict pollutant removal in treatment wetlands.
- Develop and apply a mathematical model to quantify uncertainty in predicting pollutant removal in treatment wetlands.
- Describe the nitrogen cycle and phosphorus cycle in treatment wetlands.
- Explain how temperature, season and pollutant loading affects the cycling of nutrient in treatment wetlands
- Use a loading curve and the P-k-C* model to size a FWS treatment wetland for the removal of nitrogen and phosphorus from wastewater.

c. ***Relation to Program Learning Outcomes:*** The course supports the program learning outcomes of the Environmental Systems graduate program at UC Merced

(es.ucemerced.edu). The course will enhance student's core knowledge of environmental systems through application of science and engineering principles with the aim of developing student's capacity to independently identify important research questions, develop experimental plans, analyze data, and formulate conclusions. The course will also improve student's communication skills via student presentations of research results with the aim of informing both scientific peers and non-technical decision makers. Finally, the course will promote interest in community and life-long learning through field trips to community treatment wetlands in the region and engagement with emerging topics in natural treatment system technology.

III. Course Format: The course is mainly structured as interactive lectures in which material is presented in real time on the board by me, with students being asked to help explain and interpret the lecture material. Lectures will be supplemented with PowerPoints of key figures and tables from the text book. Course material will be made available in a timely manner via CatCourses. Students are strongly encouraged to ask questions during lectures and share any insights or appropriate comments they may about the lecture material.

The course is tightly structured around the required text book (Treatment Wetlands, 2nd Edition, Kadlec and Wallace), so it is important that students have the text book. In addition, it is critical that students do assigned reading before lectures. Reading is needed to prepare for daily questions, a set of questions that students will be randomly asked during lecture. Finally, it is important for students to engage with the course material by taking notes (i.e., copying down what is put on the board and what is said by the professor and students) as the lectures unfold. Finally, work load expectations are around 3 hours per week per course unit including class lectures. Thus you are expected to study a minimum of 6 hours per week outside of class time for this 3 unit course.

IV. Course Requirements:

a. ***Class attendance and participation policy:*** Your active participation during lecture is a critical component of the course and is important to both its success and your ability to learn course material. To optimize your learning effectiveness, it is critical that you take detailed notes during lecture as we develop and discuss course material on the board. Your discussions in class, your response to daily questions, your note taking activities, and your attendance will be recorded. Course participation will be worth 10% of your grade. The following rubric will be used to assess your level of participation in the course:

- Excellent (A): Regularly makes thoughtful and appropriate contributions to discussions that seek to broaden understanding and application of material. Actively takes detailed notes and engages in lectures. Minimal absences.
- Good (B): Occasionally makes thoughtful and appropriate contributions to discussions that seek to broaden understanding and application of material. Actively takes detailed notes and engages in lectures. Occasional absences.
- Fair (C): Infrequently makes contributions to discussions with only a basic attempt to broaden understanding and application of material. Takes some notes and is passive during lectures. Modest number of absences.
- Poor (D/F): Almost never makes contributions to discussions with superficial or off-topic comments that do not broaden understanding and application of material. Takes no notes and does not engage with lectures. Frequent absences.

b. ***Course readings:*** Treatment Wetlands, 2nd Edition, Kadlec and Wallace (2009). This book is mandatory for the class. Perform the assigned reading before lectures and in consultation with the daily questions so that you are prepared to answer the daily questions in class.

c. ***Course assignments and projects:*** Course assignments and projects include: (i) daily questions, (ii) in-class student presentations, (iii) five homework assignments, (iv) three course exams, and (v) two fieldtrips. These are outlined below.

- Daily Questions (DQs) related to upcoming lecture topics will be distributed to the class prior to lectures. DQs are meant to help students understand what material in the text to focus on, as well as prepare for lectures and exams. During lecture, random students will be asked to address DQs and the quality of responses will be recorded and applied to your course participation grade.
- One two occasions, students will orally present a summary of a scientific paper on treatment wetlands to the class. The presentations will focus on emerging topics in natural treatment system technology and communicating results to both scientific peers and non-technical decision makers. You will be given a grading rubric for the presentations. In-class presentations account for 10% of your grade.
- Students will submit five intensive homework assignments, corresponding to the five sections in the course, on the due dates noted on the course schedule at end of syllabus. Start the assignments early, work with other students within the constraints noted below in the Academic Integrity section, and meet with me in office hours to discuss questions related to the assignments before they are due. Homework accounts for 20% of your grade.
- The course includes three exams, each worth 20% of your final grade, as detailed in the course schedule at end of the syllabus. Students will be allowed one page of notes for each exam (8 ½ inches by 11 inches). Students are expected to take all exams at the scheduled time. Failure to do so will result in an exam score of zero.
- We will have two mandatory field trips to treatment wetland facilities in the San Joaquin Valley at yet to be determined locales.

V. Grading Procedures: Final grades will be estimated based on the following breakdown: class participation, 10%; in-class presentations, 10%; homework, 20%; three exams, 60%. Note that you must get 73% or higher on the exam component of the course to get a C or better in the class. Final grades will be assigned on the following standard scale. I may adjust the scale accordingly at the end of the semester to ensure that an appropriate allocation of grades is obtained.

