

ENE 804: BIOLOGICAL PROCESSES IN ENVIRONMENTAL ENGINEERING
SYLLABUS
SPRING SEMESTER 2024

Time: Tuesday, Thursday: 1:00 PM to 2:20 PM
 Engineering Building Room 3400

| LECTURE | TOPIC | READINGS | DATE |
|--|---|--|-------------------|
| 1 | Energetics of Biological Reactions The Basics Homework # 1 Due on Thu Jan 18 | Lecture Notes | Tue Jan 9 |
| 2 | Stoichiometry of Biological Reactions Key Electron Donors and Acceptors | Chapter 2 Lecture Notes | Thu Jan 11 |
| Holiday University Closed | | | Mon, Jan 15 |
| 3 | Class Exercises - Energetics and Stoichiometry | Chapter 2 Lecture Notes | Tue Jan 16 |
| 4 | Microbial Kinetics - Suspended Growth Processes | Chapter 3 Lecture Notes | *Thu Jan 18 |
| 5 | The Activated Sludge Process | Chapters 3,5,6 Lecture Notes | Tue Jan 23 |
| 6 | Analysis of Existing Activated Sludge Systems | Chapters 3,5,6 Lecture Notes | Thu Jan 25 |
| Exam I: Sections 1 and 3 - Stoichiometry and Bacterial Energetics | | | Tue Jan 30 |
| 7 | Secondary Clarifier Design Homework # 2 Due on Thu Feb 15 | Chapter 6 Lecture Notes | Thu Feb 1 |
| 8 | Activated Sludge Systems Configurations and Issues Lagoons and Wetlands (Reading Assignment) | Lecture Notes Chapter 7 2020 Appendix B1 | Tue Feb 6 |
| 9 | Nitrification NH ₄ ⁺ as Donor and O ₂ as Acceptor, Kinetics and Processes, Nutrient Recovery | Chapter 9 Lecture Notes | Thu Feb 8 |
| No class | | | Tue Feb 13 |
| 10 | Denitrification NO ₃ ⁻ as Acceptor and Organic C as Donor (H ₂ can also be a donor in autotrophic denitrification), Kinetics and Processes | Chapter 10 Lecture Notes | *Thu Feb 15 |

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| 11 | Anammox Process Anaerobic Ammonia Oxidation, Full-scale Plant Performances | Lecture Notes | Tue Feb 20 |
| Exam II: Sections 4 to 8 - Activated Sludge Process | | | Thu Feb 22 |
| Spring break - Monday, 2/26 - Friday, 3/1 | | | |
| 12 | Phosphorus Removal Operational Control of P uptake, Chemical P Removal Homework # 3 Due on Thu Mar 14 | Chapter 11 Lecture Notes | Tue Mar 5 |
| 13 | Biofilm Kinetics Biofilm/Immobilized/Attached-Growth/Fixed-Film Reactors Steady-State Biofilm Model First Order and Zero Order Kinetics Simplified Design Approaches Non-steady State Biofilms | Chapter 4 | Thu Mar 7 |
| 14 | Design of Biofilm Processes Normalized Loading Curves Media Selection CMBRs in Series | Chapter 4 Lecture Notes | Tue Mar 12 |
| 15 | Aerobic Biofilm Processes Trickling Filters, Rotating Biological Contactors, Activated Biofilter Aerated Fixed and Fluidized Beds | Chapter 8 Lecture Notes | *Thu Mar 14 |
| 16 | Combined Biofilms and Suspended Growth Processes Integrated fixed-film activated sludge (IFAS), Moving-bed biofilm reactor (MBBR) process, Activated biofilter (ABF), Biological aerated filter (BAF), Upflow fluidized bed reactor (FBBR), Trickling filter with intermediate clarifier/activated sludge (TF-IC/AS), Trickling filter/solids contact (TF/SC), Trickling filter activated sludge (BF/AS, RF/AS, and TF/AS) | Lecture Notes Qasim & Zhu | Tue Mar 19 |
| 17 | Anaerobic Processes: Ecology, Sizing Configurations Consortia Energetics & Stoichiometry pH Control Digester Sizing | Chapter 13 Lecture Notes | Thu Mar 21 |

