

Florida International University
Department of Civil and Environmental Engineering

Course Syllabus
ENV 5027/4024: Bioremediation Processes/Engineering (3 credits)
Fall Semester 2009: August 24, 2009 – December 12, 2009

Overview:

This class discusses the implementation of biological treatment to different environmental media, in particular the subsurface. Bioremediation is an interdisciplinary area and the course includes brief reviews of necessary microbiology, groundwater hydrology, and chemistry. This is a fairly new area so that a lot of the material will be in the form of current literature. It is expected that the course will be project-oriented with ample opportunity for class participation and presentation.

Catalog Course Description:

Biotransformation of subsurface contaminants is gaining recognition as a viable treatment tool. This course provides students with quantitative methods required to design bioremediation systems. Project required for graduate students.

Prerequisites:

Permission of the instructor.

Instructor:

Dr. Shonali Laha, P.E.
Office Location: EC 3742
Phone/Fax: 305-348-1092 / 305-348-2802
Email: lahas@fiu.edu
Office hours: Tuesdays 1400 – 1600, Thursdays 1400 – 1700, and by appointment.

Location and Timing:

Room: EC ~~2420~~ 1113
Tuesdays and Thursdays 1230 – 1345

Textbook:

Eweis JB, Ergas SJ, Chang DPY, and Schroeder ED, *Bioremediation Principles*, McGraw-Hill Companies, Inc., 1998.

The text is currently out-of-print. However, you may be able to obtain used copies, and the bookstore will keep special re-prints from the publisher.

Excellent Science Reading:

Peter Pringle, *Food, Inc.: Mendel to Monsanto--The Promises and Perils of the Biotech Harvest*, Simon and Schuster, 2003.

Bill Bryson, *A Short History of Nearly Everything*, Broadway Books, 2003.

Alan Weisman, *The World Without Us*, St Martin's Press, 2007.

Additional Reading Materials and Reference Books:

Bioremediation is an emerging field and you can augment your understanding through additional external reading. The following list some books that have come out over the years related to bioremediation process applications.

- Bioremediation and Natural Attenuation: Process Fundamentals and Mathematical Models*. P.J.J. Alvarez and W.A. Illman, John Wiley & Sons (2006).
- Environmental Biotechnology: Principles and Applications*, B.E. Rittmann and P.L. McCarty, McGraw-Hill, Inc., New York (2001)
- Environmental Biotechnology: Theory and Application*, G.M. Evans and J.C. Furlong, John Wiley & Sons, Ltd., Chichester, England (2003)
- Bioremediation*, K.H. Baker and D.S. Herson, McGraw-Hill, Inc., New York (1994)
- Bioremediation Engineering: Design and Application*, J.T. Cookson, Jr., McGraw-Hill, Inc., New York, NY (1995)
- Bioremediation: A Desk Manual for the Environmental Professional*, D.R. Schneider and R.J. Billingsley, Cahners Publishing Company, Des Plaines, IL (1990)
- Handbook of Bioremediation*, Norris *et al.* (Robert S. Kerr Environmental Research Laboratory), Lewis Publishers, Boca Raton, FL (1994)
- Environmental Biotechnology for Waste Treatment*, G.S. Saylor, R. Fox and J.W. Blackburn (eds.), Plenum Press, New York, NY (1990)
- Applied Biotechnology for Site Remediation*, R.E. Hinchee, D.B. Anderson, F.B. Metting and G.D. Sayles (eds.), Lewis Publishers, Boca Raton, FL (1994)
- Hydrocarbon Bioremediation*, R.E. Hinchee, B.C. Alleman, R.E. Hoeppe, and R.N. Miller (eds.), Lewis Publishers, Boca Raton, FL (1994)
- Emerging Technology for Bioremediation of Metals*, J.L. Means and R.E. Hinchee (eds.), Lewis Publishers, Boca Raton, FL (1994)
- Transport and Remediation of Subsurface Contaminants*, D.A. Sabatini and R.C. Knox (eds.), ACS Symposium Series 491, American Chemical Society, Washington, DC (1992)
- Petroleum Microbiology*, R.M. Atlas (ed.), Macmillan Publishing Company, New York, NY (1984)
- Microbial Transformation and Degradation of Toxic Organic Chemicals*, L.Y. Young and C.E. Cerniglia (eds.), Wiley-Liss, Inc., New York, NY (1995)

