Proposal for a Graduate Certificate Program

# Name of the proposed graduate certificate.

Graduate Certificate in Data-Driven Food, Energy and Water Decision Making

# Name of the departments and/or programs involved.

Industrial and Manufacturing Systems Engineering

Agricultural and Biosystems Engineering

Agronomy

Mechanical Engineering

Biorenewable Resources Technology

Electrical and Computer Engineering

Economics

Sociology

# Name of the contact person.

Sarah Ryan

Joseph Walkup Professor, Industrial and Manufacturing Systems Engineering

3017 Black

294-4347

smryan@iastate.edu

# Need for the graduate certificate

There is a strong and growing need for practitioners who work in the agricultural, environmental, and industrial sectors within the Food, Energy, and Water Systems (FEWS) to have skills in data science. Increasingly, decision-making within these systems relies on understanding not only the context of FEWS, but how to use data to understand system behavior and opportunities for improvement. While Iowa State has historical strength in science and engineering disciplines that inform understanding of FEWS, traditional graduate programs typically provide a monodisciplinary perspective on FEWS, and students may or may not have exposure to data science depending on their particular research project. The proposed graduate certificate will give students an opportunity to solidify their data science background and their understanding of the context of the nexus of food, energy and water. The proposed certificate would comprise the academic component of a new NSF-funded National Research Traineeship. (<https://www.imse.iastate.edu/datafewsion/>). The full traineeship adds a FEWS workshop series as well as a graduate learning community. Thus, not only will this certificate program complement current graduate program offerings in the individual participating programs noted above, but will complement a broader suite of FEWS data science activities for students who elect to do the full traineeship.

# Objective of the graduate certificate.

The certificate aims to prepare post-baccalaureate students for multiple career paths in the food-energy-water nexus, such as research scientist, bioeconomy entrepreneur, agribusiness leader, policy maker, agriculture analytics specialist, and professor, by credentialing their understanding of said nexus and their skills in quantitative analysis of complex systems such as this.

# General description of the graduate certificate.

The graduate certificate will consist of a 12.5 credits across six courses – three core courses and one elective course within each of three focus areas. Core courses will include a new course in critical issues in FEWS, a course in science communication, and a course in entrepreneurship. Elective courses will come from approved lists in each of the following theme areas: data acquisition, visualization, and analytics; complex systems modeling for decision support; and economics, policy, business or sociology of FEWS. There is no set sequence in which the courses must be taken.

# Graduate certificate requirements including:

## Admission standards and prerequisites for the certificate program.

This certificate program is intended for students who already have a strong quantitative background, such as those provided by BS degrees in engineering, data analysis, and affiliated programs or their equivalents. Students must demonstrate through transcripts sufficient quantitative skills. GPA must meet the Graduate College guidelines for admission.

Admission to certificate program is contingent upon the following requirements:

* Bachelors degree
* Experience or educational background demonstrating strong quantitative skills, including
  + Applied science and/or mathematics
  + Statistics; and
  + Programming or algorithmic thinking
* GPA should be consistent with the Graduate College handbook requirements.
* International (non-English speaking) students need to take the Test of English as a Foreign Language (TOEFL) or the International English language Testing System (IELTS). Minimum scores for admission are: paper based TOEFL – 600; Internet TOEFL – 100; or IELTS – 7.

Students may take up to 9 credits as a non-degree seeking student, and other students may add this certificate after beginning an MS or PhD, so it is possible to begin studies before formal admittance into this program. Degree-seeking students must enroll in the certificate program prior to completion of their degree-required coursework.

The Department of Industrial and Manufacturing Systems Engineering serves as the administering unit for the Graduate Certificate, with responsibility for the Certificate program delegated to interdisciplinary DataFEWSion Committee. For this purpose, the Committee will operate as a subcommittee within IMSE’s existing graduate programs operational structure. See [Appendix B](#_Committee_Purpose) for the governance document of this subcommittee.

