COURSE SYLLABUS
GEOL 2000/ESS 2000 – Geochemical Cycles and the Earth System
Fall 2019

Dr. Kimberly Lau, ESB 3012, kimberly.lau@uwyo.edu
Office hours: M and W 10 to 11 am and Th 1 to 2 pm, or by appointment via email

TAs:
Grant Copeland, ESB 1036, gcopelan@uwyo.edu
Cody Pridmore, GE 10, cpridmo1@uwyo.edu

COURSE SCHEDULE:

Lectures:	MWF, 9:00-9:50, Room 216 SH Knight Geology
Labs:	Tues., 1:10-3:00 (section 10), Room ESB 1038, Grant Copeland
	Tues., 3:10-5:00 (section 12), Room ESB 1038, Cody Pridmore
	Tues., 5:10-7:00 (section 11), Room ESB 1038, Cody Pridmore
	Wed., 3:10-5:00 (section 13), Room ESB 1038, Grant Copeland

Labs: Bring calculator and text to lab; computers will be available for the labs that need them. You can use your own laptop for some exercises. Some of the labs use software installed on the UW computers.

PREREQUISITES:
A 4-credit 1000-level science course with lab; for geology majors this must be a 1000-level geology lab course. For ESS majors this must be a 1000-level lab course that meets ESS requirements. CHEM 1020 must be taken prior to, or concurrently with, this course.

COURSE DESCRIPTION:
This course introduces the Earth system, bringing together elements of the solid Earth, hydrosphere, biosphere and atmosphere to achieve a more integrated view of the Earth's major interacting parts – in other words, the Earth as a system. First, we explore the origins of the elements, the solar system, and the Earth. We then cover systems concepts in the context of Earth science. We examine the interactions between the components of the Earth system, along with their major past changes, recognizing that rocks provide a record of past conditions and are key to understanding how the Earth system works over the long term. This helps us understand where our resources come from and the effects of utilizing them. Understanding the Earth system helps us understand today's global issues such as resource availability (water, food, materials, and energy), global climate change, and changing biodiversity. An understanding of Earth's past changes helps us understand Earth's present – and future - changes.

COURSE OBJECTIVES:
By the end of this course, you should be able to:
1) Explain to others the origins of the universe, the elements, the solar system, and the Earth on a sound scientific basis including an understanding of the structure of atoms, isotopes, nucleosynthesis, radioactive decay, neutron capture, and other processes.
2) Mathematically describe exponential decay as applied to radiometric dating of rocks and other materials.
3) Understand and quantitatively apply the concept of steady state in many different contexts.
4) Understand the difference between perturbations and forcings, interactions between the parts of a system, positive and negative linkages between system parts, and positive and negative feedback in systems of interacting parts.