Final Examination:

Week of December 7 – 12, 2009

Grading Criteria (Parentheses () indicate graduate student criteria):

The final grade will be based on the following criteria totaling 100 points:

Homework/class participation	40 (30)
Midterm Exam	20
Quizzes/Project	10 (5/15)
Final Exam	30

Graduate Student Project:

This is a cross-listed undergraduate and graduate class – to distinguish between the two, graduate students will be required to research a topic related to environmental biotechnology. For example, the project could be an actual practical demonstration of biological treatment for waste including your home composting efforts or wastewater biosolids composting; or an examination of innovative pest management systems using biotechnology not discussed in the classroom. The projects are to be submitted as brief reports (5 – 10 pp) and presented in class (10 – 15 minutes).

Tentative Class Schedule:

Date	Topic	Chapter
8/25	1 Course introduction.	
8/27	2 Secondary wastewater treatment; HW-1 (due on 9/10)	
9/1	3 Mass balance concepts; risk assessment overview	1
9/3	4 Summarize Chapter 1; look at example problems	1
9/8	5 Risk assessment (Chapter 4 from the Masters text)	handout
9/10	6 Risk assessment; Mass balance clarifications. HW-2 (due on 9/24)	
9/15	7 Soil environment – definitions, etc.	2
9/17	8 Fate and transport in the subsurface – partitioning, continuity equation	3
9/22	9 Fate and transport in the subsurface – Darcy’s Law; retardation	3
9/24	10 Monod kinetics and other models to describe biodegradation	3
9/29	11 Quiz 1; re-examination of mass balance! HW-3 (due on 10/1)	
10/1	12 Soil microbiology – microbial ecology; review for midterm	4
10/6	13 Midterm Exam (worth 20% of grade, covers Chapters 1 – 3; HW 1 – 3)	
10/8	14 Review midterm exam; energy concepts	5
10/13	15 Metabolism and energy production. HW-4 (due 10/27)	5
10/15	16 Biodegradation of selected compounds	6
10/20	17 Mass balances in subsurface	7
10/22	18 In situ remediation of aquifers – pump-and-treat, air sparging	7
10/27	19 SVE versus Bioventing; HW-5 (due on 11/10)	7
10/29	20 Discuss problems with assignment and Chapter 7	7
11/3	21 Case studies on in situ bioremediation – real life problems	
11/5	22 Solid-phase bioremediation – land treatment versus composting	8
11/10	23 Solid-phase bioremediation: Case studies; HW-6 (due 11/24)	8
11/12	24 Slurry-Phase Bioremediation	9
11/17	25 Slurry-Phase and Vapor-Phase Bioremediation	9/10
11/19	26 Vapor-Phase Bioremediation	10
11/24	27 Presentations	
11/26	Thanksgiving holiday – no class	
12/1	28 Presentations	
12/3	29 Review Class	

ABET-related Objectives & Outcomes

This course accomplishes, to various extents, the following highlighted ABET-related objectives and outcomes:

Objective 1 - Technical Proficiency: Our graduates will have the ability to:

- 3a. Apply knowledge of mathematics, science, and engineering to solve civil engineering problems;**
- 3b. Design and conduct experiments, and analyze and interpret data related to at least one of the technical areas encompassed by civil engineering (i.e., structural, geotechnical, transportation, environmental and water resources engineering, construction, and general/comprehensive);**
- 3c. Design a system, component, or process to meet desired needs related to at least one of the technical areas encompassed by civil engineering;**
- 3e. Identify, formulate, and solve civil engineering problems;**
- 3k. Utilize the techniques, skills, and modern scientific and engineering tools necessary for civil engineering practice.**

Objective 2 - Communication: Our graduates will have an acceptable level of proficiency in:

- 3d. Working with others as part of multi-disciplinary teams;
- 3g. Written, oral, and graphical communication.

Objective 3 – Responsible Citizenship: Our graduates will have an acceptable level of appreciation for and understanding of:

- 3h. The impact of engineering solutions in a global and societal context;**
- 3j. Contemporary issues facing society as a whole.**

Objective 4 – Lifelong Learning: Our graduates will:

- 3i.1. Recognize that graduation is a first step in their development of professional engineering competency;
- 3i.2. Recognize the need for lifelong learning to maintain and enhance their professional practice of civil engineering.

