

# BIOLOGICAL AND ECOLOGICAL ENGINEERING

The Department of Biological and Ecological Engineering at OSU is involved in teaching, research and extended education relevant to the application of engineering analysis to biological, ecological and hydrological systems. The department has strength in graduate training and research and offers both an MS and PhD degree in Biological and Ecological Engineering. The graduate degree program is focused on the professional development of engineers and the analysis of environmental systems, hydrology and water resources. Activities within the department include water resource analysis, fate and transport of biologically relevant chemicals, bioreactor design and analysis, watershed analysis and resource management, simulation modeling of ecological and biological systems, regional and global hydrology, geographical information systems for environmental modeling, and the development of bio-based products and fuels.

## Undergraduate Programs

### Major

- Ecological Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/biological-ecological-engineering/ecological-engineering-bs-hbs/>)

### Minor

- Irrigation Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/biological-ecological-engineering/irrigation-engineering-minor/>)

## Graduate Programs

### Major

- Biological and Ecological Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/biological-ecological-engineering/biological-ecological-engineering-meng-ms-phd/>)

### Minor

- Biological and Ecological Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/biological-ecological-engineering/biological-ecological-engineering-graduate-minor/>)

**John P. Bolte**, *Director*

116 Gilmore Hall

Oregon State University

Corvallis, OR 97331-3906

Phone: 541-737-2041

Email: [info-bee@enr.orst.edu](mailto:info-bee@enr.orst.edu)

Website: [bee.oregonstate.edu](http://bee.oregonstate.edu) (<https://bee.oregonstate.edu>)

## Faculty

**Professors** Bolte, Godwin, Liu, Murthy, Selker, Tullos

**Associate Professors** Bachelet, Chaplen<sup>1</sup>, Ely<sup>1</sup>, Higgins

**Assistant Professors** Good, Jones, Udell, Vache

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Licensed Professional Engineer.

## BEE 101, ECOLOGICAL ENGINEERING I, 3 Credits

Introduction to engineering at OSU and the field of ecological engineering. Topics include engineering analysis and problem solving, professional ethics, the design process and teamwork.

**Recommended:** MTH 112

## BEE 102, ECOLOGICAL ENGINEERING II, 3 Credits

Introduction to common problems and solutions in ecological engineering, emphasizing the multiplicity of approaches to constraining, analyzing, and resolving challenges of ecosystem management. Two overnight field trips to local ecological monitoring and engineering sites will be required.

## BEE 103, ECOLOGICAL ENGINEERING III, 3 Credits

Programming hardware/software for sensing and control with applications in Ecological Engineering. Introduction to computational thinking strategies.

## BEE 199, SPECIAL TOPICS, 1-16 Credits

*This course is repeatable for 16 credits.*

## BEE 221, FUNDAMENTALS OF ECOLOGICAL ENGINEERING, 3 Credits

Introduction to the concepts and practice of ecological engineering. Covers chemical behavior and cycling in the environment, chemical kinetics, and unit processes of conventional treatment systems. Topics are applied to develop ecological treatment alternatives that meet the needs of human societies.

## BEE 222, ECOLOGICAL ENGINEERING COMPUTATION, 2 Credits

Develops programming skills in Python, including basic programming tasks, data analysis, data visualization, and optimization, with applications in Ecological Engineering. Builds computational thinking skills.

## BEE 270, ECOLOGY FOR ENGINEERS, 3 Credits

The study of ecology in the context of engineering. Develops an understanding of the patterns associated with species distribution in the natural world. Examines the theories of competition, predation, disease and mutualism that help explain the functioning of biological communities. Discusses interactions between abiotic and organismal factors, the environment, and ecological properties and processes.

## BEE 299, SPECIAL TOPICS, 1-16 Credits

*This course is repeatable for 16 credits.*

## BEE 311, ECOLOGICAL FLUID MECHANICS, 4 Credits

Fluid properties, fluid statics, fluid motion, conservation of mass, momentum and energy for incompressible fluids, dimensional analysis, ecological engineering applications. Lec/rec.

**Prerequisite:** (PH 212 with C or better or PH 212H with C or better) and (MTH 254 [C] or MTH 254H [C]) and (ENGR 211 [C] or ENGR 211H [C])

**BEE 312, ECOHYDRAULICS, 4 Credits**

Theory and design of hydraulic systems for ecological engineering applications. Lec/rec.

