

# Syllabus

## ECO 4421: Econometrics

### (Probability and Statistics for Economists)

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**Teaching assistant (TA):** Manuel Colorado  
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#### Course Time and Location

**Section 0409 (18600):** T/Th 11:45 — 13:40 (Periods 5 & 6). Location: MAT 107  
**Section 0410 (20312):** T/Th 13:55\* — 15:50 (Periods 7 & 8). Location: MAT 018

\*Lecture will start at 14:00 unless I announce in advance.

#### Office Hours (OH)

- I will have OH on Zoom Mondays from 13:30 to 15:30. The meeting URL is here: <https://ufl.zoom.us/j/95984155529?pwd=cTVjQm5vb3d3UVdVZlV0T1VlbnNDQ09>. If you plan to arrive after 13:40, please email me in advance so I know to wait.
- Manuel will have OH Wednesdays from 16:00 to 17:00 in room MAT 301A and is also available for individual meetings. There are no OH the first week of the semester.
- For questions on the lecture material, please ask those to me. For questions on problem sets, please ask those to Manuel (who will be grading the problem sets).

#### Course Description

ECO 4421 introduces students to the theoretical concepts in probability and statistics that form the core of econometrics. The emphasis is on understanding the theoretical concepts that are used by economists to summarize, communicate, and estimate economic relationships and to evaluate policy. The first part of the course focuses on basic probability. We then study statistics. In the last couple weeks of the course, we will start focusing on causality. We will discuss an application in development economics (the causal effect of providing fertilizer to farmers in developing countries) and an application in education economics (the causal effect of class size on test scores). We focus on disentangling causation from correlation, but

also discuss other uses of statistics in economics, such as prediction.

The course has the following objectives:

1. Improve math skills related to problem solving and critical thinking.
2. Learn the *basics* of the R statistical programming language.
3. Learn fundamental theoretical concepts in probability.
4. Apply probability to understand how uncertainty affects maximization (e.g., profits).
5. Learn the practical *intuition* of general statistical concepts, including standard errors, hypothesis testing, and confidence intervals.
6. Learn to use simulation in R to get hands-on practice with theoretical concepts (such as the Law of Large Numbers), and to explore the consequences of incorrect assumptions.
7. Learn the dangers of relying on assumptions that do not typically hold in economics.
8. Learn the *basics* of working with data.
9. Learn to disentangle causation from correlation.

## Prerequisites

The prerequisites for this course are: ECO 2013 & ECO 2023 & ECO 3101.

This course will introduce probability and statistics *from the beginning*. Econometrics is probability and statistics for economists, so if you've already taken a rigorous probability and statistics course, you might be bored in this course and you might consider taking a different course (e.g., in the statistics department). Although many students have taken a "statistics" course before, the most common background of students in ECO 4421 is a statistics course that used formulas without really understanding them. In this course, we will develop a strong theoretical understanding of what a standard error is and what a confidence interval is, not just how to calculate them from a formula.

If you already have a good understanding of probability and statistics (e.g., random variables, distributions, and confidence intervals), you might consider taking a different course.

This course will be divided (unevenly) into four parts:

Part 1 ( $\approx$  3 lectures): Math concepts and basic R.

Part 2 ( $\approx$  8 lectures): Probability.

Part 3 ( $\approx$  4 lectures): Statistics.

Part 4 (# lectures depends on time): Linear regression.

## Textbook and Readings

The lectures are self-contained and the **required reading** is to *study each lecture before the next since each lecture builds on the previous one*. It is critical that you review the slides from the previous lecture before the next, and that you clear up any misunderstanding that you have before the next lecture. Please email me, or come to OH, about questions regarding the lecture. Asking questions about the problem sets and exams is fine, but what really shows me that you are serious about the course and are motivated to receive a good grade is when you ask questions directly about the lecture material.

## Optional Textbooks

It is more important to study the lecture notes, but if you find something confusing in the lecture notes, you will find some of the material from the lecture notes covered in the two optional textbooks below:

1. Stock & Watson, *Introduction to Econometrics*, published by Pearson.
2. Wooldridge, *Introductory Econometrics: A Modern Approach*, published by Cengage Learning.

