ISE 121
Applied Engineering Statistics

Instructor: János D. Pintér   Term: Fall 2019

Office: MO 486   Lecture days/time: M/W 1:35pm-2:50pm

Phone: 610 758 4430   Lecture room: MO 453

Email: jdp416@lehigh.edu   Course Site: https://coursesite.lehigh.edu/

Webpage: https://engineering.lehigh.edu/faculty/janos-d-pinter

Office hours: M/W 3:00pm-5:00pm, or by appointment (as needed).

Teaching Assistant: Ramin Fakhimi, raf318@lehigh.edu, Office hours: TR/F 9:00 - 10:00 AM

1 Course Description: Summary

Operations Research (O.R.) is appropriately labeled as *The Science of Better (Decision-Making)*, due to its significant positive impact in many real-world settings. The prudent application of O.R. concepts and techniques helps to make our quality of life better, by carefully improved analysis and management of the environment, finances, healthcare, logistics, planning, production and distribution of goods, product design, resource allocation, services, and safety.

Within the broad context of O.R., this course serves as an introduction to statistics for engineering students. Modeling and solving real-world optimization problems requires advanced quantitative skills and techniques, including the collection, analysis, presentation and interpretation of data. The use of probabilistic concepts, models, and closely related statistical methodology becomes essential, whenever significant random factors – uncertainties, fluctuations, or other "noise" – are key factors to consider in an O.R. systems model. Statistical concepts and tools are largely based on the theory of probability. We will review the needed basic concepts of probability, followed by a discussion of topics selected from the areas of descriptive statistics, parameter estimation, confidence intervals, hypothesis testing, linear regression models, and analysis of variance. Further topics may also be discussed as time allows.

2 Learning Objectives

Having completed this course, attendees will be able to perform the following tasks.

- Apply the basic concepts and methods of probability and statistics

- Formulate analytical models and follow statistical test procedures

- Solve statistical problems using appropriately chosen tables, charts, and software tools (as needed)

- Analyze and interpret the results obtained

3 Course Prerequisites

Prerequisites for the ISE 121 course are ISE 111, or MATH 231, or another equivalent course.

4 Textbook

Douglas C. Montgomery and George C. Runger
Applied Statistics and Probability for Engineers, 7th Edition
John Wiley & Sons, 2018.

The course will cover selected topics and chapters from this textbook. Note that the use of earlier textbook editions is allowed. However, please make sure to read materials from the current edition as needed, especially when considering examples and exercises cited from the this edition.

Additional reading materials will be provided as deemed appropriate.

5 Model Development and Software Tools

At your discretion, you can use modeling and computing systems such as AIMMS, AMPL, Excel, GAMS, Maple, Mathematica, MATLAB, Python, R, or SAS *in your independent studies*, including individual work on assignments. For added clarity, it is your responsibility to learn how to use *optionally* any of these software product alternatives. In general, familiarity with some of these tools can become useful also in your other courses, and eventually in your working career. Consult the available software products at Lehigh University's software site http://software.lehigh.edu/install/?SID=209.

6 Course Site

In addition to lectures and in-class discussions, Course Site provides the primary way of communication related to this course. Lecture slides, accompanying reading materials, assignments and their solutions, exams with solutions, and announcements will be posted using the appropriate course folder at Lehigh University's Course Site https://coursesite.lehigh.edu/. Assignments completed by students will be also submitted via Course Site, unless requested otherwise.

7 Course Schedule and Lecture Topics

Lehigh University determines a semester as 14 weeks of instruction, followed by a brief reading, consultation and study period, in preparation to 9 consecutive calendar days of final examinations with four periods per day of 3 hour exam blocks. Within the fall and spring instruction time period, ISE classes are scheduled either as three 50-minute activities or as two 75-minute activities per week, depending on the semester. In summer courses, 5 weeks are available to cover the entire workload referred to above. The following schedule within the current semester is tentative. Both Lehigh University and your instructor reserve the right to make changes if needed.

Lecture Topics

- Introductory discussion

- A brief review of key concepts from probability theory in the context of this course (as needed)

- Descriptive statistics

- Parameter estimation

- Confidence intervals

- Hypothesis tests

- Linear regression models

- Analysis of variance

- Experimental design (as time allows)

- Reliability (as time allows)

- Quality control (as time allows)

8 Class Attendance and Participation

Attendance and *active participation* in classroom discussions are required. Please contact me in advance, if you have to be absent from class due to a valid reason.

In all verbal or email communications, please observe proper business etiquette and communicate your messages carefully and politely. By sending a course related email, you acknowledge that I can discuss content and answers in class, and/or post answers on Course Site, in order to share the answer with all course attendees.

You can use your computer or calculator during class, only when explicitly allowed, exclusively for the purposes of the course work (e.g. to solve computer-based exercises). In all other cases, the use of cellphones, computers, tablets, or other electronic devices and distractions is not permitted, in order to make the best use of your (our) class time.

Please feel free to provide feedback about our joint work, and ask questions (ideally, in class so that all attendees can benefit from the discussions). Please contact me (or my teaching assistant, when assigned to this course) during office hours or by appointment, if your questions could not be addressed during class time. Please understand that instructor availability cannot be always guaranteed, especially immediately before exams, and pace your work accordingly.

Audio or video recording of classes is permitted only with the approval of everyone present in the classroom. Please let me know in advance if you need to use audio or video recording, also indicating its purpose.

