




# BIOE HANDBOOK

 2020-21



**University of Manitoba**  
Engineering Society



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# Biosystems Engineering

## Department Contacts

Department Head: Danny Mann (Danny.Mann@umanitoba.ca)

Associate Head: Nazim Cicek (Nazim.Cicek@umanitoba.ca)

Undergraduate Student Advisor: Nammy Nadarajah (narmatha.nadarajah@umanitoba.ca)

## Department Description

Biosystems Engineering combines aspects of engineering with science and biology. Possible areas of study include plant and animal growth facilities, biomedical devices, new biological production systems in pharmaceutical industries and agricultural machines, among others. Biosystems Engineering also addresses concepts including the ecological impact of biological waste, new methods of food preservation, storage systems, land irrigation design, and drainage systems.

In addition to the standard Biosystems Engineering program, the department offers an Environmental, Bioresource and Biomedical specialization. Finally, the department also offers a program for students intending to enter the Faculty of Medicine. Students interested in any of these programs should consult with the Biosystems Department Office to select an appropriate set of elective courses.



## Tips for Incoming Biosystems Students

These tips are from current students in Biosystems and other departments.

1. If they are available, old midterms and finals are one of the best ways to prepare for your exams. Pay attention to the style of questions your professor has given in the past and to the concepts that were emphasized in previous years' exams.
2. Make friends, you will have several group projects for which you get to choose your partners.
3. Don't leave all of your tech electives for your last year as many of them are only offered every second year. It is important to plan them out to avoid conflicts and ensure you get into the courses you want.
4. Consider taking your complementary electives in the evenings during the summer. They are less demanding, and you can lighten your course load during the school year.
5. Many of your courses will have weekly quizzes or assignments. Even though they aren't worth a large percentage of your grade, put in as much effort as you can. Your marks in these sections of the course can help boost your overall grade.
6. Take advantage of the professors' office hours, they can provide assistance on assignments and with studying for tests and exams.
7. Get your card encoded at the earliest opportunity, there are usually a few days it is done every fall term; it will be needed to access rooms such as the CAD lab.
8. Be VERY careful if you don't follow the recommended courses because prerequisites and timing are almost impossible to plan out, especially when design electives are only offered every two years.

## What are Specializations?

In the Biosystems department students have the option to attain a designation on their transcript of a Biomedical, Bioresource or Environmental specialization. This requires the student to select their fourth-year design electives so that all three of them fit into one of the three specializations.



categories. Along with the specific design electives the students will also choose their science courses, complimentary and free electives to enhance their knowledge in the specific area. For more information on the courses required for each of the specializations go to Faculty of Engineering - Biosystems Department - Student Advising Assistance on the University of Manitoba website



## Course List

For 4 and 5-year course schedules, stream information and other helpful spreadsheets, visit:

<http://umanitoba.ca/faculties/engineering/departments/biosystems/undergrad/biosystemsstudentadvisingassistance.html>

### Second Year Courses

Solid Mechanics 1	(BIOE 2800)	4CR
Biosystems Engineering Design 1	(BIOE 2900)	4CR
Engineering Mathematical Analysis 2	(MATH 2132)	3CR
Biology for Engineers	(BIOE 2590)	3CR
Transport Phenomena	(BIOE 2110)	3CR
Chemistry	(CHEM 1310)	3CR
Engineering CAD Tech for Biosystems	(ENG 2022)	3CR
Fluid Mechanics	(BIOE 2790)	4CR
Engineering Mathematical Analysis 1	(MATH 2130)	3CR
Numerical Methods	(MECH 2150)	4CR
Statistical Analysis for Engineers	(STAT 2220)	3CR
Essentials of Microbiology	(MBIO 1220)	3CR
Impact of Engineering on the Environment	(BIOE 2480)	3CR

