CIEE Global Institute – Berlin

Course name:	Environmental Engineering
Course number:	(GI) ENGI 3001 BRGE
Programs offering course:	Berlin Open Campus Block
Open Campus track:	STEM and Society
Language of instruction:	English
U.S. semester credits:	3
Contact hours:	45
Term:	Spring 2020

Course Description

This introductory course to environmental engineering emphasizes the protection of air, water, and land resources through engineered solutions that impact human society via energy, water, climate and nutrient cycles. Topics covered include water quality engineering, solid waste management, fate and transport of contaminants in the environment, and energy production. The course emphasizes material and energy balance, and life-cycle thinking as conceptual tools.

Learning Objectives

Completing this course, students will:

1. learn what types of problems are commonly encountered by environmental engineers, become familiar with common approaches adopted by engineers, and have enhanced understanding of the role of environmental engineers in solving new or emerging environmental problems, particularly ones that are complex or inter-disciplinary.
2. possess the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
3. demonstrate knowledge and skilled use of mathematics, science, and engineering in the identification, formulation, and solving of engineering problems;
4. become adept at applying material balances and life cycle analysis to engineering problems
5. practice and expand oral communication skills
6. practice leadership and teamwork in group projects and assignments.
7. become enlightened and engaged stakeholders regarding the appropriate use of engineered solutions for environmental challenges, at home and abroad.

Course Prerequisites

Two (2) semesters of university-level courses in engineering, chemistry, or physics.

Methods of Instruction

This course is taught through the use of lectures, discussions, and readings, and assigned problem sets. The problem sets are not graded, but prepare students for weekly quizzes. Also, students investigate, and report to their peers, on real-life applications of engineering tools (analytical/quantitative).

Assessment and Final Grade

Attendance and Participation	20%
Group presentation (oral report)	10%
Weekly quizzes (3)	30%
Midterm exam	20%
Final exam	20%

Course Requirements

Attendance and Class participation (20%)

Participation

Participation is valued as meaningful contribution in the digital and tangible classroom, utilizing the resources and materials presented to students as part of the course. Meaningful contribution requires students to be prepared in advance of each class session and to have regular attendance. Students must clearly demonstrate they have engaged with the materials as directed, for example, through classroom discussions, online discussion boards, peer-to- peer feedback (after presentations), interaction with guest speakers, and attentiveness on co-curricular and outside-of-classroom activities.

Class Attendance

Regular class attendance is required throughout the program, and all unexcused absences will result in a lower participation grade for any affected CIEE course. Due to the intensive schedules for Open Campus programs, unexcused absences that constitute more than 10% of the total course will result in a written warning.

Students who transfer from one CIEE class to another during the add/drop period will not be considered absent from the first session(s) of their new class, provided they were marked present for the first session(s) of their original class. Otherwise, the absence(s) from the original class carry over to the new class and count against the grade in that class.

For CIEE classes, excessively tardy (over 15 minutes late) students must be marked absent. Attendance policies also apply to any required co-curricular class excursion or event, as well as to Internship, Service Learning, or required field placement. Students who miss class for personal travel, including unforeseen delays that arise as a result of personal travel, will be marked as absent and unexcused. No make-up or re-sit opportunity will be provided.

Attendance policies also apply to any required class excursion, with the exception that some class excursions cannot accommodate any tardiness, and students risk being marked as absent if they fail to be present at the appointed time.

Unexcused absences will lead to the following penalties:

Percentage of Total Course Hours Missed	*Equivalent Number of Open Campus Semester classes*	*Minimum Penalty*
Up to 10%	1 content classes, or up to 2 language classes	Participation graded as per class requirements
10 – 20%	2 content classes, or 3-4 language classes	Participation graded as per class requirements; **written warning**
More than 20%	3 content classes, or 5 language classes	Automatic **course failure**, and possible expulsion

Group presentation (10%)

Students work in groups of 2 or more to select a methodology presented in Chapter 2. They investigate (using online sources) real-life applications of the methods and make an oral presentation to the class. The format is a 20-minute Powerpoint presentation. Students provide the justification for the use of the methodology, explain the analytical tool, and interpret the results of its application.

Weekly quizzes (3; 30% total). Weekly quizzes draw from the problem sets at the end of each assigned chapter of the textbook. To prepare for the quizzes, students are encouraged strongly to practice solving the problems.