**Prerequisite:** BEE 311 with C or better or CE 311 with C or better or CHE 331 with C or better or CHE 331H with C or better

**BEE 313, ECOHYDROLOGY, 4 Credits**

Provides a quantitative description of fundamental ecohydrologic processes, the interactions of between water and the atmosphere, soils, and plants, as well as techniques for estimating the movement of water in the though ecosystems.

**Prerequisite:** BEE 312 with C or better and BEE 320 [C]

**BEE 320, BIOSYSTEMS ANALYSIS AND MODELING, 4 Credits**

An introduction to simulation modeling and analysis of a variety of biological and ecological systems. Systems approaches to describing ecological systems.

**Prerequisite:** BEE 222 with C or better and (MTH 256 [C] or MTH 256H [C])

**Recommended:** MTH 256

**BEE 322, ECOLOGICAL ENGINEERING THERMODYNAMICS AND TRANSFER PROCESS, 4 Credits**

A study of the transport processes of fluid flow, heat transfer and mass transfer applied to biological organisms and ecological systems.

**Prerequisite:** BEE 320 with C or better

**BEE 361, ECOLOGICAL ENGINEERING LABORATORY, 3 Credits**

Introduction to modern measurement methods for ecological and environmental applications includes sensors and systems for measuring soil, water and atmospheric properties. No final exam; field trip required. Lec/lab.

**Prerequisite:** BEE 312 with C or better

**BEE 362, ECOLOGICAL ENGINEERING MICROBIAL PROCESSES, 3 Credits**

Applies ecological engineering principles to the modeling, analysis and design of microbial processes in the environment.

**Prerequisite:** BEE 320 with C or better or ENVE 322 with C or better

**BEE 399, SPECIAL TOPICS, 0-16 Credits**

*This course is repeatable for 16 credits.*

**BEE 401, RESEARCH, 1-16 Credits**

*This course is repeatable for 16 credits.*

**BEE 405, READING AND CONFERENCE, 1-16 Credits**

**Equivalent to:** BRE 405

*This course is repeatable for 16 credits.*

**BEE 407, SEMINAR, 1-16 Credits**

Departmental seminars. Graded P/N.

**Equivalent to:** BEE 407H, BRE 407

*This course is repeatable for 16 credits.*

**BEE 407H, SEMINAR, 1-16 Credits**

Departmental seminars. Graded P/N.

**Attributes:** HNRS – Honors Course Designator

**Equivalent to:** BEE 407

*This course is repeatable for 16 credits.*

**BEE 410, ECOLOGICAL ENGINEERING INTERNSHIP, 1-12 Credits**

Internship in ecological engineering to provide students with an opportunity to apply course work and theory to the real world. Requires internship opportunity identification by student.

*This course is repeatable for 12 credits.*

**BEE 411, GLOBAL ENVIRONMENTAL CHANGE: USING DATA TO INFORM DECISIONS, 3 Credits**

Empowers students interested in global change research to focus on the interactions between changes in human land use and climate. Using an innovative online data and mapping tool called Data Basin, students will explore topics accessing the highest quality datasets available in an all-in-one platform.

**Prerequisite:** FE 257 with C or better

*Available via Ecampus*

**BEE 415, PROFESSIONAL DEVELOPMENT, 1 Credit**

Preparation for student professional careers. Students will interact with and hear seminars from professionals working in the ecological engineering field to learn from their experiences.

**Corequisites:** BEE 469

**BEE 433, IRRIGATION SYSTEM DESIGN, 4 Credits**

Principles of soil physics and plant water use applied to irrigation system design. Design of gravity, pressurized, and trickle irrigation systems, improving on-farm water management, performance characteristics of pumps and other irrigation equipment. Lec/lab. Offered alternate years.

**Prerequisite:** BEE 312 with C or better or CE 313 with C or better

**Equivalent to:** BRE 433

**BEE 438, ECOLOGICAL SYSTEMS ANALYSIS, 4 Credits**

An introduction to sustainability with a focus on case studies that are relevant to biological and ecological engineers. An introduction to tools that perform technical feasibility analysis, economic viability analysis, environmental risk assessment, resource sustainability assessment and life cycle assessment (LCA). Course will consist of theory and case studies highlighting the use of LCA methods to assess sustainability.

