Site:Rose-Hulman Institute of Technology.Course:MA487: Winter 2020-21Book:Syllabus

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Description

** I reserve the right to modify the course content, schedule, topics, policies, etc. outlined in this syllabus.**

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Basic Information

Catalog Description

This is an applied course in design of experiments. Emphasis is placed on designing statistical studies to solve problems in engineering and science. A variety of designs are presented, including the full factorial, screening, response surface, and split plot. It is demonstrated how constraints on the randomization process due to the design are related to the appropriate analysis method and meaning of the results. Statistical software is used for data analysis throughout.

Course Topics

One-, Two-, and K-way ANOVA; Factorial Designs; Multiple Comparisons; Fractional Factorial Designs; Response Surface Methodology; Complete Block Designs; Nested Factor Designs; Incomplete Block Designs; Hasse Diagrams

Prerequisite

MA223 (Engineering Statistics) OR MA382 (Introduction to Statistics)

Role of the Prerequisite

An introductory course in statistics is a requirement for this course. We will assume you have experience with statistical inference and terminology. Specifically, we will rely heavily on previous knowledge of hypothesis testing and ANOVA.

No Textbook Required

The class notes and assignments provided within Moodle are comprehensive for the course. Thus, purchase of a textbook is not required. However, if you prefer to have a formal textbook source as a reference, we loosely follow the textbook by Oehlert.

Oehlert. A First Course in Design and Analysis of Experiments. (2010). 1st edition. Online pdf available for free.

Statistical Software

We will use software specifically designed for statistical analysis in this course, specifically R. More information is available on the Getting Started with R page.

Hybrid Format

First 3.5 Weeks of Class

During the "online" beginning of winter term, we will not have synchronous class meetings. This means that you have freedom to engage with the class/lecture materials at times during the day that work within your schedule. I will still hold synchronous office hours via Teams so that you have a chance to connect with me and ask questions in real-time.

With this flexible format, it is extremely important that you maintain the suggested daily class schedule and do not fall behind. The discussion and exam assignment timing also should help encourage working through the material in a metered, scheduled fashion.

Face-to-Face Classes (After Winter Break)

Monday and Thursday, 11am in G317

The face-to-face class meetings will have a similar feel to a traditional lecture (e.g. instructor-led content and activities). In order to accommodate the potential need for students to quarantine/stay home due to illness, all of the lecture material from the face-to-face days will also be available electronically in the Moodle site.

Online Classes (After Winter Break)

Tuesday and Friday, asynchronous

The online days will contain a mixture of new content, example data analyses, and activities. *Important: Although we will not meet at a specific time, it is expected that students work through the provided material at some point during the specified day.* The face-to-face meetings will operate under the assumption that the previous days' online material was completed.

Office Hours

All office hours will occur on Microsoft Teams. (This is in accordance with the Rose Ready Guide.) Anyone is welcome to log-on during these times. No new or additional course contents will be delivered during office hours. You are encouraged to bring specific questions about the course content or assignments.

Here is the LINK to the Monday, Thursday 10:00-10:50am (Eastern) office hour meeting.

During the first 3.5 weeks of winter term when we are online, I will also hold office hours on Teams during our scheduled lecture time at 11am. I hope that this provides everyone with the opportunity for face-to-face contact with me, if needed. No additional course material will be covered during this time.

Here is the LINK to the Monday, Thursday 11:00-11:50am (Eastern) office hour meetings during December 2020.

Staying Engaged

Frequent engagement with course material, your classmates, and Dr. Heyman is extremely important! There are several recommended avenues achieve this engagement.

Moodle Forums

If you have a question about course content, I recommend posting within the weekly Moodle Forum. This allows me to communicate the same information to all students in the course, especially for frequently asked questions. This is different from the "Design Discussion" assignment, which is a directed conversation.

Office Hours

I will hold synchronous office hours via Teams each week. Please feel free to attend these at any time during the term.

Study Groups

I highly encourage you to reach out and work with classmates on assignments where <u>collaboration</u> is allowed. In practice, statistical analyses are conducted together on a team, not in isolation. I want to encourage you to work together as you would on the job.

Email

If you have a more personal question (or a question you don't feel is appropriate for the Moodle forum), feel free to reach out to me over email. I generally check email messages between 8am and 10pm, Monday - Friday and try to reply within 4 hours of receiving any message. Email communication is not guaranteed on the weekend, since this is time I spend with my family.

Individual Meetings with Dr. Heyman

Please reach out to me first via email. This email should contain the question/topic you would like to discuss. If it is a question that can be answered over email (or potentially is most appropriate to answer for the entire class via the Moodle Forum), we will start there. If the matter is more complicated, then I will work with you to schedule a one-on-one meeting over Teams.

