The University of Manitoba
Department of Biosystems Engineering

Course Number	**BIOE 4420**	**Course Title**	**Crop Preservation**
Academic Session	Fall 2020	**Credit Hours**	4

Prerequisites and how they apply to this course
BIOE 2110 Transport Phenomena provides students with: 1) an introduction to the heat and mass transfer inside the biomass materials, 2) basic knowledge on temperature gradients; and 3) experience on Psychometric chart which will be used to explain grain drying and aeration. BIOE 7110 (3 hr/week) will build upon this knowledge.

Classroom Location	On-line
Meeting Days and Class Hours	MWF 9:30 am to 10:20 am
Lab Location	Grain Storage Lab. 120
Lab Hours and Tutorial	Monday 2:30 to 5:15 pm, On line (Students can choose lab time after the third weeks)

Student Contact Time (Hrs)

Lectures:	2.5 hrs lecture/week × 13 weeks/term = 32.5 hrs/term
Laboratories:	2 hr/week × 12 weeks = 24 hrs
Tutorials:	laboratorial time or TBA

Instructor Information

Name & Title	Dr. Fuji Jian, P. Eng. Assistant Professor
Office Location	E1-532 EITC
Office Phone Number	204-474-7965, 204-294-1295 (cell)
Email Address	**fuji.jian**@umanitoba.ca
Office Hours	By appointment
Teaching Assistant(s)	Vimala (skvb@myumanitoba.ca)
TA Office Hours and Location	By appointment

Important Dates

First day of class	Sep. 9, 2020
Voluntary withdrawal date	November 23, 2020
Midterm examination	Before end of October
Final examination	Arranged by the Department
Assignment Due Date	Approximately in a week

Course Philosophy

Students' Learning Responsibilities

Attendance for lectures and laboratories is strongly expected. To benefit the most from this class, you must be willing to participate in class discussions. You are expected to read the texts and course materials, do assignments independently (even though you are encouraged to discuss with your classmates and instructor), and understand principles and theories. Deadlines are a reality in the world of engineering; I expect assignments to be completed on time.

Why this course is useful?

Any biomaterials will: 1) spoil if not stored under proper conditions; and 2) have a finite storage life even though it is properly stored. The principles and theories delivered in this course can be used to design qualified storage facilities and make sound storage decisions. This course also focuses on practice. Therefore, the lectures, texts, and course materials can be directly used in industrial applications. Laboratory activities are intended to expose students to grain storage practices.

Students' knowledge will be enriched in the following areas: 1) Engineering such as heat and mass transfer, drying, aeration, ventilation, fan selection, air conditioning, material handling, and engineering design; and 2) biology such as stored product insects, mites, moulds and their monitoring and control; ecosystems; and physical properties of biomaterials.

Who should take this course?

Students in Biosystems Engineering and Agriculture with an interest in the storage life of biomaterials.

How this course fits into the curriculum?

It is intended that students take this course during the third or fourth year or at graduate level after they have gained experiences and knowledge on biology, engineering design, heat and mass transfer, and environmental control. This course introduces students to several fundamental engineering competencies and "solid skills" for grain and biomass storage and handling.

Course Description/Objectives

Instructional Methods

Learning is most effective when both the instructor and the students are engaged in the subject material. The role of the instructor, therefore, is to create an environment that facilitates students' engagement (and therefore learning). In this course, some dissemination of information will occur using the traditional lecture format (PowerPoint presentations). However, a substantial portion of the content will be distributed as reading materials which will be covered using classroom discussion (tutorial). Therefore, you will be expected to prepare for class by reading the assigned materials. Also you will conduct experiments at your home.

Course Content:

1. Introduction and overview of the postharvest grain industry in Canada. Grain storage in the world. Why storage is needed?
2. Grain physical properties: moisture contents, relative humidity, ERH-EMC curves, specific heat, thermal conductivity, thermal diffusivity, densities, angles of repose, distribution of dockage, and mass and funnel flow. Psychometric chart. Grain depth and air flow resistance, vertical vs horizontal air flow resistance.

3. Ecosystem components: respiration of biological materials, pre- and post-harvest fungi, insects, and mites. Mycotoxin in stored grain and oil seeds. Characteristics of grain storage ecosystems. Example of hot spot and storage life.
4. Grain temperature: Initial temperatures, temperatures in stored grain bins. Effect of bin diameter and height, initial grain temperature, bin wall material, solar radiation, and geological location.
5. Grain moisture contents: change in moisture content. Moisture migration.
6. Controlled atmosphere storage.
7. Grain drying: Principles of drying.
8. Design of non-ventilated storages. Design of aerated storages.
9. Design of near-ambient drying systems.
10. Design of heated-air drying systems.
11. Advanced grain storage practice. Safety and health hazards.