Objective 5 – Ethical Behavior: Our graduates will:

- 3f. Have an understanding of professional and ethical responsibility.**

The outcome identifiers, herein used (e.g., “3h”), correspond to the same calling system that is used in the ABET Criteria for Accrediting Engineering Programs (www.abet.org).

[For the black-and-white copied, the outcomes and objectives relevant to this class are: Objective 1: 3a, 3b, 3c, 3e and 3k; Objective 3: 3h and 3j; and Objective 5: 3f.]

Refereed Journal Publications Available at FIU:

The following lists some journals that may come useful in this class. Only journals available at the FIU libraries are enumerated. This is not a complete listing; its only purpose is to serve as a guide to adequately exploiting/utilizing library resources at FIU. UP is the University Park Campus Library, while N. Miami refers to the library on the Biscayne Bay or North Campus. The Call Numbers recorded next to each journal title are intended to assist you in locating the journals at the library. A lot of the journals are now available in electronic form.

The Internet is very useful in yielding useful information in the field of bioremediation, but you must be aware that there is no peer review process performed for articles published on the internet. In other words, there is little guarantee regarding the content/quality of internet articles unless the website is a reliable one. It is necessary that you adequately employ library resources for your projects and presentations. Also, be aware that all Elsevier publications and many other journals are available electronically at the FIU library.

Applied and Environmental Microbiology (UP Periodicals 3rd fl, QR1 .A6)
Advances in Microbial Ecology (UP Periodicals 3rd fl, QR100 .A36)
Archives of Environmental Contamination and Toxicology (N. Miami Periodicals 2nd fl, QH545.P4 A7)
Biochemical Society Symposium (UP Periodicals 3rd fl, QH345. B522)
Bioremediation in the Field (USEPA, UP Gov Doc. 2nd fl, EP1. 105)
Biotechnology and Bioengineering (UP Periodicals 3rd fl, QH324 .B5)
Critical Reviews in Environmental Control (UP Periodicals 3rd fl, TD172 .C5)
Critical Reviews in Environmental Science and Technology (UP Periodicals 3rd fl, TD172 .C5)
Current Microbiology (UP Periodicals 3rd fl, QR1 .C87)
Ecotoxicology and Environmental Safety (UP Periodicals 3rd fl, QH545.A1 E29)
Environment 21 (UP Periodicals 3rd fl, HC79.E5 F55)
Environment International (N. Miami Periodicals 2nd fl, TD169 .E54)
Environmental Conservation (UP Periodicals 3rd fl, TD169. E58)
Environmental Engineering & Science (UP Periodicals 3rd fl, TD 811.5.H3957)
Environmental Impact Assessment Review (N. Miami Periodicals 2nd fl, TD194.6. E592)
Environmental Management (UP Periodicals 3rd fl, TA170 .E5)
Environmental Manager (UP Periodicals 3rd fl, TD 1.E5)
Environmental Pollution (UP Periodicals 3rd fl, QP82.2.P6 E55)
Environmental Research (UP Periodicals 3rd fl, RA565.A1 .E58)
Environmental Science & Technology (UP Periodicals 3rd fl, TD 180.E5)
Environmental Technology (UP Periodicals 3rd fl, TD 1.E565)
Environmental Toxicology and Chemistry (N. Miami Periodicals 2nd fl, QH545.A1 E594)
Geomicrobiology Journal (UP Periodicals 3rd fl, QH344 .G46)
Ground Water (UP Periodicals 3rd fl, GB1001 .G75)
Ground Water Monitoring and Remediation (UP Periodicals 3rd fl, GB1001 .G76)
Hazardous and Industrial Waste: Proc. of the Mid-Atlantic Industrial Waste Conference (UP General collection, TD811.5 .M5)
Hazardous Waste (UP Periodicals 3rd fl, TD811.5. H3957)
Hazardous Waste and Hazardous Materials (UP Periodicals 3rd fl, TD811.5. H3957)
Hydrobiologia (UP Periodicals 3rd fl, QH90 .H9)
International Journal of Environment and Pollution (UP Periodicals 3rd fl, TD 1.I5)
Journal of Agricultural, Biological, and Environmental Statistics (UP Periodicals 3rd fl, S566.55 .J68)
Journal of Applied Chemistry & Biotechnology (UP Periodicals 3rd fl, TP1 .S612)
Journal of Applied Ecology (UP Periodicals 3rd fl, S3 .J86)
Journal of Applied Bacteriology (UP Periodicals 3rd fl, QR1 .J58)
Journal of Biological Chemistry (UP Periodicals 3rd fl, QP501 .J7)
Journal of Chemical Technology and Biotechnology (UP Periodicals 3rd fl, TP1 .S6122)
Journal of Cold Regions Engineering (UP Periodicals 3rd fl, TA713 .J6)
Journal of Contaminant Hydrology (UP Periodicals 3rd fl, TD426 .J6)