**Prerequisite:** ENGR 391 with C or better or ENGR 391H with C or better

**BEE 439, IRRIGATION PRINCIPLES AND PRACTICES, 4 Credits**

Survey of irrigation systems, system configurations, factors that influence irrigation efficiency, crop water requirements, energy requirements, pumps, irrigation scheduling. For non-engineers. Lec/lab/rec.

**Prerequisite:** MTH 111 with C or better

**Equivalent to:** BRE 439

**BEE 446, RIVER ENGINEERING, 4 Credits**

Multipurpose river use; natural physical processes in alluvial rivers; channel modification practices; river structures; design practices; impact of river modification; problem analysis; and impact minimization. Offered alternate years.

**Prerequisite:** BEE 312 with C or better or CE 313 with C or better

**Recommended:** CE 313

**BEE 458, NONPOINT SOURCE POLLUTION ASSESSMENT AND CONTROL, 3 Credits**

Problem solving in nonpoint source pollution. Methods for evaluating the extent, rate, timing, and fate of Non-Point Source (NPS) pollutants in agricultural and urban environments.

**Prerequisite:** BEE 313 with C or better or CE 412 with C or better

*Available via Ecampus*

**BEE 468, BIOREMEDIATION ENGINEERING, 4 Credits**

Examines strategies for using a variety of biological processes for treating municipal, agricultural and industrial contaminants. Lec/lab.

**Prerequisite:** BEE 221 with C or better or ENVE 322 with C or better

*Available via Ecampus*

**BEE 469, ^ECOLOGICAL ENGINEERING DESIGN I, 4 Credits**

Engineering design processes for ecological engineering applications, including specifications, performance criteria, timelines, and project logistics, principles and practices of working in engineering teams. (Writing Intensive Course)

**Attributes:** CWIC – Core, Skills, WIC

**Prerequisite:** BEE 322 with C or better

**Recommended:** ENGR 391 or ENGR 391H

**BEE 470, ECOLOGICAL ENGINEERING DESIGN II, 4 Credits**

Engineering design processes for ecological engineering applications, including specifications, performance criteria, timelines, and project logistics, principles and practices of working in engineering teams.

**Prerequisite:** BEE 469 with C or better

**BEE 472, INTRODUCTION TO FOOD ENGINEERING PRINCIPLES, 5 Credits**

Fundamental engineering principles for scientists and non-process engineers. Topics include fluid flow, mass and energy transfer, and material and energy balances. Directed at food scientists and other majors who need or would like a working knowledge of food engineering principles.

**Prerequisite:** MTH 112 with C- or better and (MTH 227 [C-] or MTH 251 [C-] or MTH 251H [C-]) and PH 201 [C-]

**Equivalent to:** BEE 452

**BEE 473, INTRODUCTION TO FOOD ENGINEERING PROCESS DESIGN, 3 Credits**

Fundamental engineering process design principles for food scientists and non-process engineers. Directed at those who need or would like a working knowledge of applied food engineering process design. Lec/rec.

**Equivalent to:** BEE 453

**Recommended:** BEE 472 or BEE 572

**BEE 481, ^ECOLOGICAL ENGINEERING DESIGN I, 4 Credits**

Explores engineering design processes for ecological engineering applications, including specifications, performance criteria, timelines, and project logistics, principles and practices of working in engineering teams. (Writing Intensive Course)

**Attributes:** CWIC – Core, Skills, WIC

**Prerequisite:** BEE 322 with C or better

**Equivalent to:** BEE 469

**BEE 482, ECOLOGICAL ENGINEERING DESIGN II, 3 Credits**

Designs engineering processes for ecological engineering applications, including specifications, performance criteria, timelines, and project logistics, principles and practices of working in engineering teams.