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| 18 | Anaerobic Processes – Toxicity, Inhibition H ₂ partial pressure Ionic Strength Alkalinity Trace Nutrients Ammonia and Sulfide Toxicity Temperature Hydrolysis | Chapter 13 Lecture Notes | Tue, Mar 26 |
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| Exam III: Sections 9 to 12 (N and P Management and Recovery) | | | Thu Mar 28 |
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| 19 | Solids Processing Thickeners, Sludge Drying Beds, Composting | Lecture Notes | Tue Apr 2 |
| 20 | Membrane Bioreactors Basic Principles, Design Considerations Homework # 4 Due on Tue Apr 16 | Lecture Notes | Thu Apr 4 |
| 21 | Activated Sludge Models ASM1 to Current | Lecture Notes | Tue Apr 9 |
| 22 | Model Simulations Demonstration | Lecture Notes | Thu Apr 11 |
| 23 | Bioremediation / Detoxification Key Contaminants Issues Biostimulation Bioaugmentation | Chapters 14 & 15 Lecture Notes | *Tue Apr 16 |
| 24 | From Treatment to Resource Recovery Microbial Electrochemical Cells Photosynthetic Biofactories | 2020 Appendix B3 2020 Appendix B4 | Thu Apr 18 |
| Classes End | | | Sun, Apr 21 |

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| Exam IV - Sections 13-24, Wed, Apr 24, 10:00 AM - 12:00 PM |
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*** HOMEWORK DUE DATE**

TEXTBOOKS

1. Bruce E. Rittmann and Perry L. McCarty, Environmental Biotechnology: Principles and Applications, 1st Ed. 2001.
2. Bruce E. Rittmann and Perry L. McCarty, Environmental Biotechnology: Principles and Applications, 2nd Ed. 2020 (<https://www.accessengineeringlibrary.com/content/book/9781260441604>).

Note: Both these editions are available online through MSU Library website. Chapters listed in the above table refer to 1st Ed. except where noted as 2020.

Other books that may be helpful as a reference for selected topics (available in the library):

1. Wastewater Treatment and Reuse: Theory and Design Examples: (Two-Volume Set) 1st Ed. CRC Press - by Syed R. Qasim and Guang Zhu.
2. Metcalf & Eddy, Inc. Wastewater Engineering, Treatment and Reuse. 4th Ed, McGraw Hill Book Co., New York, 2003 (For wastewater characteristics and treatment plant design concepts).
3. Anaerobic Biotechnology, by Richard E. Speece, Archaea Press.

INSTRUCTOR

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GRADING POLICY

Grades will be based upon the total points accumulated in **4 Exams** – equally weighted. The following scale will be used for awarding grades: 90+ = 4.0, 85-89 = 3.5, 80-84 = 3.0, 70-79 = 2.5, 60-69 = 2.0, 50-59 = 1.5, 40-49 = 1.0.

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| Exam I | 25% |
| Exam II | 25% |
| Exam III | 25% |
| Exam IV | 25% |
| Total | 100% |

EXAM POLICY

- 1) All exams will be closed book, closed notes administered in class.
- 2) Each exam booklet will contain tables that you may need to consult and list some of the molecular weights etc.
- 3) You are allowed to bring formula sheet(s) consisting of a4 size (8.25 in x 11.75 in) paper.
- 4) For exams i, ii, iii, and iv, you can bring one, two, three, and four formula sheets, respectively.
- 5) You are welcome to update the sheet(s) used in a previous exam as you see fit.

HOMEWORK POLICY

Homework assignments are not graded but if you submit, they will be checked for errors. A total of 4 homework assignments are planned. They are designed to help you learn concepts and designs. The HW should be individually completed. Please do not submit homework that is a copy of another person's homework even if you did it together.

KEEP LEARNING

<https://remote.msu.edu/learning/index.html>

COUNSELING AND PSYCHIATRIC SERVICES (CAPS): STUDENT HEALTH & WELLNESS

<https://caps.msu.edu/>

REASONABLE ACCOMMODATIONS

Michigan State University is committed to providing equal opportunity for participation in all programs, services and activities. Requests for accommodations by persons with disabilities may be made by contacting the Resource Center for Persons with Disabilities at 517-884-RCPD or on the web at rcpd.msu.edu. Once your eligibility for an accommodation has been determined, you will be issued a verified individual services accommodation ("VISA") form. Please present this form to me at the start of the term and/or two weeks prior to the accommodation date (test, project, etc.). Requests received after this date will be honored whenever possible.