### Third Year Courses



Design of Structural Components in Machines	(BIOE 3400)	4CR
Mechanics of Biological Materials	(BIOE 3590)	4CR
Kinematics and Dynamics	(MECH 3482)	4CR
Instrumentation and Measurement for Biosystems	(BIOE 3270)	4CR
Biosystems Engineering Design 2	(BIOE 3900)	4CR
Engineering Properties for Biological Materials	(BIOE 3320)	4CR

#### Fourth Year Courses

Design 3	(BIOE 4900)	4CR
Design 4	(BIOE 4950)	4CR
Engineering Economics	(CIVL 4050 or ENG 3000)	3CR
Technology, Society and the Future	(CIVL 4460 or ANTH 2430)	3 CR
Graduation Project	(BIOE 4240)	3CR

#### Electives

\* Biosystems engineering students are required to take eight (8) electives as part of their program: 3 BIOE Design Electives, 2 Science Electives, 2 Complementary Studies Electives, and 2 Free Electives

#### DESIGN ELECTIVES (choose 3)

Design of Light-Frame Building Systems	(BIOE 4412)	4CR
Unit Operations 1	(BIOE 4390)	4CR



Crop Preservation	(BIOE 4420)	4CR
Bioprocessing for Biorefining	(BIOE 4440)	4CR
Management of By-Products from Animal Production	(BIOE 4590)	4CR
Design of Water Management Systems	(BIOE 4600)	4CR
Textiles in Healthcare and Medical Applications	(BIOE 4650)	4CR
Air Pollution Assessment and Management	(BIOE 4460)	4CR
Remediation Engineering	(BIOE 4620)	4CR
Alternative Building Design	(BIOE 4700)	4CR
Imaging and Spectroscopy for Biosystems	(BIOE 4414)	4CR
Design of Assistive Technology Devices	(BIOE 4610)	4CR
Bioengineering Applications in Medicine	(BIOE 4640)	4CR

## SCIENCE ELECTIVES

Any Course in the Science Department that is not already counting towards your degree works. If you wish to have a specialization, these science electives may need to be certain courses.

## FREE ELECTIVES

Any university course at the 1000-level or above can be used as a free elective. However, ARTS 1100 Introduction to University may not be used for credit in the Faculty of Engineering. Please note that additional BIOE design electives can be taken as free electives. If you are planning to complete a Specialization, please take note that there are specific courses to be used as free electives.





## Course Descriptions

### SECOND YEAR CORE COURSES

#### **Solid Mechanics (BIOE 2800) 4CR**

Analysis of deformable bodies; stress and strain in three dimensions; equilibrium equations and strain-displacement relations; constitutive relations and mechanical behaviour of materials; radially symmetric and plane problems in elasticity; relevant experimental demonstrations.

**Difficulty:** Not Available    **Workload:** 2    **Math Content:** 3    **Memorized Content:** 0

**Tips:** Not Available

#### **Biosystems Engineering Design 1 (BIOE 2900) 4CR**

Biosystems Engineering and its place in the professions of engineering and agrolology. Design concepts, with an emphasis on team building and technical communication skills. Philosophy of project planning. Preparation of a conceptual design by teams in response to design assignment submitted by industry. Written report presented orally.

**Difficulty:** Not Available    **Workload:** 4    **Math Content:** 1    **Memorized Content:** 3

**Tips:** Make sure to start on the written assignments early and not leave them to the last minute, taking the time to review and edit your reports for grammar and formatting makes a big difference.

#### **Engineering Mathematical Analysis 2 (MATH 2132) 3CR**

(Lab required) Infinite series, Taylor and Maclaurin Series; ordinary differential equations including Laplace transforms. For Engineering and Geophysics students only. MATH 1210 and MATH 1710 are prerequisites.

**Difficulty:** Not Available    **Workload:** 3    **Math Content:** 5    **Memorized Content:** 2



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**Tips:** The best way to prepare for your midterms and final is to do lots of practice problems in the textbook. The tutorials are taught by the professor, so they are a great opportunity to go through additional practice problems and ask your questions.