## Courses and seminars.

Table 1. Certificate curriculum, 12.5 credits

|  |  |  |
| --- | --- | --- |
| **Knowledge Area** | **Requirement** | **Course Options** |
| Fundamental understanding of interactions in the FEW nexus | Core Course | * A B E 615[[1]](#footnote-1): *Key Performance Indicators for Agriculture (2 credits) \*\* THIS COURSE IS IN DEVELOPMENT*   *Description provided in* [*Appendix A*](#_A_B_E)*.* |
| Communication | Core Course | * GR ST 566[[2]](#footnote-2): *Communications in Science (0.5 credits)* |
| Entrepreneurship | Core Course | * *BCB 590 / EE 690X: Entrepreneurship for Graduate Students in Science and Engineering (1 credit)*   *Description provided in* [*Appendix C*](#AppendixC)*.* |
| Data acquisition, visualization, and analytics | Elective  (Choose One) | * M E 592X: *Data Analytics and Machine Learning for Cyber-Physical Systems Applications (3 credits)* * E E 529: *Data Analytics in Elect. & Comp. Engineering (3 credits)* * I E 483: *Knowledge Discovery and Data Mining* *(3 credits)* * A B E 504: *Instrumentation for Agricultural and Biosystems Engineering (3 credits)* * STAT 587: *Statistical Methods for Research Workers (3 credits)* * STAT 407: *Methods of Multivariate Analysis (3 credits)* |
| Complex systems modeling for decision support | Elective  (Choose One) | * A B E 580: *Engineering Analysis of Biological Systems* *(3 credits)* * I E/E E/AER E 565: *Systems Engineering & Analysis (3 credits)* * I E 564: *Decision Analysis in System Design (3 credits)* * I E/AERE 568: *Large-Scale Complex Engineered Systems* *(3 credits)* * M E 525: *Optimization Methods for Complex Design (3 credits)* * AGRON 525: *Crop and Soil Modeling (3 credits)* |
| Economics, Policy, or Sociology of FEW | Elective  (Choose One) | * ECON 560: *Agricultural, Food, and Trade Policy (3 credits)* * ECON 580: *Interm. Environment. & Resource Economics (3 credits)* * BRT/POL S 516: *Biorenewables Law and Policy (3 credits)* * M E 510: *Econ. & Policy of Engineering Energy Systems (3 credits)* * SOC 544: *Sociology of Food and Agricultural Systems (3 credits)* * SOC 549: *Sociology of the Environment (3 credits)* |

# General description of the resources currently available and future resource needs:

## A list of supporting faculty members including a brief description of their expertise relating to the graduate certificate.

All graduate faculty are eligible to teach in this program.

The core faculty leading the traineeship program are listed below. These faculty will serve as the admissions and curriculum committee for the certificate (see [Appendix B](#_Committee_Purpose) for the governance document for this committee), as a subcommittee within the IMSE department which will serve as the administrative home for the certificate.

* Sarah Ryan, Professor IMSE, and chair of the certificate committee – operations research and data-driven decision models for complex systems with uncertainty
* Amy Kaleita, Professor ABE – data analytics for understanding agricultural impacts on soil and water quantity and quality
* Michelle Soupir, Associate Professor ABE – water quality and watershed management
* Robert Brown, Distinguished Professor ME – sustainable processing of biomass into energy
* Sergio Lence, Professor Economics - agricultural economics, welfare and market analysis

## The effects of any new courses on faculty workload.

One new course is being developed as part of this certificate; however, this course is also supported by the ABE department with the expectation that it will be highly relevant to students in their own ABE and IAT graduate degree programs. All other courses are already being offered.

## Other resources required for the program including graduate assistants, laboratories and other facilities, supplies, etc.

The certificate itself is coursework only; thus, no resources are required except for those already in use in the included courses.

# Relationship of the proposed graduate certificate to the strategic plans of the department, college, and the university.

The program is a critical part of the larger traineeship, which builds capacity in two strategic growth areas at the university (data science, and the food-energy-water nexus). The traineeship will actively support diversity of thought and background in its recruitment activities and programming; thus, we anticipate this certificate program will also enhance diversity particularly in STEM and STEM-adjacent disciplines.

The certificate program adheres to Iowa State University’s 2017-2022 strategic plan by providing students crucial skills to “Create, share and apply knowledge to make Iowa and the world a better place.” By educating students on issues related to the overlap of agricultural production, water quality, and bio-based energy, which suffuses some of the most hot-button issues facing the State of Iowa and beyond. By providing the quantitative tools to inform data-driven decision-making, we work to ensure that Iowa and the world make progress on understanding and better managing our myriad resources.

# Plan for periodic review of the certificate program.

During the first four years of the certificate program, it will be internally reviewed on an annual basis as part of the regular review of the larger DataFEWSion Traineeship. Student input will be solicited, as well as input from faculty who mentor those students who are also in an MS or PhD program. The review will collect statistics and may result in changes to the program such as the selection of classes. Once students are graduating with the certificate, tracking their post-graduate job placement will also be part of the review.

After the conclusion of the funded traineeship and its concomitant regular review and assessment, the certificate program will be reviewed by the Industrial and Manufacturing Systems Engineering Department, overseen by the Graduate College Catalog and Curriculum Committee, every five years.