Midterm exam (20%)

Students take a 60-point exam consisting of questions in the format of multiple choice, short answer questions, and calculations on lecture and reading materials.

Final Exam (20%)

Students take a 80-point exam consisting of questions of multiple choice and short answer questions, and calculations.

Weekly Schedule

NOTE: this schedule is subject to change at the discretion of the instructor to take advantage of dynamic experiential learning opportunities.

Week 1 **Introduction**

Class 1:1 Topic: Introduction to this course.

We will review the syllabus, learning objectives, and assessment methods, including aspects of participation and engagement in class. The introduction will cover the scope of the course, a conceptual framework, plus fundamental concepts and definitions.

Readings:

Mihelcic, J. R., Naughton, C. C., Verbyla, M. E., Zhang, Q., Schweitzer, R. W., Oakley, S. M., ... & Whiteford, L. M. (2017). The grandest challenge of all: The role of environmental engineering to achieve sustainability in the world's developing regions. *Environmental Engineering Science*, *34*(1), 16-41.

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Folke, C. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, *347*(6223), 1259855

Week 2 Topic: Engineering for sustainability: what it is and how to measure it

Class 2.1 This session includes a lecture and discussion of the assigned articles.

Lecture. Sustainable design, engineering, and innovation. The evolution of environmental protection to sustainability; the imperative for sustainable design, engineering, and innovation. How to operationalize sustainability: life cycle thinking, systems thinking, resilience thinking, and frameworks for sustainable design. How to measure sustainability in engineered systems. Great challenges and opportunities for environmental engineers.

Readings**:**

Textbook, Chapter 1: Sustainable design, engineering, and innovation

Class 2.2 This session includes a lecture and Quiz 1

Lecture. Environmental measurements. Mass concentration units; volume/volume and mole/mole units; partial-pressure units; mole-volume units; normality; concentrations of greenhouse gases

Readings:
Textbook, Chapter 2: Environmental measurements.

Assessment:
Quiz 1 (drawn from problem sets in Chapters 1; 10%)

Week 3 Topic: Chemistry for engineers.

Class 3.1 This session has a lecture and an assigned reading.

Lecture. Chemistry for engineers. Part 1. Approaches in environmental chemistry. Activity and Concentration. Reaction stoichiometry. Thermodynamic laws.

Readings:
Textbook, Chapter 3.1 – 3.4: Chemistry.

Class 3.2 This session has a lecture and an assigned reading.

Lecture. Chemistry for engineers, Part 2. Thermodynamic laws. Volatilization and air-water equilibrium. Acid-base chemistry. Ox-redox. Precipitation-dissolution. Fundamentals of kinetics.

Readings:
Textbook, Chapter 3.5-11: Chemistry.

Class 3.3 This session is devoted entirely to the Midterm Exam (25%).

Students take a 60-point exam consisting of questions in the format of multiple choice, short answer questions, and calculations on lecture and reading materials to date.

Week 4 Topic: Physical processes: mass and energy balances, and mass transport

Class 4.1 This session includes a lecture and required readings.
Lecture. Physical processes for the environmental engineer, Part 1. Mass balances: mass balance equation for the completely mixed flow reactor (CMFR); batch and plug-flow reactor; retention time; materials flow analysis and urban metabolism.

Readings:
Textbook, Chapter 4.1 Physical Processes (Mass balances)

Class 4.2 This session includes a lecture, required readings, and Quiz 2

Lecture. Physical processes for the environmental engineer, Part 2. Energy balances: forms of energy; conducting an energy balance; the greenhouse effect and impacts of GHG emissions on Earth energy balance; energy efficiency in buildings; urban heat islands.

Readings:
Textbook, Chapter 4.2-4.3: Physical Process (Energy balances)

Assessment:
Quiz 2 (drawn from problem sets in Chapters 5 and 7; 10%)

Class 4.3 This session includes a lecture and group oral presentations

Lecture. Physical processes for the environmental engineer, Part 3. Mass transport processes. Mass transport processes; advection, dispersion; movement of particles in a fluid (Stokes' Law).

Readings:
Textbook, Chapter 4.4. Physical Processes (Mass transport)

Assessment:
Group oral presentation

Week 5 Topic: Ecology and Environment meet the Engineer

Class 5.1 This session consists of a lecture and assigned readings

Lecture. Ecosystems and ecosystem functions. Definitions: ecosystems, species, populations, individuals. Principal ecosystem functions. Cycles of energy and materials through natural systems (including water, oxygen, carbon, nitrogen, phosphorous).