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### **Biology for Engineers (BIOE 2590) 3CR**

Provide theories and principles of Biology to engineering students and present applications of biological principles to engineering problems. Fundamental theories involved in cell structure and function, metabolism, genetics and heredity, bacteria and virus structure and function, plant and animal structure and function are covered. An introduction to animal and plant physiology is also provided. Laboratory sessions and term assignments focus on the engineering applications of these basic theories and principles to provide a good understanding of the role of Biology in Engineering.

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**Difficulty:** Not Available    **Workload:** 2    **Math Content:** 0    **Memorized Content:** 5

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**Tips:** When Dr. Levin teaches this course, he has graduate students come out to the tutorials to tell you about their research projects. This can be a great opportunity to learn more about the wide range of topics that Biosystems Engineering covers.

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### **Transport Phenomena (BIOE 2110) 3CR**

Principles of heat transfer, solar radiation, psychometrics, molecular diffusion, mass transfer and refrigeration and their application to biosystems.

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**Difficulty:** Not Available    **Workload:** 3    **Math Content:** 4    **Memorized Content:** 1

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**Tips:** Make sure to take the time to do all of the tutorial questions and review them before the exams.

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### **Chemistry (CHEM 1310) 3CR**

Thermochemistry, chemical thermodynamics, and chemical kinetics. This course expands on topics covered in high school chemistry that were not included in CHEM 1300. This course is more math intensive than CHEM 1300, which some people have difficulty with. CHEM 1300 is a prerequisite.

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**Difficulty:** Not Available    **Workload:** 3    **Math Content:** 3    **Memorized Content:** 3

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**Tips:** Start your lab write ups early so that you have time to ask questions if needed and also to consult with other peers.

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### Engineering CAD Tech for Biosystems (ENG 2022) 3CR

Instruction in the use of current CAD technology for conveying design through the use of graphics. Students will gain knowledge in technical drawing, 3D modelling techniques, production technology, and visual communication. Registration restricted to students in Engineering.

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**Difficulty:** Not Available    **Workload:** 4    **Math Content:** 1    **Memorized Content:** 1

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**Tips:** Pay attention during the step by step demonstrations during the in-lab instruction and take notes if you feel that you are going to get behind as it can be difficult to try to catch up and remember what all of the steps are.

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### Fluid Mechanics (CIVL 2790) 4CR

Definition of fluid; fluid properties; variation of pressure in a fluid; hydrostatic forces; buoyancy; kinematics of flow; control volumes; continuity; Bernoulli's equation; momentum equation; energy equation; flow in closed conduits; open channel flow.

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**Difficulty:** Not Available    **Workload:** 3    **Math Content:** 3    **Memorized Content:** 2.5

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**Tips:** Not Available

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### Engineering Mathematical Analysis 1 (MATH 2130) 3CR

Multivariable differential and integral calculus up to and including multiple integrals in cylindrical and spherical coordinates. For Engineering and Geophysics students only.

Prerequisites: MATH 1210 or MATH 1211 and MATH 1710

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**Difficulty:** Not Available    **Workload:** 2    **Math Content:** 5    **Memorized Content:** 1.5

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**Tips:** Make sure to review your notes from Calculus 2 before starting this class. The textbook has lots of practice problems, which are a great way to prepare for the tests. Make an effort to attend the tutorials, as the professors will go through practice problems.

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### Numerical Methods (MECH 2150) 4CR

Numerical methods applied to problems in engineering; roots of nonlinear equations and systems of linear equations, numerical differentiation and integration, initial-value problems.

**Difficulty:** Not Available    **Workload:** 1.5    **Math Content:** 2    **Memorized Content:** 2

**Tips:** Not Available

### Statistical Analysis for Engineers (STAT 2220) 3CR

Descriptive statistics, basic probability concepts, special statistical distributions, statistical inference-estimation and hypothesis testing, regression, reliability, statistical process control.