5) Understand and construct computer models of simple systems.
6) Explain to others the Earth's energy balance between the total input of energy to the planet from the sun and total output of energy from the planet in the form of radiation, including the application of steady state concepts to this balance (see number 3 above).
7) Explain to others how a system of interacting parts can be self-regulating, (e.g., the Daisyworld model).
8) Understand the major factors in atmospheric circulation on Earth, including heat and mass transport, pressure gradients, geostrophic winds, etc.
9) Understand the major factors in ocean circulation on Earth, including gyres, thermohaline circulation, convergent and divergent circulation, etc.
10) Understand the major components of the Earth's cryosphere.
11) Explain to others the circulation of the solid Earth (plate tectonics).
12) Understand the major components of the Earth's carbon cycle, including the difference between organic and inorganic carbon, major carbon reservoirs, and the flux of carbon between reservoirs.
13) Understand the basics of how carbon dioxide dissolves in water to create carbonic acid.
14) Understand the basics of energy flow through biological systems, including the ability to recognize photosynthesis and respiration; understand the necessities of life such as sources of carbon, of water, and of energy.
15) Understand the basics of the genomic tree of life and a few basic relationships among the different major branches of living things.
16) Understand the properties of the earliest life forms, their basic chemical requirements, and their impact on the global environment over long periods of time.
17) Understand the difference between oxidizing and reducing conditions, the oxygen cycle on Earth, and the rise of oxygen in Earth's atmosphere due largely to biological activity.
18) Understand and explain the major outlines of Earth's climate regulation systems.
19) Understand what is meant by basic biological terms such as taxonomy, extinction, natural selection, evolution, adaptation – and understand major events in the history of biology and biodiversity on Earth and their relationship to climate changes and major events such as asteroid impact events.
20) Understand the major outlines of Earth's climate history, including major glaciation events.
21) Understand the Earth's orbital parameters and their influence on solar energy input to Earth (Milankovich cycles).
22) Understand current thinking with regard to the origins and feedbacks affecting ice ages during the last ~800,000 years of Earth's history.
23) Understand the scientific reasoning behind climate change and global warming on Earth now and in the future, with reference to past climate events that affected people profoundly.
24) Understand how large the anthropogenic carbon, nitrogen, and other fluxes are compared to natural fluxes (flows of energy or material between reservoirs in a system).
25) Understand the limits of exponential growth and ideas concerning the carrying capacity of Earth with regard to its human and other populations.
26) Understand the basics of Laramie's municipal water supply with regard to local geological structures.
27) Be able to solve quantitative problems with regard to exponential decay, exponential growth, steady state, the interaction of a system's parts, atmospheric concentrations and masses, energy input and output, matter and energy fluxes, mineral formulae and their meaning, and atmospheric processes.

TEXTS AND READINGS:

Required textbook: *The Earth System, 3rd edition*, by Kump, Kasting, and Crane, Pearson Prentice-Hall, 2010. We will also post, on the course website, supplements covering subjects that the textbook does not cover. You are expected to read all chapters that are covered in class along with the supplements. In addition, you will be assigned problems from the book, usually from the "Critical Thinking Problems" at the end of each chapter.

COURSE REQUIREMENTS AND EXPECTATIONS:

Format: GEOL/ESS 2000 consists of 3 lectures per week, a laboratory exercise on all but the first and last weeks of class, and homework problems handed out or assigned from the book every Monday and due every Friday (in class, including exam weeks) except the first and last weeks of class. There is a "practice" problem set the first week of class that must be turned in. It will not be graded formally, but credit will be lost from the subjective evaluation as noted below if it is not turned in.

University Studies: GEOL/ESS 2000 carries an "SE" designation under the older University Studies Program requirements (but does not carry a "PN" designation). As such it contains significant content addressing the Earth-Sun relationship and astronomy (in the form of thinking about where our universe, solar system, and elements came from as well as the role of Earth-sun relations in modulating Earth's climate through Milankovitch cycles), and geological features and principles as applied to understanding the components, linkages, and feedback loops in the Earth System. We look at and interpret maps, we include large course segments that deal with the atmosphere and climate systems, we look at ocean circulation and nutrient systems, and we cover the role of soils, vegetation, and microorganisms in the Earth system.

The course goes beyond the basics of Earth science, taking a more quantitative approach than in 1000-level introductory courses. The subject is an excellent one for showing how present-day scientific thinking is the result of adjusting to new evidence as that evidence has been uncovered. The laboratory exercises and lecture content provide extensive familiarization with the scope and limitations of the scientific method, and the subject of climate in particular amply demonstrates relationships between scientific research and contemporary society. The laboratory exercises provide you with an opportunity to work with aspects of the Earth system in quantitative fashion, as well as to make measurements that allow us to derive simple quantitative relationships.

Attendance and Note Taking: Taking notes is an important skill. It helps your mind take in new information, to pick the most important points from a lecture, to remember more of the content later, and to develop writing skills. You cannot take notes if you are not present in class. It is therefore expected that you come to the class and take notes on each lecture. Do not hesitate to stop us, to ask questions, to slow us down so that you have time to take in what you need to take in. The lecture materials will be available on the course website (see below).