Only some of the material from lecture is covered in the above optional textbooks. Getting the newest edition is not important (i.e., don't waste your money).

## Software and Programming

Some of the problem sets in the course will involve simulation or empirical analysis and will require the use of a statistical software. R is the statistical software for this course. You will likely find RStudio to be a more user-friendly way of using R. You are not required to have any knowledge of R or other programming experience, but you must be willing to learn.

For instructions on installing R and RStudio, please go here: <https://gitlab.com/scottkosty/dots-and-hats#installing-r-and-rstudio>.

It is recommended that you install R and RStudio Desktop (both free and open source) on your personal computer. If for some reason that is not convenient for you, R and RStudio are installed on many computers around campus (e.g., Marston Science Library), as well as on UF apps: <https://info.apps.ufl.edu/published-applications/>.

## Participation

An essential part of this course is participation. I call on students randomly in class. I might take volunteers for especially difficult questions, but otherwise I do random calls in order to make sure everyone is involved and to get an idea of whether the material is clear to everyone (not just the 3 or 4 people who always raise their hands). I do a lot of random calling and I generally use the following approach:

1. I ask a question to the class.

2. ***Everyone should prepare an answer.*** I will give a few seconds or a few minutes depending on the difficulty. It is best that you write down your answer and circle it on your paper so that if you are called on all you have to do is read what's circled on your paper.
3. I call on someone at random.

If you do not understand something, or you're not sure about what the question was, it's essential that you raise your hand and ask for clarification *before* step (3) (i.e., before I call someone's name). If I call someone's name and then they ask a question, that slows things down.

As long as you are put in effort and give reasonable answers, even if they are not correct, you will do well on participation. If it happens several times that after I call on you, you say "what was the question?" or "I have no idea", then you will not do well on participation.

Don't worry if you don't know the answer sometimes. If you consistently don't know the answer, even when the questions are easy, that is a suggestion that you are not paying close enough attention, or not asking questions in class when you're confused.

When called on, please be prepared to explain *how* you arrived at an answer. It's important to learn how to communicate your method of problem solving, and to break it down into easy steps that you can explain to me and to the rest of the class.

In addition to *answering* questions when called on randomly, a great way to participate is by *asking* questions.

## Problem Sets

There will be approximately seven or eight problem sets. Please follow the following guidelines for the problem sets:

1. If you have questions regarding the problem sets, please either go to the TA's OH, or send emails to the TA. The TA is responsible for grading the problem sets, so to be sure about what the criteria is, ask them.
2. Write legibly or use software that can write math.
  - I recommend LyX (or LaTeX in general). LyX is free (open source) and can produce professional quality documents containing math, using the powerful LaTeX typesetting engines. For example, I use LyX to make the beamer lecture slides and the problem sets. LyX is free and available for Windows, Mac, and Linux: <https://www.lyx.org/Download>.
3. Show your work. Even if you get the correct answer, you will often be penalized many (possibly most) of the points a problem is worth if you do not show your work for how you arrived at an answer.
4. You are encouraged to work with other students on the problem sets, but ***each student must write up their answer separately***. There should not be any part of your problem set that is the same or that is just a rewording of what someone else wrote.

- The only exception to this is that some of the lines of your R commands can be copied. When this is the case, please state explicitly who you copied the R code from. Even if you copy R code, it is still your responsibility to fully understand what you copied.
5. For problem sets involving a computer, it is up to you to take the necessary precautions to find a way to turn the problem set in on time. If your computer crashes, or the internet stops working for you and you cannot turn it in on Canvas before the deadline, these are not valid reasons to be granted extensions to turn problem sets in late. Turn the problem set in early to avoid these computer-related problems, or have a backup system and plan: for example, if your Wi-Fi goes out, use your cell phone data or leave enough time to go to the library to get internet access. Similarly, use backup software so you can still access your files if your computer suddenly has problems. In summary, I will not accept the virtual analog of “my dog ate my homework” as a valid excuse.
  6. I will automatically drop your lowest problem set score. I strongly encourage you to do all of the problem sets and plan to complete all and turn all in. The reason I allow for one drop is that you might have an unexpected but unexcused reason for not turning one in. For example, perhaps you had to go home for an emergency but the Dean of Student’s Office was not willing to write a letter to excuse you.