**Difficulty:** Not Available    **Workload:** 1.5    **Math Content:** 3.5    **Memorized Content:** 3

**Tips:** Make sure you keep up with the practice problems. Although the material is relatively straightforward, it can get a little overwhelming if you fall behind.

### Essentials of Microbiology (MBIO 1220) 3CR

An introduction to the essential principles of microbiology including immunity, with emphasis on microbial disease.

**Difficulty:** Not Available    **Workload:** 1    **Math Content:** 0    **Memorized Content:** 5

**Tips:** Not Available

### Impacts of Engineering on the Environment (BIOE 2480) 3CR

Students will gain an understanding of overall sustainability of industrial activities, life-cycle and risk assessment techniques for sustainability, and design improvements to enhance environmental performance of engineered systems. This course will introduce basic methodologies for conducting environmental impact assessments, including physical, chemical, ecological, social and economic impacts.

**Difficulty:** Not Available    **Workload:** 1    **Math Content:** 0    **Memorized Content:** 4.5

**Tips:** Not Available



## THIRD YEAR CORE COURSES

### Design of Structural Components in Machines (BIOE 3400) 4CR

Design of structural components in machines; designing for axial tension and compression, connections for axial loadings, pinned trusses, bending, torsion, and combined loads; designing for welded connections; use of fluid power to enable movement of structural components. Students will use the computer as a design tool. Prerequisite: BIOE 2800.

**Difficulty:** Not Available    **Workload:** 3    **Math Content:** 4.5    **Memorized Content:** 1.5

**Tips:** Not Available

### Mechanics of Biological Materials (BIOE 3590) 4CR

In this course students will be exposed to both the theory and physical behaviour of materials when subjected to loads. The course will be delivered using a combination of lectures and hands-on labs. The materials presented include a wide range of design biosystems engineers may be involved with, including plastics, bone, wood, concrete, steel, other biological materials and composites.

**Difficulty:** Not Available    **Workload:** 3    **Math Content:** 3.5    **Memorized Content:** 3

**Tips:** Not Available

### Kinematics and Dynamics (MECH 3482) 4CR

Fundamentals of 2D and 3D rigid body motions (kinematics) and the forces/moments (kinetics) needed to produce such motions. Applications will emphasize elements of machine design.

**Difficulty:** Not Available    **Workload:** 5    **Math Content:** 5    **Memorized Content:** 2

**Tips:** Not Available

### Instrumentation and Measurement for Biosystems (BIOE 3270) 4CR

Basic instrumentation for measuring electrical and non-electrical quantities associated with biosystems engineering and industry; transducers for automatic control.



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**Difficulty:** Not Available    **Workload:** 3.5    **Math Content:** 3.5    **Memorized Content:** 3

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**Tips:** Not Available

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### **Biosystems Engineering Design 2 (BIOE 3900) 4CR**

An introduction to the use of reverse engineering to deduce design features from previously-designed products or systems. Considerations such as design for sustainability and design for disassembly will be discussed. Students will have opportunity to use reverse engineering principles to understand how components fit together to form functional systems, to identify flaws and to propose design improvements. Students will learn appropriate techniques for documenting the reverse engineering process. Prerequisites: BIOE 2900.

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**Difficulty:** Not Available    **Workload:** 2.5    **Math Content:** 0    **Memorized Content:** NA

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**Tips:** Not Available

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### **Engineering Properties of Biological Materials (BIOE 3320) 4CR**

Engineering properties of biological and interacting materials within the system. Relationship between composition, structure, and properties of plant, animal, and human tissues. Definition and measurement of mechanical, thermal, electromagnetic, chemical and biological properties and their variability. Use of these properties in engineering calculations.