Appendix A: Description of new course developed for this certificate

# A B E 615: Key performance indicators for agriculture. (2-0) Cr. 2. S\*.

Key performance indicators for agriculture: how did we get here, and what’s next?

Performance measurement is a fundamental principle of design and management as they define success and allow appropriate constraints to be set. This is especially critical for complex systems where multiple objectives are important, and yet for the most part our agricultural systems have relied on economics alone to shape how farming has changed and evolved. Our purpose here is to frame agricultural productivity, sustainability, and environmental impacts – particularly on soil and water resources – through a set of key performance indicators (KPIs) that provide insight into how agriculture is performing today, and to allow us to examine how it has evolved over the past 150 years. We will use this lens to consider where agriculture might be headed – from perennial and/or energy crops to vertical farms to reactor grown protein – and to think about how the selected KPIs inform this trajectory. This course presumes a high level of numerical literacy (comfort with spreadsheets and with at least one programming language) and an ability to do systematic, quantitative problem-solving (such as performing mass and energy balances).

\*First offering is intended for Spring 2020. Depending on enrollments, course may be offered alternating (even) Spring semesters.

Appendix B: Governance Document for DataFEWSion Committee

# Committee Purpose

The DataFEWSion Committee develops and oversees the Graduate Certificate in Data-Driven Food, Energy and Water Decision Making. The DataFEWSion Committee subscribes to principles of Shared Governance as described in the Faculty Senate Constitution. The Committee will also oversee the DataFEWSion Traineeship through the procedures explained in the project proposal for the NSF-funded program. This document explains policies and procedures applicable to the Committee’s oversight of the Graduate Certificate.

# Committee Governance Structure, Procedures, and Functions

## Overview

The Department of Industrial and Manufacturing Systems Engineering serves as the administering unit for the Graduate Certificate, with responsibility for the Certificate program delegated to interdisciplinary DataFEWSion Committee. For this purpose, the Committee will operate as a subcommittee within IMSE’s existing graduate programs operational structure.

## Committee Membership

The DataFEWSion Committee consists of a minimum of five qualified faculty members, self-selected based on academic and professional qualifications in data-driven food, energy, and water decision making Membership may come from any department or program in the university. Voting committee members include all interdisciplinary faculty members serving on the Committee. The chair of the Committee, identified by vote from the Committee membership, serves as the director of graduate studies for the Certificate program. Should a Committee member be unable or unwilling to serve, if the resulting membership is less than five faculty, the Committee will solicit nominations (including self-nominations) to the Committee.

## Committee Responsibilities

The joint responsibilities of the Committee are to:

* develop and initiate academic requirements for the Graduate Certificate in Data-Driven Food, Energy and Water Decision Making, and the process for approval of all changes to them;
* admit students into the certificate program;
* oversee marketing and recruitment for the certificate program;
* serve as the forum for discussion of concerns;
* document key decisions made by the committee;
* gather and assess necessary information for the review of the certificate program.

## Committee Meetings

### Overview

The purposeof committee meetings is to serve as a forum for conducting business of the committee on matters of Committee importance. The Committee shall **meet** at least twice per each of the ISU fall and spring semester sessions and as needed during the summer. The Committee Members will agree upon dates, times, and locations for meetings. In addition to regularly scheduled meetings, the chair may call special meetings.

### Motions

Motionsmay be made any member of the Committee. Motions may be seconded for further consideration. If a committee member cannot attend, can he or she vote by email.

### Quorum

A quorum**,** made up of a simple majority of voting members, must be present to conduct a vote on any motion. If there is not a quorum present, an electronic ballot will be sent to committee members. Except for approval of amendments to the governance document, a simple majority of votes cast will be required for approval of motions voted on by the faculty.

# Procedures for Amending the Governance Document

This Governance Document may be amended by a two-thirds majority vote of the Committee. University governance and academic policy have the final say in the event of any conflict between this governance document and the other applicable policies.

Appendix C

From: Martin Gross <[martin@gross-wen.com](mailto:martin@gross-wen.com)>   
Sent: Wednesday, March 13, 2019 10:10 AM  
To: Ryan, Sarah M [IMSE] <[smryan@iastate.edu](mailto:smryan@iastate.edu)>  
Cc: Lidtke, Cynthia D [IMSE] <[lidtke@iastate.edu](mailto:lidtke@iastate.edu)>; Scott, Nicole M [E CPE] <[nmscott@iastate.edu](mailto:nmscott@iastate.edu)>  
Subject: RE: introduction to entrepreneurship instructor

Sarah,

Nice to meet you.  I am currently teaching the course this semester under the following course number:  BCB 590

We are in the process of converting it into an  experimental course (E E 690X)  (<https://nextcatalog.registrar.iastate.edu/courseadminx/>) .  We are in the process of evaluating what other departments want to co-list the course (Nicole please jump in if you have any additional comments).