Journal of Ecology (UP Periodicals 3rd fl, QH540 .J68)
Journal of Environmental Economics and Management (UP Periodicals 3rd fl, HC79. E5J5)
Journal of Environmental Engineering (UP Periodicals 3rd fl, TD 1.A3)
Journal of Environmental Health (UP Periodicals 3rd fl, RA565.A1 S3)
Journal of Environmental Management (UP Periodicals 3rd fl, HC79.E5 J68)
Journal of Environmental Quality (UP Periodicals 3rd fl, S1 .J78)
Journal of Environmental Sciences (UP Periodicals 3rd fl, TA1. J637)
Journal of Environmental Systems (UP Periodicals 3rd fl, TD1 .J67)
Journal of Exposure Analysis and Environmental Epidemiology (N. Miami Periodicals 2nd fl, RA565 .A1 J673)
Journal of Geophysical Research (UP Periodicals 3rd fl, QC811 .J6)
Journal of Geotechnical and Geoenvironmental Engineering (UP Periodicals 3rd fl, TA705. A525)
Journal of Hydrologic Engineering (UP Periodicals 3rd fl, GB651 .J62)
Journal of Hydrology (UP Periodicals 3rd fl, GB651 .J6)
Journal of Irrigation and Drainage Engineering (UP Periodicals 3rd fl, TC801 .A4)
Journal of Petroleum Technology (UP Periodicals 3rd fl, TN860 .J65)
Journal of Petrology (UP Periodicals 3rd fl, QE420 .J68)
Journal of Physical and Colloidal Chemistry (UP Periodicals 3rd fl, QD1 .J95)
Journal of Scientific and Industrial Research (UP Periodicals 3rd fl, T1 .J83)
Journal of Sedimentary Research (UP Periodicals 3rd fl, QE420 .J64)
Journal of Soil and Water Conservation (UP Periodicals 3rd fl, S622 .S5)
Journal of Soil Contamination (UP Periodicals 3rd fl, TD878 .J68)
Journal of Soil Science (UP Periodicals 3rd fl, S590 .J6)
Journal of Technical Topics in Civil Engineering (UP Periodicals 3rd fl, TA1 .A4)
Journal of the Air & Waste Management Association (UP Periodicals 3rd fl, TD883 .A48)
Journal of the American Water Resources Association (UP Periodicals 3rd fl, GB651. W315)
Journal of the American Water Works Association (UP Periodicals 3rd fl, TD201. A512)
Journal of the Atmospheric Sciences (UP Periodicals 3rd fl, QC851. A283)
Journal of Toxicology and Environmental Health (N. Miami Periodicals 2nd fl, RA1190 .J68)
Journal of Water Resources Planning and Management (UP Periodicals 3rd fl, TC401. A552)
Microbial Ecology (UP Periodicals 3rd fl, QR100 .M5)
Microbiological Reviews (UP Periodicals 3rd fl, QR1 .B25)
Microbiology (UP Periodicals 3rd fl, QR1 .J64)
Project Descriptors/Environmental Monitoring and Assessment Program (UP Gov Documents 2nd fl, EP 1.23/5)
The Journal of General Microbiology (UP Periodicals 3rd fl, QR1 .J64)
Water Research (UP Periodicals 3rd fl, TD 420.W37)
Water Resources Research (UP Periodicals 3rd fl, GB 651.W32)
Water Science and Technology (UP Periodicals 3rd fl, TD 430.P7)

The following journals are not available at FIU but may also be helpful in your ongoing/future research endeavors. Note that you may also have access to additional scientific/technical journals and publications that I have not listed.

Biodegradation
Bioremediation Journal
Chemosphere
Critical Reviews in Microbiology
Dev. Ind. Microbiol.
FEMS Microbiol. Rev.
Journal of Hazardous Materials
Journal of Water Pollution Control Federation