# RESEC 701: Probability Theory and Statistical Inference

Instructor - Yongjoon Park

Fall 2022

## Course Description

This is the first course in Resource Economics department's graduate level econometrics series. In RESEC 701, students will learn core concepts of probability theory and statistical inference, which form the main foundations of econmerics analysis. Probability theory is the main building block that will allow you to understand estimation and statistical inference. We will start with univariate distributions and then move on to multivariate distributions, with care taken to differentiate between discrete and continuous random variables. We will then move on to estimation and inference. In this part, we will be able to cover different estimation methods and the basics of estimators' properties. The objective of this course is to develop understanding of probability theory and statistical inference concepts at an intuitive and practical level. To acheive this goal, students will learn and practice various computational exercises using a widely used statistical software, `R`, which will help strengthen knowledge of probability and statistical concepts.

## Prerequisites

You must be familiar with basic statistical concepts, linear (matrix) algebra and calculus. You do not need to have previous knowledge of `R`; however, to gain comfort and familiarity with `R`, you will need to be proactive (I can and will provide as much support as I am able, but a large portion of your success will depend on your own initiative to grapple with and solve coding issues yourself - as is expected from graduate students).

## General Course Information

Class meets on Monday 10:00am-12:40pm at Library Tower (room 1667)

### Instructor

- Yongjoon Park (yongjoonpark@umass.edu)
- Office: Stockbridge Hall Room 306A
- Office hours: By email appointment.

### Teaching Assistant

- Name: Onupruba Das
- Email: odas@umass.edu
- Office hours: TBD

## Class Material

1. **Text**: Mathematical Statistics with Applications, by Wackerly, Mendenhall and Scheaffer (WMS)
2. **For Computational Exercise**: For computational exercise, students will using `R`, an open-source free statistical software.
3. **Moodle**: Course-related announcements will be posted in Moodle, so please check Moodle on a regular basis.

# Academic Honesty Policy

Since the integrity of the academic enterprise of any institution of higher education requires honesty in scholarship and research, academic honesty is required of all students at the University of Massachusetts Amherst. Academic dishonesty is prohibited in all programs of the University. Academic dishonesty includes but is not limited to: cheating, fabrication, plagiarism, and facilitating dishonesty. Appropriate sanctions may be imposed on any student who has committed an act of academic dishonesty. Instructors are expected take reasonable steps to address academic misconduct. Any person who has reason to believe that a student has committed academic dishonesty should bring such information to the attention of the appropriate course instructor as soon as possible. Instances of academic dishonesty not related to a specific course should be brought to the attention of the appropriate department Head or Chair. Since students are expected to be familiar with this policy and the commonly accepted standards of academic integrity, ignorance of such standards is not normally sufficient evidence of lack of intent. For more information please check the academic honesty policy.

# Work Expectations and Grades

Grades will be determined based on exam grades, in-class computation exercises, and problem sets.

## Exams (45%)

There will be a midterm and a cumulative final exam. The two exams in total are worth 45% of student's final grade.

| | Exam Date |
|---|---|
| Midterm | October 31, in class |
| Final | TBD |

## In-class computation exercises (30%)

For the in-class computation exercises, students will be asked to work on a code; you will work individually on these assignments, but you can engage in collaboration with other students in the class. (I do, however, strongly suggest that you try to solve the problem(s) yourself through different means before asking someone else for the solution, as this will help to advance your knowledge and understanding). The in-class assignments throughout the semester have a total weight of 30%.

## Problem Sets (25%)

Homework will consist of 8 assignments. Each homework will be posted in Connect. Homework grading will be based on the points that students earn for answering questions correctly. Homework assignments are worth 15% of student's final grade. Below is a tentative homework schedule.

## Grading Table

Final grades will be calculated according to the following minimum cutoff points:

| | | |
|---|---|---|
| | A = 90 | A- = 85 |
| B+ = 80 | B = 75 | B- = 70 |
| C+ = 65 | C = 60 | |

## Accommodation Statement

The University of Massachusetts Amherst is committed to providing an equal educational opportunity for all students. If students have a documented physical, psychological, or learning disability on file with Disability Services (DS), they may be eligible for reasonable academic accommodations to help them succeed in this course. If students have a documented disability that requires an accommodation, please notify me within the first two weeks of the semester so that we may make appropriate arrangements. Finally, if students are experiencing disruption in learning because of COVID19-related issues, please let me know so I can try to find a way to accommodate, if possible.

## Course Content

1. Introduction
2. Probability Theory

- Basic concepts of probability, calculating probabilities, laws of probability, events and random variables
- WMS: Chapter 2

3. Discrete Random Variables and Probability Distributions

- Basic concept, probability distribution for a discrete random variable, expected values, examples of discrete probability distributions.
- WMS: Chapter 3

4. Continuous Variables and Probability Distributions

- Basic concept, probability distributions, expected values, examples of continuous probability distributions.
- WMS: Chapter 4

5. Multivariate Probability Distributions and Functions of Random Variables

- Some selected topics from bivariate and multivariate probability distributions, marginal and conditional distributions, covariance, variance, multinomial distributions.
- WMS: Chapter 5 and 6

6. Sampling Distributions and the Central Limit Theorem.

- Basic concept, sampling distributions and the normal distribution, central limit theorem.
- WMS: Chapter 7

7. Estimation

- Introduction/basic concept, classes of estimators, evaluating estimators and confidence intervals.
- Chapters 8 and 9

8. Hypothesis Testing

- Basic concept, elements of a test, common tests, errors, power of a test, relationship to confidence intervals, p- values.
- Chapter 10