Assessment Structure

You will find that this is NOT a typical mathematics course.

A poor statistical analysis may contain completely valid computations. However, an exemplary statistical analysis not only contains correct mathematical computation, but also a thorough data exploration and interpretation of results in context.

Specific to the area of Design of Experiments, you will notice that essentially all of the statistical analyses in this course use some form of ANOVA. The challenge in MA487 is not running the analysis, but understanding the details of the design so that a correct analysis and interpretation of results occurs. We will also heavily focus on the step before data collection -- study design.

Two types of assignments occur each week

Each week, students will complete a **Module Report** and a **Design Discussion**. The Module Report consists of 4 components: Basic Ideas Quiz, Data Analysis, Interpretation, and Recommendation. You will see that the individual components within each report are short, and graded independently of the other exam components. These components will gauge your comprehensive knowledge of the module topic.

At the end of the term, there will also be a **Final Exam**, consisting of several scenarios where you will identify components of the implemented experimental design.

Students who are aiming for an "A" in the course will also complete a **Topic Report**, related to a special topic in design of experiments that we do not specifically cover.

Module Report

Module Reports will occur weekly and consist of 4 components.

These components are: Basic Ideas Quiz, Data Analysis, Interpretation, and Recommendation. You will see that the individual components within each report are short, and graded independently of the other exam components. These components will gauge your comprehensive knowledge of the module topic.

Basic Ideas Quiz

Goal: Students will demonstrate literacy in the area of statistical design. **Objectives**:

- 1. Define and recognize statistical terminology correctly and in context.
- 2. <u>Identify</u> design components based on a stated scenario.
- 3. Describe procedures for implementing specific experimental designs.
- 4. <u>Recognize</u> statistical designs based on a stated scenario.

Each quiz will consist of 5 multiple choice questions and students will have two attempts at the quiz. In order to pass the quiz, all questions must be answered correctly. Students will work individually on this component.

Data Analysis

Goal: Students will know how to perform statistical analyses on data from controlled experiments. **Objectives**:

- 1. Use statistical software to create visual displays of data and create reproducible statistical analyses.
- 2. <u>Support</u> the use of a statistical method based upon the underlying reasonable assumptions.
- 3. Identify relevant components of output produced by statistical software.
- 4. Implement an appropriate statistical analysis based on the implemented study design and available data.

Each Data Analysis will consist of producing requested analyses using R. In order to pass the Data Analysis component, all listed criteria for the question must be met. Students may collaborate on this component.

Interpretation

Goal: Students will interpret results from statistical analyses of controlled experimental data. **Objectives**:

- 1. Describe what the employed statistical analysis technique is doing and how it works.
- 2. Use statistical terminology correctly and in context.
- 3. Support the use of a statistical method based on reasonable underlying assumptions.
- 4. Make a decision for a question of interest that is supported by the statistical analysis result and practical constraints.
- 5. Interpret relevant information from the statistical analysis output.
- 6. Explain why common incorrect analysis interpretations are incorrect.

Each Interpretation will consist of a question that may be answered in 3-4 sentences. In order to pass the Interpretation component, all listed criteria for the question must be met. Students may collaborate on this component.

Recommendation

Goal: Students will make recommendations regarding experimental design and areas of improvement. **Objectives**:

- 1. Describe limitations related to the parameter(s) of interest and/or statistical inference technique.
- 2. Address both statistical and practical significance when discussing analysis results.
- 3. <u>Recommend</u> improvements for a process (subsequent experimental designs or process settings) based on results from a statistical analysis.
- 4. <u>Recommend</u> a statistical design to incorporate all factors of interest, constraints to the process, and that could produce data to answer a stated question of interest.

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Each Recommendation will consist of a question that may be answered in 3-4 sentences. In order to pass the Recommendation component, all listed criteria for the question must be met. Students must work individually on this component.

Other policies Related to Module Reports

- There will be 9 Module reports, occurring weekly during the term.
- The Module Exam consists of the four components detailed above.
- Each Module Exam will open at 8am on Tuesday and close at 5pm on Wednesday. Any of the components may be attempted at any time during these hours.
- Students will work on the Basic Ideas and Recommendation Module Report components individually.
 - Students who collaborate on Module Exam assignments will receive no course credit for the offense. <u>Collaboration</u> will result in a "0" on all components of the Module Exam, for all parties involved. Moreover, the "0" will NOT be dropped from the counts within each category when creating the final course grade.
 - Academic Affairs will be notified of plagiarism, in accordance with Mathematics policy.
- Student may collaborate on the Data Analysis and Interpretation Module Report components. The <u>Collaboration</u> document provides guidelines for such collaborations.