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**Difficulty:** Not Available    **Workload:** 4    **Math Content:** 2    **Memorized Content:** 4.5

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**Tips:** Not Available

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## **FOURTH YEAR CORE COURSES**

### **Design 3 (BIOE 4900) 4CR**

An opportunity for the Biosystems Engineering student to practice fundamental engineering competencies (project management, technical communication) in the preparation of a preliminary design for the client. Students will be expected to demonstrate professionalism as a part of a design team. May not be held with BIOE 3580. Prerequisite: BIOE 3900.

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**Difficulty:** Not Available    **Workload:** 4.5    **Math Content:** 3    **Memorized Content:** 1

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**Tips:** Not Available

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## Design 4 (BIOE 4950) 4CR

An opportunity for the Biosystems Engineering student to validate a conceptual solution to an engineering problem through fabrication and testing of a prototype. Students will be expected to employ project management skills to ensure completion of both prototype and an engineering report for a client by the end of the semester. May not be held with BIOE 4580.

Prerequisite: BIOE 4900.

**Difficulty:** Not Available    **Workload:** 4.5    **Math Content:** 3    **Memorized Content:** 1

**Tips:** Not Available



### Engineering Economics (CIVL 4050) 3CR

Introduction to engineering economics. Time value of money and discounted cash flow calculations. Comparing alternatives. Replacement analysis and life-cycle costing. Public sector engineering economy studies. Private sector engineering economy studies. Before and after-tax analysis. Applications in cost-estimating. Applications in asset management systems. Basic accounting. Accommodating capital limitations. Dealing with inflation. Dealing with risk and uncertainty. Prerequisite: STAT 2220 or (STAT 1000 and STAT 2000).

**Difficulty:** Not Available    **Workload:** 3.5    **Math Content:** 3.5    **Memorized Content:** 4

**Tips:** Not Available

### Engineering Economics (ENG 3000) 3CR

Introduction to engineering economics. Time value of money and discounted cash flow calculations. Comparing alternatives. Replacement analysis and life-cycle costing. Public sector engineering economy studies. Private sector engineering economy studies. Before and after-tax analysis. Applications in cost-estimating. Applications in asset management systems. Basic accounting. Accommodating capital limitations. Dealing with inflation. Dealing with risk and uncertainty. Prerequisite: STAT 2220 or (STAT 1000 and STAT 2000).

**Difficulty:** Not Available    **Workload:** 3    **Math Content:** 3    **Memorized Content:** 2.5

**Tips:** Not Available

### Technology, Society and the Future (ANTH 2430) 3CR

Impact of technology and technological change on society - past, present, future; specific technologies, e.g. construction, machine power, computers, communications, medical, military: the process of technological change; invisible effects of technology; technology and resource use; sustainable development, limits to growth and the role of technology.

Prerequisite: written requirement

**Difficulty:** Not Available    **Workload:** 1.5    **Math Content:** 0    **Memorized Content:** 3.5

**Tips:** Not Available





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### Technology, Society and the Future (CIVL 4460) 3CR

Impact of technology and technological change on society - past, present, future; specific technologies, e.g. construction, machine power, computers, communications, medical, military: the process of technological change; invisible effects of technology; technology and resource use; sustainable development, limits to growth and the role of technology.

Prerequisite: written requirement

**Difficulty:** Not Available    **Workload:** 2    **Math Content:** 0    **Memorized Content:** 4

**Tips:** Not Available

### Graduation Project (BIOE 4240) 3CR

Either an independent or a directed study including at least one of: a comprehensive literature review, an experimental research project, or an engineering design problem. The project is to be concluded by a formal report or thesis. Prerequisites: BIOE 3270 or approval of department.