Readings:
Textbook, Chapter 5: Biology

Class 5.2 This session consists of a lecture, assigned readings and Quiz 3.

Lecture. Water quality and quantity. Freshwater forms and availability: surface water, ground water. Water consumption patterns across the globe, water reclamation and reuse. Water quality of lakes, rivers, and in groundwater: dissolved oxygen, BOD, nutrient loads, oxygen depletion and eutrophication. Nature's models for the purification and distribution of clean water, and why engineers should care.

Readings:
Textbook, Chapter 7: Water: Quantity and quality.

Assessment
Quiz 3 (10%), drawn from problem sets in Chapter 5.

Class 5.3 This session consists of a lecture, assigned readings, and group oral presentations

Lecture. Treat water respectfully. Life cycle analysis of wastewater streams; global and local trends in waste water production; primary and secondary waste water management; facility design and function; facility levelized costs; compare and contrast water treatment plant with water cycles in nature. The role of the environmental engineering in mitigating environmental and social issues associated with waste water management practices.

Readings:

Textbook, Chapter 9: Wastewater and Stormwater: Collection, Treatment, and Resource Recovery.

Assessments:

Group oral presentations

Week 6 Topic: Solid waste and its management

Class 6.1 This session consists of a lecture and required readings

Lecture. Solid Waste. What is ‘waste’? Where does it come from, and where does it go? Global and local trends in municipal solid waste production; significance to human and other life in the context of the Anthropocene. Life cycle analysis of waste and waste streams. Physical and chemical characterization of solid waste. Hazardous waste. Components of solid waste: storage, collection and transport. Conventional solid waste management; the landfill: facility design and function; plant longevity and levelized costs. Incineration: when, where, why, and how.

Readings:

Textbook, Chapter 10: Solid waste management.

Class 6.2 This session consists of a lecture and required readings

Lecture. How to manage solid waste and recover resources. Managing greenhouse gas emissions and waste water lixiviate. Recycling and materials recovery. Composting; waste-to-energy; solid waste – energy techonologies. Ecological and social issues of siting solid waste treatment/recovery plants. The role of the environmental engineering in mitigating environmental and social issues associated with solid waste management practices.

Readings

Lou, X. F. & Nair, J. (2009). The impact of landfilling and composting on greenhouse gas emissions – a review. *Bioresource Technology, 100*, 3792-3798

Medina, M. (2010). Solid wastes, poverty and the environment in developing country cities: Challenges and opportunities. Working paper 2010/23. United Nations University-World Institute for Development Economics Research. Retrieved 7 January 2013, from http://www.wider.unu.edu/publications/working-papers/2010/en_GB/wp2010-23/

Class 6.3 Final Exam.

Course Materials

Course Textbooks

Mihelcic, J. R., & Zimmerman, J. B. (2014). *Environmental engineering: Fundamentals, sustainability, design* (2nd Edition). Hoboken: Wiley

Readings

Lou, X. F. & Nair, J. (2009). The impact of landfilling and composting on greenhouse gas emissions – a review. *Bioresource Technology, 100*, 3792-3798

Medina, M. (2010). Solid wastes, poverty and the environment in developing country cities: Challenges and opportunities. Working paper 2010/23. United Nations University-World Institute for Development Economics Research. Retrieved 7 January 2013, from http://www.wider.unu.edu/publications/working-papers/2010/en_GB/wp2010-23/

Mihelcic, J. R., Naughton, C. C., Verbyla, M. E., Zhang, Q., Schweitzer, R. W., Oakley, S. M., ... & Whiteford, L. M. (2017). The grandest challenge of all: The role of environmental engineering to achieve sustainability in the world's developing regions. *Environmental Engineering Science*, *34*(1), 16-41.

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Folke, C. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, *347*(6223), 1259855

Online Resources

https://works.bepress.com/Ivanasup/

https://www.epa.gov/eco-research

https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid
https://www.epa.gov/ghgreporting
https://www.epa.gov/heat-islands
https://www.esrl.noaa.gov/
https://ghgprotocol.org/
https://www.oercommons.org/authoring/1660-the-sustainability-learning-suites/view
http://www.sustainablemeasures.com/
https://toxics.usgs.gov/