Course Objectives

Students are expected to gain an understanding of the physical (grain physical properties, temperature, moisture, and gas), chemical (chemical materials and chemical reaction such as grain respiration), biological (insects, mites, and microorganisms), and economic variables affecting the preservation and storage of cereal grains, oilseeds, and other agricultural products such as biomass and vegetables. The principles are applied to the design and operating criteria of storage systems. After the completion of the lectures, students should have the knowledge of industrial grain storage practice to maintain quality of grain and their products.

The laboratory work will also provide students with an opportunity to collaborate equitably with group members in a team setting to manage an engineering testing project and write a technical report.

Learning outcomes

At the conclusion of the course, the student should be able to:

- Understand fundamental concepts of the grain and biomass storage and handling
    1. Explain the physical, chemical, biological, and economic variables affecting the preservation and storage of cereal grains, oilseeds, and other agricultural products such as biomass and vegetables.
    2. Identify safety concerns during grain and biomass storage and handling.
- Use the principles and theories delivered in this course to solve problems
    1. Evaluate existing storage scenarios to identify condition likely to cause storage losses.
    2. Design storage systems to preserve the quality of grain, oilseeds, and other agricultural products such as biomass and vegetables.
    3. Design suitable drying and aeration systems to store biomaterials under safe storage conditions.

Grade Evaluation

The grade will be based on the assignments, lab performance and reports, and midterm and final examination.

The final grade is the combination of the following grades:

1. 40% on final examination
2. 30% on mid-term test
3. 30% on term work, assignments, design project, and laboratory report.

Final letter grades will be assigned on the basis of the overall performance of the class, the spread of the numerical marks, and in comparison with previous classes.

Description of Assignments

Questions will be assigned weekly or biweekly and will be evaluated for content (Total eight assignments). The reports should be presented in a neat and easy to read format. The mark of the lab report will be counted as two assignments.
The questions include the understanding of theories, principles, and design works. The design works will be assigned in one assignment (one project). The mark of the design project will be counted as two assignments.
Students are expected to complete their assignments on an individual basis even though discussion with the instructor and class mates are encouraged.

Description of Laboratories
One laboratory period (3 hr) per week throughout the semester. Laboratory work includes demonstrations and experiments with written reports.
List of the laboratories
1. Tour to grain storage facility, identification of insects, mites, and molds (video).
2. Design project: design a detail protocol to evaluate grain quality during storage and when the stored grain is delivered to elevators.
4. Experimental project: deterioration of wheat and canola during storage.
5. Writing of complete proposal and experimental reports.

Description of Examinations
The mid-term exam is scheduled on Oct 30 (Friday), 2020 - the lecture time. The results of the mid-term exam will be returned to students before the voluntary withdrawal deadline.
Date of the final exam will be scheduled by the University of Manitoba.
The examinations will be close-book exams. The questions will be similar to those assignments plus descriptive questions on theory and design works. Material presented in class, in laboratories, and in the textbook will be covered.

Texts, Readings, Materials

Textbook(s) – Authors, Titles, Edition
Dr. W. E. Muir. 1999. Grain Preservation Biosystems. Students are required to purchase this text book.
Supplementary Reading
Canadian Grain Storage CD-Rom.
Additional Materials
Supplied by instructor.

Course Policies

Late Assignments
Will not be accepted and will receive a zero grade.
Missed Assignments
Will receive a zero grade
Missed Exams
If the midterm or/and final examination is missed and the student has a valid medical certificate or compassionate reason (i.e., death of an immediate family member), a make-up examination will be scheduled by the course instructor. Students who miss the examination without a valid reason will receive a grade of zero for the examination.

Academic Integrity

Plagiarism or any other form of cheating in examinations, term tests or academic work is subject to serious academic penalty. Cheating in examinations or tests may take the form of copying from another student or bringing unauthorized materials into the exam room. Exam cheating can also include exam impersonation. A student found guilty of contributing to cheating in examinations or term assignments is also subject to serious academic penalty. Students should acquaint themselves with the University's policy on plagiarism, cheating, exam impersonation and duplicate submission.

Use of Third Party Detection and Submission Tools
Electronic detection tools may be used to screen assignments in cases of suspected plagiarism.