Design Discussion

Design Discussions will occur weekly.

These assignments will consist of adding to conversation related to a directed question in a class discussion forum. The criteria to pass these assignments will be listed within each forum. Generally, the discussion must be completed by midnight each Friday. These won't require a "correct" answer, but instead evidence of a good faith effort to consider and discuss the question at hand.

Goal: Students will understand the role of randomization in implementation, analysis, and interpretation of a controlled experiment. **Objectives**:

- 1. <u>Outline</u> steps of good data collection procedure when presented with a question of interest.
- 2. <u>Justify</u> the choice of a design.
- 3. <u>Criticize</u> an implemented or proposed experimental design.

Topic Report

Students will gain in-depth knowledge of a specific area of DoE.

During the term, students aiming for an "A" in the course will learn about an area in design of experiments that is not explicitly covered in MA487. At the end of the term (Thursday of 10th week), students will present information about their topic in a 10-20 minute video that will be posted in our Moodle course site. Moreover, these students will participate in a short Q&A session with Dr. Heyman and classmates to answer questions about their topic.

Guidelines for the video format and details about the Q&A session will be provided after winter break. **Students interested in completing a Topic Report should contact Dr. Heyman of their interest by the end of Module 3 so there is adequate time to select and learn about a topic.**

Goal: Students will further their knowledge in design of experiments **Objectives**:

- 1. Critically critique statistical results, noting both strengths and limitations.
- 2. Document and synthesize collected knowledge
- 3. Professionally respond to criticism.
- 4. Speak about statistics in an articulate, sound and well-organized fashion.

Final Exam

The Final Exam is comprehensive and focuses on recognizing experimental design components.

The exam will consist of 10 scenarios/questions. You will be asked to identify components related to the experimental design and/or relevant analysis results. Each scenario/question will be graded independently. The score on the final will be the number of correct questions out of 10.

The final will be available staring on Thursday of 10th week and will be due by 5pm on Friday of 10th week.

Students must work independently on this assignment. They will be able to utilize any course notes or Moodle materials as reference when working on the final.

Grades

I want this course to create a strong foundation in design of experiments for you. **In order to help you achieve this, I will be implementing a version of "specifications-based grading."** That is, instead of taking a weighted average of points earned on a series of assignments throughout the term, you will earn grades based on the requirements you choose to complete. Each assignment is graded pass/fail (meaning no partial credit is awarded).

In order to help you achieve a passing score, very clear expectations will be provided on every assignment. You have complete control over your grade in the course; I will provide you with the necessary tools and feedback to help you achieve your desired grade.

You will also notice that I am not expecting perfection. For example, a student may achieve an A in the course without having to pass every single course assignment. However, successfully completed/passing assignments will be based on clear, high standards.

Letter Criteria

Final letter grades in this course will be assigned based on the mastery of course material demonstrated throughout the term.

An "F" is assigned when the criteria to earn a "D" are not achieved.

In order to earn a grade of "D"

Students must...

- Successfully complete/pass at least 5 Basic Ideas Quizzes
- Successfully complete/pass at least 5 Data Analyses
- Successfully complete/pass at least 5 Interpretations
- Successfully complete/pass at least 5 Recommendations
- Successfully complete/pass at least 5 Design Discussions

In order to earn a grade of "C"

Students must...

- Successfully complete/pass at least 6 Basic Ideas Quizzes
- Successfully complete/pass at least 6 Data Analyses
- Successfully complete/pass at least 6 Interpretations
- Successfully complete/pass at least 6 Recommendations
- Successfully complete/pass at least 6 Design Discussions

In order to earn a grade of "B"

Students must...

- Successfully complete/pass at least 7 Basic Ideas Quizzes
- Successfully complete/pass at least 7 Data Analyses
- Successfully complete/pass at least 7 Interpretations
- Successfully complete/pass at least 7 Recommendations
- Successfully complete/pass at least 7 Design Discussions

In order to earn a grade of "A"

Students must...

- Successfully complete/pass at least 8 Basic Ideas Quizzes
- Successfully complete/pass at least 8 Data Analyses
- Successfully complete/pass at least 8 Interpretations
- Successfully complete/pass at least 8 Recommendations
- Successfully complete/pass at least 8 Design Discussions
- Successfully complete the Topic Report

Final Exam: Failure to successfully complete at least 7/10 questions on the final exam will result in the course grade being reduced by half a letter grade (A to B+, C+ to C, etc.)

Outliers

Life happens. We all have different priorities, and at times the priorities may not easily align with the timing for class assignments. I recognize that this happens with the busy schedules that students have at RHIT and want to give every student adequate opportunity to succeed.

Every student will begin the term with 2 "Outliers."