## Extra Credit (EC)

In this section I discuss ways to get EC in this course.

Do not wait to receive a low exam score to start pursuing the EC opportunities below. That is, you should view EC as a small amount of “insurance” that you build up *in case* you get an exam score lower than you were expecting. I am not planning to offer any EC opportunity in addition to the below.

### Lecture critiques (up to 1 point EC for course grade)

I will not specify exactly how much EC you will receive throughout the semester. I will figure that out after exam 2 when I am looking at your class performance as a whole.

After I post the lecture slides following class, you may email me a “lecture critique”, which I will give details on below. If your lecture critique leads to an actual change in the slides that I will use for the following semester, you will receive EC. Even if it is a small change (e.g., a typo), you can receive EC. How much EC you receive will depend on the type of change. I will go through your critiques at the end of the semester in order to determine how much EC you receive for your final course grade.

1. Make a specific suggestion for what to add to the slides or how to improve them in some way.
  - (a) If you propose the addition of a new slide, be very specific. Draw on a paper exactly how you imagine the slide, rather than giving a vague description. Also specify the current slide after which the new slide should be placed.

- (b) The suggestion may be small, such as a grammar improvement or spelling typo.
  - (c) Does a specific slide or concept make you think of a meme, movie clip, or sports highlight? If so, send in the suggestion. Making connections like this help students to understand and remember key concepts.
  - (d) Instead of suggesting to add a slide, you could suggest to remove a slide. If this is the case, please be very specific in your explanation of why you think a slide should be removed. You need to say more than just “this slide was confusing so it should be removed.”
  - (e) You might suggest some humor that relates to one of the slides, or concepts. For example, you might suggest a specific meme for a slide. The point of this is that suggesting a joke or meme pushes you to understand the concept, and also to think about how to communicate it.
2. Which slides you found confusing and what in particular (be as specific as possible) you found confusing about them. This critique must be constructive in some way (i.e., lead to a potential improvement in the slides). You do not have to come up with the exact way to improve them, as in (1) above, but you must say something like “give a second example about abc because it is not clear from the first example because the first example only does xyz”.

## **Participation**

If you participate in class by asking and answering questions, and you are respectful (e.g., with body language) of your classmates’ questions and answers, you will receive a small amount of EC that could make a difference if your grade is on a border. If you come to class but are not participating or are distracted (e.g., looking at a phone), you will not receive any extra credit.

## **EC quizzes (up to 6 percentage points on each exam grade)**

At the very beginning of most lectures, I will ask a couple of short questions about a previous lecture (usually the most recent lecture). I will not announce in advance which day will have an EC quiz. These questions are not similar to exam questions. They might be about notation, acronyms, or definitions introduced in the previous lecture; or a simple exercise; or mathematical properties that we discussed in the previous lecture. If you would like to participate in this EC opportunity, it’s your responsibility to bring a 3x5 index card and pen/pencil to each lecture, to arrive on time in case there happens to be an EC quiz that day, and to clear your desk (i.e., no phones or computers) when I announce there is an EC quiz (i.e., please do not try to quickly review the last lecture).

The reasoning for these quizzes is that usually the material of each lecture builds on material from a previous lecture, so it is important to give incentives to students to understand the previous lecture and have it fresh in their minds. Another reason for the quizzes being EC is that often you will be working on a problem set requiring older material, so it is an additional effort to study the newer material from the previous lecture. The EC questions will be graded as pass/fail and there is no partial credit. Since they are extra credit, unless you get the question completely, you will not receive any extra credit for it.

Time is an important part of the EC quizzes. You will typically have just one minute to answer. The reasoning for this is that if you studied the slides carefully, you should know the answer right away. The questions are not designed to assess whether you can reason it out with enough time.