Group Work Policies:
You will be required to share your laboratorial results with your classmates. If you could not provide your results on time, penalties deducted for late sharing will be 10% per day.

Recording Class Lectures
Dr. Fuji Jian and the University of Manitoba hold copyright over the course materials, presentations and lectures that form part of this course. No audio or video recording of lectures or presentations is allowed in any format, openly or surreptitiously, in whole or in part without permission from Dr. Fuji Jian. Course materials (both paper and digital) are for the participant's private study and research.

The University of Manitoba

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Supplemental Course Information for BIOE 4420

All courses in the Biosystems Engineering program are expected to contribute, in some way, to the development of one or more of the 12 graduate attributes that have been identified by the Canadian Engineering Accreditation Board. The graduate attributes which will be emphasized and evaluated in this course have been defined below for your information:

- **A Knowledge Base for Engineering**
  Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.
- **Problem Analysis**
  An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.
- **Investigation**
  An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.
- **Design**
  An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations.
- **Use of Engineering Tools**
  An ability to create, select, apply, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.
- **Individual and Team Work**
  An ability to work effectively as a member and leader in teams, preferably in a multi-disciplinary setting.
- **Communication Skills**
  An ability to communicate complex engineering concepts within the profession and with society at large. Such ability includes reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions.

To maintain the accreditation of our Biosystems Engineering program, it is a requirement that student competency with respect to the 12 graduate attributes be assessed. To enable such assessment to occur in a meaningful manner, the Faculty of Engineering and representatives from industry developed a comprehensive list of indicators for each of the 12 graduate attributes. The indicators being formally assessed in BIOE 4420 are shown in the table below.

The ultimate goal of mapping the course evaluation to graduate attributes and indicators is the identification of potential deficiencies in the Biosystems Engineering program so that continuous improvement can occur. Data generated from this course will be compiled with data collected from other sources (i.e., other courses, SEEQ surveys, exit surveys, co-op surveys) to facilitate on-going review and improvement of the Biosystems Engineering curriculum.

Mapping of Course Evaluation to Graduate Attributes & Indicators

Grade Component	Specific Evaluation Point	Graduate Attribute [b]	Indicators Being Assessed [b]
Assignments (15%)	Assignment 1	1. Knowledge base 2. Problem analysis	1.15 Specialized Discipline-specific Engineering Concepts 2.2 Contextualize problem
	Assignment 2	1. Knowledge base 2. Problem analysis	1.15 Specialized Discipline-specific Engineering Concepts 2.2 Contextualize problem
	Assignment 3	1. Knowledge base 2. Problem analysis	2.2 Contextualize problem 2.8 Evaluate solution
	Assignment 4	1. Knowledge base 2. Problem analysis	2.2 Contextualize problem 2.8 Evaluate solution
	Assignment 5	1. Knowledge base 2. Problem analysis	2.2 Contextualize problem 2.8 Evaluate solution
	Assignment 6 (marks as two assignments)	4. Design 5. Use of engineering tools	4.3 Implementing design strategy 4.4 Evaluating final design 5.2 Identify and use tools
	Assignment 7 (marks as two assignments)	4. Design 5. Use of engineering tools	4.3 Implementing design strategy 4.4 Evaluating final design 5.2 Identify and use tools
Laboratory (15%)	Design testing procedure	3. Investigation 4. Design	3.9 Procedure 4.2 Problem solving
	Conduct testing	5. Use of engineering tools 6. Individual and teamwork 3. Investigation	5.2 Identify and use tools 6.2 Time management 6.7 Working with others 3.10 Data/evidence collection
	Lab report	3. Investigation 7. Communication skills	3.11 Data presentation and error analysis 3.12 Evaluation of experiment 7.10 Formatting/layout/design of communication
Midterm Examination (30%)	Part A and B	1. Knowledge base 2. Problem analysis 5. Use of engineering tools	1.15 Specialized Discipline-specific Engineering Concepts 2.2 Contextualize problem 2.8 Evaluate solution 5.2 Identify and use tools
	Part C	4. Design	4.2 Problem solving 4.3 Implementing design strategy
Final Examination: (40%)	Part A and B	1. Knowledge base 2. Problem analysis 5. Use of engineering tools	1.15 Specialized Discipline-specific Engineering Concepts 2.2 Contextualize problem 2.8 Evaluate solution 5.2 Identify and use tools
	Part C	4. Design	4.2 Problem solving 4.3 Implementing design strategy