**Prerequisite:** BEE 481 with C or better

**BEE 483, ECOLOGICAL ENGINEERING DESIGN III, 2 Credits**

Designs engineering processes for ecological engineering applications, including specifications, performance criteria, timelines, and project logistics, principles and practices of working in engineering teams

**Prerequisite:** BEE 482 with C or better

**BEE 499, SPECIAL TOPICS, 0-16 Credits**

**Equivalent to:** BEE 499H, BRE 499

*This course is repeatable for 16 credits.*

**BEE 499H, SPECIAL TOPICS, 1-16 Credits**

**Attributes:** HNRS – Honors Course Designator

**Equivalent to:** BEE 499

*This course is repeatable for 16 credits.*

**BEE 501, RESEARCH, 1-16 Credits**

**Equivalent to:** BRE 501

*This course is repeatable for 16 credits.*

**BEE 503, THESIS, 1-16 Credits**

**Equivalent to:** BRE 503

*This course is repeatable for 999 credits.*

**BEE 505, READING AND CONFERENCE, 1-16 Credits**

**Equivalent to:** BRE 505

*This course is repeatable for 16 credits.*

**BEE 506, PROJECTS, 1-16 Credits**

**Equivalent to:** BRE 506

*This course is repeatable for 16 credits.*

## BEE 507, SEMINAR, 1 Credit

Section 1: Graduate Student Orientation Seminar to acquaint new graduate students with graduate school and departmental requirements, policies and expectations, and departmental research programs.

Section 2: Graduate Research Publication Seminar to expose students to requirements for successful proposals and publication of research results. Section 3: Oral Presentation Improvement—A highly participatory educational effort designed to improve performance in presenting research reports, technical papers and in responding to oral examination questions. Graded P/N.

**Equivalent to:** BRE 507

*This course is repeatable for 99 credits.*

## BEE 511, GLOBAL ENVIRONMENTAL CHANGE: USING DATA TO INFORM DECISIONS, 3 Credits

Empowers students interested in global change research to focus on the interactions between changes in human land use and climate. Using an innovative online data and mapping tool called Data Basin, students will explore topics accessing the highest quality datasets available in an all-in-one platform.

*Available via Ecampus*

## BEE 512, PHYSICAL HYDROLOGY, 3 Credits

Principles of hydrologic processes and the integration of these processes into the hydrologic cycle. Topics include atmospheric processes, precipitation and runoff, storm response in streamflow on a watershed scale, and major concepts in groundwater systems.

**Equivalent to:** BRE 512

**Recommended:** One year of calculus.

*Available via Ecampus*

## BEE 522, DATA ANALYSIS AND VISUALIZATION USING PYTHON, 3 Credits

Foundation course in computational thinking and computational skills relevant to data analysis and visualization of environmental data.

## BEE 525, STOCHASTIC HYDROLOGY, 3 Credits

Introduction to fundamental concepts that are needed for stochastic modeling of hydrologic processes in presence of nonstationarity and uncertainty. CROSSLISTED as BEE 525/CE 525.

**Prerequisite:** CE 512 with C or better or BEE 512 with C or better

**Equivalent to:** CE 525

## BEE 529, BIOSYS MODELING TECHNIQUES, 3 Credits

Development of mathematical models of biological and ecological systems; linear and nonlinear systems analysis; stochastic modeling and random processes; model solution and analysis techniques.

## BEE 533, IRRIGATION SYSTEM DESIGN, 4 Credits

Principles of soil and plant water use applied to irrigation system design. Design of gravity, pressurized, and trickle irrigation systems, improving on-farm water management, performance characteristics of pumps and other irrigation equipment. Lec/lab. Offered alternate years.

**Equivalent to:** BRE 533

**Recommended:** ENGR 332

## BEE 538, ECOLOGICAL SYSTEMS ANALYSIS, 4 Credits

An introduction to sustainability with a focus on case studies that are relevant to biological and ecological engineers. An introduction to tools that perform technical feasibility analysis, economic viability analysis, environmental risk assessment, resource sustainability assessment and life cycle assessment (LCA). Course will consist of theory and case studies highlighting the use of LCA methods to assess sustainability.

**Recommended:** ENGR 391 or ENGR391H

## BEE 540, ENVIRONMENTAL TRANSPORT PROCESSES, 3 Credits

Mixing and transport processes in the environment.

## BEE 542, VADOSE ZONE TRANSPORT, 4 Credits

Introduction to the physical and hydraulic properties involved in flow from the soil surface to groundwater. Classical infiltration equations will be derived and presented with exact and approximate solutions. Attention is focused on application to pollutant transport and recent advances in non-ideal flow.

**Equivalent to:** BRE 542

**Recommended:** MTH 254

## BEE 544, OPEN CHANNEL HYDRAULICS, 4 Credits

Steady, uniform, and nonuniform flow in natural and artificial open channels; unsteady flow; interaction of flow with river structures; and computational methods. Offered alternate years.