***Other Expectations*:** Expectations in a college course are different from those that may have been the norm in some peoples' K-12 experience. We find that in some cases people have grown used to "having their hands held" through even fairly simple problems and have come out unaccustomed to having to figure things out independently, without a step-by-step procedure provided. In this course you will have the opportunity to think your way through a problem independently. Struggle is not a bad thing – it is a way to get your brain working. Struggle teaches, and one of the more important things it teaches is self-reliance and the fact that you can do it, something that is almost impossible to teach any other way. Embrace struggle, and work through it! True independent thinking and problem solving are learned skills – and you should seize the opportunity to practice whenever possible. We are happy to answer questions – but you should grapple with each problem yourself first in order to ask the most useful questions. Forming good questions is also an important learned skill.

EVALUATION/GRADING:
The basis for grading will be 3 in-class hour exams, a final exam, lab performance, and homework performance. In addition, there is a subjective evaluation that we call, in general terms, "professionalism".

Hour Exams: Friday Sept. 27
Friday Oct. 25
Friday Nov. 22 (all hour exams are in-class)
Final Exam: Wednesday Dec. 18, 8:00 am to 10:00 am (in-class)

Hour Exams:	100 points each	300	(30%)
Final Exam:	200 points	200	(20%)
Homework:	200 points total	200	(20%)
Labs:	250 points total	250	(25%)
Professionalism:	50 points total	50	(5%)
TOTAL POINTS AVAILABLE:		**1000**	

Note that content from the labs is in part meant to reinforce material introduced in class and therefore may be included on the tests. Lab subject material is also meant to supplement you with material *not* covered in class.

There will be no scheduled make-up tests. If you need to miss a test for an emergency, please email me prior to the scheduled time. Alternative arrangements cannot be made after the exam. All exam and due date conflicts must be resolved within the first two weeks of the semester.

Lab write-ups are due at the following lab session. Late labs will receive a 10% automatic reduction in grade. Labs more than one week late will receive no credit. If you will need to miss a lab for a very good reason, contact the TA to make *prior* alternate arrangements. I have asked the TAs *not to do any make-up labs* unless students have made *appropriate* prior arrangements.

Homework problems that are up to one week late will also receive a 10% reduction. Homework problems more than one week late will receive no credit.

Any questions regarding grading should be addressed as described below.
1. Please wait 24 hours after receiving your grade before initiating questions regarding grading.
2. Notify me within one week of the return of the assignment/exam of any grading question. (If questions are not raised within one week of the return of the exam or assignment, the grade is final). If there is no obvious error in the grading, then you must follow the procedure outlined in 3 and 4 below.
3. Using your class notes, handouts and or/other information, you must write an explanation as to why you believe your answer is correct.
4. After evaluating the explanation I will determine if the grade should be altered and I will respond to you either verbally or with a written explanation. Faculty decision on the grade is final.

COURSE POLICIES:
Course Website
This course will use the WyoCourses website set up for this class. The website has the syllabus, problem materials for any problems not from the book, review sheets prior to exams, lecture materials if you wish to print them out for note-taking, etc. Lecture slides will be posted before

each class. Most course communication will be through WyoCourses; please check your email or the site daily to keep current with the course.
The information contained in the course syllabus, other than the grade and absence policies, may be subject to change with reasonable advance notice. Substantive changes to the syllabus during the semester shall be communicated via the website, course announcements, or in class with reasonable notice.

Attendance and Participation
University sponsored absences must be cleared beforehand. Students who are absent consistently without a valid excuse (legitimate medical condition or mandatory university activity) will be penalized 5% from their total grade. For other attendance questions please email me at least 2 hours before class begins.