**Difficulty:** Not Available    **Workload:** NA    **Math Content:** NA    **Memorized Content:** NA

**Tips:** Not Available

## DESIGN ELECTIVE DESCRIPTIONS

### Design of Light-Frame Building Systems (BIOE 4412) 4CR

Light-frame buildings as a structural and environmental system; structural loads in building systems; energy (heat), moisture and air contaminants in building systems; built-environment for building occupants. Hands-on labs of constructing small-scale structures for students to gain an understanding of building construction techniques. Prerequisites: BIOE 2110 and BIOE 3590

**Difficulty:** Not Available    **Workload:** NA    **Math Content:** NA    **Memorized Content:** NA

**Tips:** Not Available

**NOTE:** This course is only offered in the winter term of even years



### Unit Operations 1 (BIOE 4390) 4CR

Equipment and systems used in handling, mixing, size reduction, separation and size enlargement of value-added food products. Prerequisites: CIVL 2790 or MECH 2262.

Corequisites: BIOE 3320, BIOE 3270.

**Difficulty:** Not Available    **Workload:** 3    **Math Content:** 3.5    **Memorized Content:** 3

**Tips:** Not Available

**NOTE:** This course is only offered in the fall term of odd years

### Crop Preservation (BIOE 4420) 4CR

Biological and physical deterioration during storage. Methods of preserving and storing cereals, oilseeds, and other agricultural crops. Prerequisite: BIOE 2110

**Difficulty:** Not Available    **Workload:** NA    **Math Content:** NA    **Memorized Content:** NA

**Tips:** Not Available

**NOTE:** This course is only offered in the winter term of odd years

### Bioprocessing for Biorefining (BIOE 4440) 4CR

This course will provide students with an understanding of the principles involved in the design of proper conditions for processing of biomaterials for production of high-quality biofuels and bioproducts. The content of this course is built on the principles of physics, transport phenomena, thermodynamics, reaction, kinetics, fermentation, and industrial unit operations. Prerequisite: BIOE 2110. Pre-or corequisite: BIOE 3320.

**Difficulty:** Not Available    **Workload:** NA    **Math Content:** NA    **Memorized Content:** NA

**Tips:** Not Available

**NOTE:** This course is only offered in the fall term of even years

### Management of By-Products from Animal Production (BIOE 4590) 4CR

Topics covered include solid and liquid manure, manure characteristics, manure collection, storage, land application and utilization, biological treatment, design of equipment and facilities for manure handling. Environment issues, such as odour and water pollution



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associated with manure management will also be discussed. Prerequisites: CIVL 2790 or MECH 2262

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**Difficulty:** Not Available    **Workload:** NA    **Math Content:** NA    **Memorized Content:** NA

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**Tips:** Not Available

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**NOTE:** This course is only offered in the winter term of odd years

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### **Design of Water Management Systems (BIOE 4600) 4CR**

To introduce the basic theoretical principles in the design of irrigation and drainage systems. Topics covered include the determination of irrigation depth and interval, evapotranspiration, measurement and analysis of precipitation, design of sprinkler and drip irrigation systems, selection of pumps, surface and subsurface drainage design, water quality issues, salinity management, and the environmental impact of water management practices.

\*offered in fall term of odd years

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**Difficulty:** Not Available    **Workload:** 3    **Math Content:** 2.5    **Memorized Content:** 3.5

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**Tips:** Not Available

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**NOTE:** This course is only offered in the fall term of odd years

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### **Textiles in Healthcare and Medical Applications (BIOE 4650) 4CR**

This course provides students with an introduction to medical textiles and healthcare products used in current practices, as well as fundamentals for designing textile products and devices that improve the health and quality of life of human beings. The course includes both basic topics related to healthcare and medical textiles (i.e., materials and structures, nanofibers for medical uses, comfort and health problems with textiles, biocompatibility and biostability issues) and applications of textile products for healthcare and medical end uses (i.e., protective and hygiene textiles, external devices, tissue engineering and intelligent/smart textiles). Prerequisite: BIOE 2590. Pre- or Corequisite: BIOE 3320.

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**Difficulty:** Not Available    **Workload:** 2    **Math Content:** 0    **Memorized Content:** 3.5

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**Tips:** Not Available

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### **Air Pollution Assessment and Management (BIOE 4460) 4CR**