9 Homework Assignments

An essential part of this course is to gain hands-on experience in applying O.R. and optimization to a range of problems inspired by realistic decision-making scenarios. These problems will be often stated in "everyday language": your task is to translate the problem into an appropriate quantitative model, to solve it, and to interpret the results. All homework assignments have to be completed by their deadline, also in preparation for the exams. Late homeworks may be penalized or may not be accepted, at your instructor's discretion.

Electronic submissions via Course Site are the standard way to submit assignments, unless course attendees are advised otherwise. Please submit well-prepared documents to expect good feedback and grades. Use Word or a similar quality text processor to create high-quality documents, as opposed to poorly readable, hand-written notes. The experience gained from preparing these assignments will

become useful also in your working career. For homeworks that include computer-based exercises, submit your properly documented code as well as its result, based on your own fully functional (working) code.

You can always discuss all course work and assignments in small groups. However, you must work out the solution by yourself, and you must write and submit your own homework, including computer code development. Following these ethical guidelines will also help you to acquire active knowledge.

10   Exams

In principle, each exam could cover *all* materials presented in class prior to the time of the exam, as well as *all* topical examples and exercises of the textbook, and *all* homework assignments. The final exam is comprehensive. Before each exam, its actual content will be discussed and clarified in class.

In courses held during the fall or spring semester, there will be two midterm exams, scheduled approximately 5 and 10 weeks after the beginning of the semester. In 5-week courses held during the summer, there is one midterm exam, scheduled approximately 2.5 weeks after the beginning of the semester. All exams are *closed book and closed notes*, unless agreed otherwise. The usage of hand-written summaries (typically, maximum two handwritten pages) and a calculator is allowed, at your instructor's discretion.

Please do your best to attend all exams, to avoid creating problems for yourself, and extra work for all else involved. In order to pass the course, all students have to take the final exam. In case of substantial medical or other reasons that lead to missing an exam, please inform your instructor as soon as possible, and follow the procedures described at https://studentaffairs.lehigh.edu/content/student-absence. Upon accepting the absence report, *at your instructor's discretion*, a make-up exam may be arranged.

11   Course Work Evaluation and Grades

The evaluation of course work is based on the following weighted components:

	Fall / Spring courses	Summer courses
• Participation:	10%	10%
• Assignments:	30%	30%
• Midterm 1:	15%	25%
• Midterm 2:	15%	
• Final exam:	30%	35%

- Your final exam score has to be at least 60 out of max. 100 points.

Students who participate in classroom discussions and work diligently on all homework assignments typically do well also on their exams. Consider all classes and homework assignments as an opportunity to learn, to challenge yourself and to get feedback, rather than viewing these as just a "grade component of your final grade".

Please pay close attention and be active in all your classes. Study at a steady, manageable pace. Submit your assignments on time. Not participating and missing assignments could negatively affect your preparation to exams, your final grade, and – most importantly – your professional knowledge.

The following correspondence between numerical grades (based on the weighted average of the component scores, each normalized by a maximal score of 100) and letter grades is used:

Numerical Grade	≥93	≥90	≥87	≥83	≥80	≥77	≥73	≥70	≥67	≥63	≥60	<60
Letter Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F

12 University Policies, Activities and Services

Principles of Equitable Community, Diversity and Inclusion

Lehigh University endorses the above stated principles, and we expect all course attendees to acknowledge and to practice them. Respect for each other, and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.
For more information, visit https://www1.lehigh.edu/diversity.

Accommodations for Students with Disabilities

If you have a disability or some other valid reason to request special accommodations, then please contact both your instructor and the Office of Academic Support Services as early as possible during the semester. Please obtain proper documentation from Academic Support Services before special accommodations can be granted. Please visit https://studentaffairs.lehigh.edu/disabilities for further information.

Academic Integrity

Irresponsible behavior can ruin opportunities for you and/or for other attendees of the course, and there is no room or excuse for such behavior. Examples of irresponsible behavior include cheating, copying the work of others and other forms of plagiarism, slacking on responsibilities, unfairly exploiting the efforts of others, making false statements about the work of others, creating hazards or disruptions, and lacking civility. Various forms of carelessness or disregard for safety considerations, abuse of others, compromising opportunities for others, failing to work in good faith can also have serious consequences.

It is the firm policy of this course, and of all Lehigh University courses, that cheating or plagiarism are unacceptable violations of academic integrity: all such actions will earn an F semester grade in the course. Please meet all coursework requirements honestly and in good spirit, and always do your fair share of assigned work.

While all students are encouraged to discuss assignments, the eventual solution is your individual responsibility (or team responsibility as applicable). Do not ask for other student's completed work, and do not share your completed work with others. Do not copy assignment reports by other students currently or previously enrolled, and avoid any form of cheating on exams. Offenders may lose points from their course totals and may fail the course. Serious offenders could be expelled from the course, and even from the University.

For further explanation and guidelines regarding academic integrity expectations at Lehigh University, with illustrative cases, please consult https://www.lehigh.edu/~inprv/faculty/academicintegrity.html. See the link to downloadable Academic Integrity Vignettes and the section titled Resources for Students.

Further Lehigh University Activities and Services

Lehigh University Library & Technology Services: https://lts.lehigh.edu/services.

Religious Life at Lehigh University: https://chaplain.lehigh.edu.

The Center for Dialogue, Ethics and Spirituality: https://dialogue.lehigh.edu.