97 to 100	A+	87 to 89.9	B+	77 to 79.9	C+	60 to 66.9	D
93 to 96.9	A	83 to 86.9	B	73 to 76.9	C	below 60	F
90 to 92.9	A-	80 to 82.9	B-	70 to 72.9	C-		

VI. Course Schedule: A detailed course schedule is attached. The schedule is subject to change, but we will do our best to follow this schedule.

VII. Academic Integrity:

a. 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.

b. You 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 electronic or 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.

c. 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.

VIII. Other Announcements:

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. I am 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 to verify their eligibility for appropriate accommodations.
Contact Information: (209) 228-4542; SSB 230

Counseling and Psychological Services
The mission of UC Merced Counseling and Psychological Services (CAPS) is to support the mental health and well-being of our students. It is the intention of all CAPS staff to provide a safe, confidential atmosphere of acceptance and accessibility to professionals in the field of psychology.
Contact Information (Confidential Help): (209) 228-4266; counseling@ucmerced.edu

Discrimination & Sexual Violence Prevention
The University of California is committed to creating and maintaining a community where all individuals who participate in university programs and activities can work and learn together in an environment free of harassment, exploitation or intimidation.
Contact Information: (209) 285-9510; msalvador2@ucmerced.edu, Director Michael Salvador

CARE Office
Campus Advocacy, Resources, & Education (CARE) provides prevention education for the UC Merced community to achieve an environment free from the threat of sexual violence, dating/domestic violence, and stalking. They provides free and confidential assistance for all UC Merced affiliates including undergraduate students, graduate students, staff and faculty.
Contact Information (Confidential Help): (209) 386-2051; KL 107

Week	Day	Lecture Topic	Text Reading	Home-work Problems	Daily Questions
	Section 1. Introduction				
	W, Aug 23	Course Introduction; Introduction to Wetlands	TW 1.1-1.4		DQ1
Week 1	M, Aug 28	Wetlands Hydrology; Hydrologic Nomenclature; Wetland Water Budget	TW 2.1		DQ2
	W, Aug 30	Hydraulics of Free Water Surface Wetlands	TW 2.2		DQ3
Week 2	**Section 2. Wetland Structure and Function**				
	M, Sept 4	*Holiday*			
	W, Sept 6	*No Class*			
Week 3	M, Sept 11	Biomass and Growth; Decomposition; Treatment Wetland Vegetation Types	TW 3.1-3.5	**HW 1 Due**	DQ4
	W, Sept 13	Wetland Energy Flows; Evapotranspiration; Water Temperature	TW 4.1-4.3		DQ5
Week 4	M, Sept 18	Air, Water and Soil Chemical Interactions I: Oxygen Dynamics; Volatilization	TW 5.1-5.3		DQ6
	W, Sept 20	Air, Water and Soil Chemical Interactions II: Oxidation-Reduction Potential, pH	TW 5.4-5.6		DQ7
Week 5	M, Sept 25	Review		**HW 2 Due**	
	W, Sept 27	**Exam 1**			
Week 6	**Section 3. Reactor Kinetics and Quantifying Treatment Performance**				
	M, Oct 2	Review of Reactor Kinetics			DQ8
	W, Oct 4	Representing Treatment Performance I: Variability; Mass Balances	TW 6.1-6.3		DQ9
Week 7	M, Oct 9	Representing Treatment Performance II: Removal Processes; Hydraulics	TW 6.4-6.5		DQ10
	W, Oct 11	Representing Treatment Performance II: Removal Processes; Hydraulics	TW 6.4-6.5		DQ11

Week	Day	Lecture Topic	Text Reading	Home-work Problems	Daily Questions
Week 8	M, Oct 16	Representing Treatment Performance III: P-k-C* Model; Temperature Effects	TW 6.6-6.8		DQ12
	W, Oct 18	Representing Treatment Performance III: P-k-C* Model; Temperature Effects	TW 6.6-6.8		DQ13
Week 9	M, Oct 23	Review		**HW 3 Due**	
	W, Oct 25	**Exam 2**			
Week 10	**Section 4. Nitrogen Removal in Wetlands**				
	M, Oct 30	Nitrogen in Wetlands; Effects of Vegetation; Nitrogen Mass Balances	9.1-9.5		DQ14
	W, Nov 1	Organic N, TKN and TN Removal; Ammonia Removal	9.6-9.9		DQ15
Week 11	M, Nov 6	Organic N, TKN and TN Removal; Ammonia Removal	9.6-9.9		DQ16
	W, Nov 8	Nitrate Removal; Sequential Nitrogen Removal	9.10-9.11		DQ17
Week 12	M, Nov 13	Student Journal Paper Presentations (N focus)		**HW 4 Due**	
	Section 5. Phosphorus Removal in Wetlands				
	W, Nov 15	Phosphorus in Wetlands	10.1-10.2		DQ18
Week 13	M, Nov 20	Spatial and Temporal Effects	10.3-10.4		DQ19
	W, Nov 22	*Thanksgiving Break*			
Week 14	M, Nov 27	Phosphorus Removal in Free Water Surface Wetlands	10.5-10.8		DQ20
	W, Nov 29	Phosphorus Removal in Free Water Surface Wetlands	10.5-10.8		DQ21
Week 15	M, Dec 4	Student Journal Paper Presentations (P focus)			
	W, Dec 6	Review		**HW 5 Due**	
	Sat, Dec 9	**Exam 3, 8-11 am**			