Your exam grade on Canvas will include the points you received on the EC quizzes. i.e., your Exam 1 grade will include the EC points you received on EC quizzes up until Exam 1; and your Exam 2 grade will include the EC points you received on EC quizzes since Exam 1.

## Exams

There will be two exams. On the exams there will not be complicated computations. You are expected to be able to multiply decimal numbers (e.g.,  $2.35 \times 4.89$ ). You do not need a calculator. If you would like, you may buy and bring a four-function calculator. The location and times of all assessments are the same as our normal class location and time. The tentative dates for the assessments are as follows:

**Exam 1: Thursday 29 February**  
**Exam 2: Tuesday 23 April**

If you have an excused conflict (e.g., a religious holiday) with any ECO 4421 class this semester, or if you have two other exams on one of the exam dates listed above, please email me **by the end of the first week** of class.

## Grades

Your course grade will be calculated as follows:

Exam 1	25%
Exam 2	25%
max(Exam 1, Exam 2)	5%
Problem sets	45%
Total	100%

We use Canvas for the individual problem sets and exam grades, but to calculate your overall grade please aggregate the individual grades according to the weights listed above. Your final letter grade will be determined as follows:

93–100	A
90–92	A-
87–89	B+
83–86	B
80–82	B-
77–79	C+
73–76	C
70–72	C-
67–69	D+
60–66	D
0–59	E

## Attendance Policy and Behavior

Irregular attendance or inattentiveness will most likely result in a substantial reduction in course performance. Econometrics requires participation and attention. Please shut off or put away laptops, tablets, phones and other electronic devices or toys during class, unless asked otherwise. Also notify me if you will be absent from class. I adhere to the UF attendance policy, described in detail at <https://catalog.ufl.edu/ugrad/1718/regulations/info/attendance.aspx>.

## Student Responsibility

Enrollment in this course constitutes acknowledgment of the following:

1. Check your emails and Canvas announcements at least once a day. It is your responsibility to make sure you do not miss an email from me. I use the email list to communicate important information. Every time that a student thought they did not receive an email from me in the past, after investigating with UF IT we have discovered that they did indeed receive it and they just incorrectly processed it (e.g., they deleted it accidentally because they did not realize it was a class email). It is your responsibility to make sure you do not incorrectly process emails.
2. I understand that the University of Florida expects its students to be honest in all of their academic work. I agree to adhere to this commitment to academic honesty and understand that my failure to comply with this commitment may result in disciplinary action, up to and including expulsion from the University.
3. I will adhere to university copyright policies as found at <http://guides.uflib.ufl.edu/copyright/>.
4. Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation.
5. Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

## Course Outline (tentative)

The following is a tentative plan for the course. We will deviate from the schedule, but it gives an approximate idea of how things will go.



- Week 1  
Go over syllabus and expectations; Math concepts (especially, summation operator).  
PS1 assigned.
- Week 2  
Introduction to R; More R.  
PS1 due.  
PS2 assigned.
- Week 3  
Introduction to probability and random variables; More random variables, probability mass functions.  
PS2 due.
- Week 4  
Continuous random variables and distributions; Expected value.  
PS3 assigned.
- Week 5  
More expected value, variance; Standardization, joint distributions.  
PS3 due.  
PS4 assigned.
- Week 6  
Independence, covariance, correlation; Sums of random variables, independent and identically distributed random variables.  
PS4 due.  
PS5 assigned.
- Week 7  
Conditional probability and distributions; Introduction to statistics.  
PS5 due.
- Week 8  
Exam 1: Thursday 29 February.
- Week 9  
Properties of estimators; Confidence intervals.
- Week 10  
Spring break.
- Week 11  
Hypothesis tests and  $p$ -values; Interpreting coefficients of a line.  
PS6 assigned.

- Week 12  
Estimating coefficients of a line.  
PS6 due.  
PS7 assigned.
- Week 13  
Causality.  
PS7 due.
- Week 14  
Causality and OLS.  
PS8 assigned.
- Week 15  
Misc. depending on time.  
PS8 due.
- Week 16  
Exam 2: Tuesday 23 April.

## Changelog

Here I will list any important updates made to the syllabus throughout the semester.