Each "Outlier" provides a second chance -- you may resubmit an assignment that did not pass the first time or that you were not able to submit by the deadline. Outliers are valid for use on: Basic Ideas Quiz, Data Analysis, Interpretation, Recommendation. After each Module Report is graded, Dr. Heyman will contact the class with details of how the outliers may be used and when the resubmission would be due.

Note, each Outlier is valid for use on *one* component of the Module Report that was unsuccessful. It is possible to use both Outliers within one module. Any component may only be resubmitted once.

I'm also allowing students to re-submit components of the Module 1 Report as a way for you to adjust to the specifications grading scheme. That is, any Module 1 Exam component that does not pass may be re-submitted once for "free."

*In statistics, outliers are observations/cases which are very different from the rest of the data.

"Plus" Criteria

Students may earn a "+" on their letter grade if either of the following cases occurs. (Exception: I can't give an A+ within the RHIT system.)

- Both "Outliers" remain/were not used during the term
- A student achieves more than the required number of passes in at least one of the assignment type categories: Basic Ideas Quiz, Data Analysis, Interpretation, Recommendation.
- A student receives at least 9/10 on the final exam.

Note, in the event that a student receives less than 7/10 on the final exam and has the credit toward a "+", the "+" criteria boost will cancel with the final exam result half a letter grade decrease. For example, if the student meets criteria for a C with both outliers remaining but receives a 6/10 on the final, the student will receive a C in the course.

Participation

I want our classroom to be an open and safe environment to share and discuss ideas. Thus, it is expected that students and the professor are good citizens during and outside of class, treating each other with mutual respect.

- **Discussion and questions are encouraged during class**. Feel free to speak up at any time during lecture sessions. My classroom is a fairly informal atmosphere.
- Any student treating others with disrespect will be asked to leave the classroom or discussion. An individual conversation will also occur with Dr. Heyman after such an event.
- If anything occurs during or outside of our class which makes you feel uncomfortable, please reach out to me. I want all students to feel comfortable in my classroom, and communication is key.
- Active engagement with course material is integral to success. It is easy to fall behind from missing 1 or 2 class sessions.
 With the hybrid format, it is especially important to keep on schedule, since we have fewer face-to-face meetings.
- Please do not use your cell phone during class. It is disruptive to other students and the professor. Laptop use should be responsible and appropriate to our class activities.

Rose-Hulman Institute of Technology is **committed to being an inclusive community** in which the multiplicity of values, beliefs, intellectual viewpoints, and cultural perspectives enrich learning and inform scholarship.

Institute Policies

Students with Accessibility Needs

Rose-Hulman Institute of Technology strives to make all learning experiences accessible to students. If you anticipate or experience academic barriers based on accessibility issues, please feel free to communicate those needs and register with Student Accessibility Services.

Student Accessibility Services will work with you understand the process and to determine what accommodations are most appropriate for your individual situation. Visit <u>the Accessibility Services website</u> for more information. Please note that accommodations are not retroactive and accommodations cannot be provided until verified.

Please contact Student Accessibility Services for more information at HMU 156, 812-877-8040, or eaton1@rose-hulman.edu.

Please note that it is the student's responsibility to request any approved, documented academic accommodations (such as extra time) at least three days in advance of exams.

Academic Integrity

Plagiarism, offering, and accepting solutions to assessments when a student is required to work individually are cases of academic misconduct. These instances are taken seriously by the professor and university, and will be reported. Anyone found cheating will not be permitted to withdraw and will be (appropriately) heavily penalized in the course. Academic affairs will be informed.

The **<u>Student Handbook</u>** and Rose-Hulman's **<u>Academic Rules and Procedures</u>** describe penalties and processes invoked as a consequence if academic misconduct (such as cheating, plagiarizing, or interfering with the academic progress of other students) takes place. It is the responsibility of each student to know and follow Rose-Hulman's rules about academic integrity.

Incompletes

Incompletes are granted only when a student is forced to miss several days of class due to extraordinary circumstances such as a documented confining illness or family emergency. To receive an incomplete grade, students should obtain approval from the professor before the last day of class.

No incompletes will be given unless a prior written agreement with the professor exists, following typical Rose-Hulman policy. In this course, an "I" grade will be given only in cases of extreme hardship. Poor performance in the course is not grounds for an incomplete. An incomplete shall be recorded as an "F" if the work is not completed within the time agreed upon by the professor and student.

Emergency Information

To receive email or text messages regarding emergency situations that may impact campus and, possibly, the delivery of classes, register for RAVE alerts and/or follow @Rose-HulmanAlert on Twitter. Any announcements about the Institute's ability to offer classes will be shared on Rose-Hulman's website.