**Equivalent to:** BRE 544, CE 544

**Recommended:** CE 313

## BEE 545, SEDIMENT TRANSPORT, 4 Credits

Principles of sediment erosion, transportation and deposition in rivers, reservoirs, and estuaries; measurement, analysis, and computational techniques. Offered even years in winter term. CROSSLISTED as BEE 545/FE 545.

**Equivalent to:** BRE 545, FE 545

**Recommended:** CE 313 or FE 330

## BEE 546, RIVER ENGINEERING, 4 Credits

Multipurpose river use; natural physical processes in alluvial rivers; channel modification practices; river structures; design practices; impact of river modification; problem analysis; and impact minimization. Offered alternate years.

**Equivalent to:** CE 546

**Recommended:** CE 313

## **BEE 549, REGIONAL HYDROLOGIC MODELING, 3 Credits**

Challenges in regional-scale water resource analysis and management with emphasis on application to production agriculture. Application of geostatistical techniques to spatially variable systems and remote sensing to large-scale water resource systems. Development of soil-water-atmosphere-plant models. Analysis of evapotranspiration estimating methods. Offered alternate years.

**Equivalent to:** BRE 549

**Recommended:** BEE 512 and MTH 256

## **BEE 558, NONPOINT SOURCE POLLUTION ASSESSMENT AND CONTROL, 3 Credits**

Problem solving in nonpoint source pollution. Methods for evaluating the extent, rate, timing, and fate of Non-Point Source (NPS) pollutants in agricultural and urban environments.

*Available via Ecampus*

## **BEE 568, BIOREMEDIATION ENGINEERING, 4 Credits**

Examines strategies for using a variety of biological processes for treating municipal, agricultural and industrial contaminants. Lec/lab.

*Available via Ecampus*

## **BEE 572, INTRODUCTION TO FOOD ENGINEERING PRINCIPLES, 5 Credits**

Fundamental engineering principles for scientists and non-process engineers. Topics include fluid flow, mass and energy transfer, and material and energy balances. Directed at food scientists and other majors who need or would like a working knowledge of process engineering principles.

**Recommended:** MTH 112 and (MTH 227 or MTH 251 or MTH 251H) and PH 201

## **BEE 573, INTRODUCTION TO FOOD ENGINEERING PROCESS DESIGN, 3 Credits**

Fundamental engineering process design principles for food scientists and non-process engineers. Directed at those who need or would like a working knowledge of applied food engineering process design. Lec/rec.

**Equivalent to:** BEE 553

**Recommended:** BEE 472 or BEE 572

## **BEE 585, METABOLIC SYSTEMS ENGINEERING, 3 Credits**

Quantitative and experimental approaches for describing and engineering biological networks and an introduction to the principles and methodologies of metabolic engineering and synthetic biology.

**Equivalent to:** BIOE 585

**Recommended:** Statistics, biology, biochemistry or microbiology.

## **BEE 586, PROBLEM SOLVING FOR METABOLIC SYSTEMS ENGINEERING, 1 Credit**

Matrix algebra and linear optimization for engineers and life scientists who lack linear algebra, linear optimization, and differential equations. Real-world analysis and optimization problems applied to the design and engineering of biological networks. Lab.

**Corequisites:** BEE 585

**Recommended:** MTH 251 and MTH 252

## **BEE 599, SPECIAL TOPICS, 0-16 Credits**

**Equivalent to:** BRE 599

*This course is repeatable for 16 credits.*

## **BEE 601, RESEARCH, 1-16 Credits**

**Equivalent to:** BRE 601

*This course is repeatable for 16 credits.*

## **BEE 603, THESIS, 1-16 Credits**

**Equivalent to:** BRE 603

*This course is repeatable for 999 credits.*

## **BEE 605, READING AND CONFERENCE, 1-16 Credits**

**Equivalent to:** BRE 605

*This course is repeatable for 16 credits.*

## **BEE 606, PROJECTS, 1-16 Credits**

**Equivalent to:** BRE 606

*This course is repeatable for 16 credits.*

## **BEE 607, SEMINAR, 1-16 Credits**

Graded P/N.

**Equivalent to:** BRE 607

*This course is repeatable for 16 credits.*

## **BEE 699, SPECIAL TOPICS, 1-16 Credits**

*This course is repeatable for 16 credits.*