Academic Honesty
Academic dishonesty will not be tolerated in this class. In this class, I expect you not use previous exams nor pass your exams to future students. Cases of academic dishonesty will be treated in accordance with UW Regulation 2-114. The penalties for academic dishonesty can include, at my discretion, an "F" on an exam, an "F" on the class component exercise, and/or an "F" in the entire course. Academic dishonesty means anything that represents someone else's ideas as your own without attribution. It is intellectual theft – stealing - and includes (but is not limited to) unapproved assistance on examinations, plagiarism (use of any amount of another person's writings, blog posts, publications, and other materials without attributing that material to that person with citations), or fabrication of referenced information. Facilitation of another person's academic dishonesty is also considered academic dishonesty and will be treated identically. Please see UW Regulation 6-802.

In addition, the specific ethics guidelines for this course are as follows:

(1) I encourage you to discuss assignments with other students in the class, but do not collaborate with other students when you write your responses.
(2) Exams must be completed without any collaboration with anyone else.

Computers and electronic devices
I encourage you to take notes with pen and paper, as this method has been shown to increase focus and retention. When you do use your computer in class, please be aware that this is a privilege and I expect that you will be using technology in ways that are only for your learning. This expectation holds for cell phones, which should be on silent or turned off, and kept in your backpack.

Conduct and Classroom Behavior
University Regulation 29, change 1, states that the instructor can "establish reasonable standards of conduct for each class which should be made known at the outset." In this class I expect engagement and participation, including regular attendance, and that we all treat each other with courtesy and respect. This does not mean we have to agree with each other- but professionalism and civility are an expectation.

Other Policies
Classroom Statement on Diversity: The University of Wyoming values an educational environment that is diverse, equitable, and inclusive. The diversity that students and faculty bring to class,

including age, country of origin, culture, disability, economic class, ethnicity, gender identity, immigration status, linguistic, political affiliation, race, religion, sexual orientation, veteran status, worldview, and other social and cultural diversity is valued, respected, and considered a resource for learning.

Disability Support: The University of Wyoming is committed to providing equitable access to learning opportunities for all students. If you have a disability, including but not limited to physical, learning, sensory or psychological disabilities, and would like to request accommodations in this course due to your disability, please register with and provide documentation of your disability as soon as possible to Disability Support Services (DSS), Room 128 Knight Hall. You may also contact DSS at (307) 766-3073 or udss@uwyo.edu. It is in the student's best interest to request accommodations within the first week of classes, understanding that accommodations are not retroactive. Visit the DSS website for more information at: www.uwyo.edu/udss.

Duty to Report: UW faculty are committed to supporting students and upholding the University's non-discrimination policy. Under Title IX, discrimination based upon sex and gender is prohibited. If you experience an incident of sex- or gender-based discrimination, we encourage you to report it. While you may talk to a faculty member, understand that as a "Responsible Employee" of the University, the faculty member MUST report information you share about the incident to the university's Title IX Coordinator (you may choose whether you or anyone involved is identified by name). If you would like to speak with someone who may be able to afford you privacy or confidentiality, there are people who can meet with you. Faculty can help direct you or you may find info about UW policy and resources at http://www.uwyo.edu/reportit . You do not have to go through the experience alone. Assistance and resources are available, and you are not required to make a formal complaint or participate in an investigation to access them.

Student Resources on Campus:

DISABILITY SUPPORT SERVICES: udss@uwyo.edu, 766-3073, 128 Knight Hall, www.uwyo.edu/udss
COUNSELING CENTER: uccstaff@uwyo.edu, 766-2187, 766-8989 (After hours), 341 Knight Hall, www.uwyo.edu/ucc
ACADEMIC AFFAIRS: 766-4286, 312 Old Main, www.uwyo.edu/acadaffairs
DEAN OF STUDENTS OFFICE: dos@uwyo.edu, 766-3296, 128 Knight Hall, www.uwyo.edu/dos
UW POLICE DEPARTMENT: uwpd@uwyo.edu, 766-5179, 1426 E Flint St, www.uwyo.edu/uwpd
STUDENT CODE OF CONDUCT WEBSITE: www.uwyo.edu/dos/conduct