Attached is the course syllabus for this semester.

Thanks,

Martin

**Entrepreneurship for Graduate Students in Science and Engineering**

**Course Information (Spring 2019):**

Instructor: Martin Gross PhD

Instructor Contact: magross@iastate.edu

Location: 0009 Curtiss Hall

Time: Mondays; Class Time 5-6pm; Office Hour/Workshop Time 4-5pm

**Course Overview:**

The overarching objective of this course is to provide graduate students in the science and engineering disciplines an understanding of key topics of starting a technology-based company. This 15-week course is formulated around building an understanding of what it means and what it takes to develop a technology-led idea into an early-stage entrepreneurial business. During the semester important concepts will be discussed such as: entrepreneurship basics, starting a business, funding your business, protecting your technology/business IP. Throughout the semester subject matter experts and successful, technology-based entrepreneurs will provide real world examples from their experience with entrepreneurship. The students will be informed about the world class entrepreneurship ecosystem at ISU and Central Iowa. During the second half of the semester the class will decide upon 4 topics in entrepreneurship that interest them. Students will be assigned a topic to research and present to their peers on. During the final weeks of the class, each student will be responsible for filling out a business model canvas for a business idea they have.

The course culminates in a 5-minute pitch competition to a panel of investors, professors, and entrepreneurs. The panel will have “fake money” to invest in the best business idea. This technology-led entrepreneurship course develops an understanding of: (i) what entrepreneurship is and how to start a business (ii) how to fund your business (iii) how to protect innovation in your business (iv) how to create a business model (v) how to leverage the assets at ISU to form a successful startup company.

Top two pitches receive $500 prize

**Grading Plan:**

***Weekly Reflections (100pts):*** Each week you will submit a ½ page reflection on the previous week’s topic. This should be submitted at the beginning of each class. Each week is worth 10pts.

***Topic of Interest Presentation (50pts):*** The class will be broken into groups and each group will present on a “topic of interest” to the class.

***Business Model Canvas (50pts):***A business model canvas will be submitted and presented to the class.

***5-minute Pitch (50pts):*** A 5-minute oral presentation will be made. This presentation will be in the form of a business plan pitch to “fake investors”.

**Course Schedule:**

* Week 1: Entrepreneurship basics (1/14)
  + Martin Gross, Overview of course; Overview of entrepreneurship
* Week 2:  Guest entrepreneur presentation (1/28)
  + Dan Oh, Former CEO of Renewable Energy Group (confirmed)
* Week 3:  How to start a business (2/4)
  + Richard Malm, Dickinson Law Firm (confirmed)
* Week 4:  Funding your business (2/11)
  + Martin Gross, Overview of funding your business
* Week 5:  Funding your business through equity (2/18)
  + Adam Koppes, Venture Capital in Iowa (confirmed)
* Week 6:  Funding your business through government grants (2/25)
  + Kris Johansson, ICORP Program; Martin Gross, SBIR (confirmed)
* Week 7:  Intellectual property and how do you protect it (3/4)
  + Craig Forney, ISURF (confirmed)
* Week 8:  Guest IP attorney discussion (3/11)
  + Chris Proskey, Brown Winick (confirmed)
* Week 9:  ISU entrepreneur ecosystem (3/25)
  + Bill Adamowski, ISU Startup Factory (request sent)
* Week 10:  Discussion on topics of interest to students (4/1)
  + Martin Gross
* Week 11:  Begin business model canvas (4/8)
  + Kevin Kimle, Ag Entrepreneurship Initiative, Business Model Canvas Discussion (confirmed)
* Week 12:  Entrepreneurship topic presentation by student (4/15)
* Week 13:  Entrepreneurship topic presentation by student (4/22)
* Week 14:  Presentation of business model canvas (4/29)
* Week 15:  5-minute pitch competition to “investors” (5/6)
  + Find best time for this? Week of 4/29?

1. This course is at the 600-level because it is intended for graduate students only, following university catalog guidelines on course numbering: <http://catalog.iastate.edu/informationaboutcourses/>. [↑](#footnote-ref-1)
2. Elena Cotos confirmed in an email that the Center for Communication could continue to offer this course. [↑](#footnote-ref-2)