

## **Game Theory and Applications**

ECO 4400 Section: 0150

**Class Periods:** Monday/Wednesday, Periods 7-8, 1:55-3:50pm

**Location:** MAT 0119

**Academic Term:** Spring 2022

### **Instructor:**

Professor Daniel Wagner

[wagnerdnlj@ufl.edu](mailto:wagnerdnlj@ufl.edu)

352.294.0989

Office Hours: Monday and Wednesday 4-5pm in MAT 339, or by appointment

### **Course Description**

Introduces modern game theory, including the formal theory of Nash equilibrium and solutions techniques.

Applications include strategic barriers of entry; cooperative behavior in oligopoly, auctions and bidding strategies; and durable goods sales.

4 credits

### **Face-to-Face ONLY**

This class will be held face-to-face. All students are expected to attend class in person. Lectures will not be streamed or recorded. **Masks are expected** in all economics classes. <https://coronavirus.ufl.edu/health-guidance/>.

### **Course Pre-Requisites**

Intermediate Microeconomics(ECO 3101) and Calculus I(MAC 2311) or equivalents.

Game Theory is an advanced interdisciplinary topic that is as much mathematics as it is economics. This course builds heavily on the calculus and firm optimization explored in ECO 3101 and equivalents and it is important to not just have taken these courses but be comfortable with the material and algebra skills in general. Most students do well in this course but those who do not usually struggle with the calculus, probability, and manipulating firm profit functions in particular.

### **Course Objectives**

Analyze and model strategic decision making by rational actors under perfect and imperfect information, study industrial organization and pricing decisions in a more mathematically rigorous context and conclude with longer games and decisions under uncertainty.

### **Required Textbook**

- Games, Strategies, and Decision Making
- Joseph E. Harrington Jr.
- 2015, 2009, 2nd Edition
- ISBN number: 978-1-4292-3996-7

### **Recommended Materials**

- [Partial Derivatives- Khan Academy Review](#)
- Dixit, Skeath, and McAdams- textbook used in Professor Lee's Game Theory section

## Module 1: Introduction to Game Theory

This module provides an introduction to Game Theory and develops concepts that will be used through the rest of the course. We will study how equilibrium is achieved in simultaneous and sequential move games with 2 players, allowing modeling of topics such as firm duopolies and the Cold War, and setting the stage for more complex games.

### Week 1: Introduction to Game Theory *January 5 – January 7*

- Read: Harrington Chapter 1 and 2 for Wednesday, 3 for Monday
  - Optional reading- Dixit, Skeath, McAdams: Chapter 1 and 2

### Week 2: Simultaneous Move Games and Strict Dominance *January 10 – January 14*

- Read: Harrington Chapter 4, up to part 4.5 for Monday, remainder for Wednesday
  - Dixit Chapter 4
- Syllabus Quiz Monday
- Online Skill Assessment Quiz due Tuesday
- Problem Set 1 given Wednesday, due next Wednesday
- Quiz 1 Wednesday

### Week 3: Sequential Move Games and Subgame Perfection *January 17 – January 21*

- Holiday Monday- Martin Luther King Jr. Day
- Read: Harrington Chapter 8 to 8.4 Wednesday, remainder next week
  - Dixit Chapter 3
- Problem Set 1 due Wednesday

### Week 4: Subgame Perfection Wrapup/Relationship between Normal Form and Extensive Form *January 24 – January 28*

- Read: Review Harrington Chapter 8 and 2
  - Dixit Chapter 6
- Quiz 2 Wednesday
- Problem Set 2 Given Wednesday, Due next Wednesday

### Week 5: Relationship between Normal Form and Extensive Form & Review *January 31 - February 4*

- Problem Set 2 Due Wednesday
- Pre-exam Review Session Friday online (optional)

### Week 6: *February 7 - February 11*

- Exam 1 Monday
- Module 2 begins Wednesday

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## Module 2: Mixed Strategies, Continuous Strategies, and Repeated Games

This module integrates probabilities and calculus to introduce mixed and continuous strategies, respectively, before moving on to repeated games, building on the framework from the previous module with a wider range of moves, including randomizing moves, infinite strategy choices, and negotiating agreements.

Week 1: Mixed Strategies Part 1 *February 14- February 18*

- Read: Harrington Chapter 7, Through 7.3 for Wednesday, Remainder for next Monday
  - Dixit Chapter 7
- Problem Set 3 Given Wednesday, due next Wednesday

Week 2: Review of Partial Derivatives and Profit Maximization, Start Continuous Strategies *February 21- February 25*

- Read: Harrington Chapter 6, part 6.1 and 6.2 for Wednesday, and 6.3 for next Monday
  - Review Derivatives and Partial Derivatives on Khan Academy
  - Dixit Chapter 5
- Problem Set 3 due Wednesday

Week 3: Continuous Strategies *February 28- March 4*

- Read: Harrington Chapter 6
  - Dixit Chapter 5
- Quiz 3 Wednesday
- Problem Set 4 Given Wednesday, due Wednesday after next

Spring Break: *March 7 - 11*

Week 4: Repeated Games and Tacit Collusion *March 14- March 18*

- Read: Harrington Chapter 13 for Monday and 14 for Wednesday
- Problem Set 4 Due Wednesday
- Quiz 4 Monday
- Virtual Exam Review Friday

Week 5: Exam 2, Exam 2 *March 21- March 23*

- Exam 2 Monday

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Module 3: Incomplete Information and Applications

This module introduces games with incomplete information, and applications of Game Theory to more complex real world examples and other disciplines. We study Bayesian and Perfect Bayesian Nash Equilibrium concerning players who are unsure who their rival(s) are. Continuing more complex real world games we will study N-Player Games- games with many or infinite players and more complex strategic scenarios such as purchase of durable goods. These topics further integrate probability for actions under uncertainty and combine calculus with discount rates to model Tacit Collusion, or implicit restrictions of supply used to form cartels without direct communication.

Week 1: Tacit Collusion *March 23 - March 25*

- Read: Harrington Chapter 9, up to 9.4 for Wednesday, Remainder for next Monday
  - Dixit Chapter 8 and 9
- Quiz 5 Wednesday

Week 2: Bayesian Games/Signaling *March 28-April 1*

- Read: Harrington Chapter 10, up to 10.4 for Wednesday, Remainder for next Monday
- Problem Set 5 given Monday, due next Monday

Week 3: Signaling *April 4- April 8*

- Read: Harrington Chapter 5 for Wednesday
- Problem Set 6 given Wednesday, due next Wednesday
- Quiz 6 Wednesday

Week 5: N Player Games and Durable Goods *April 11- April 15*

- Read: Harrington Chapter 5
- Problem Set 6 Due Wednesday

Week 6: Durable Goods Wrap Up and Final Review *April 18 - April 22*

- Quiz 7 Monday
- Final Review Session Wednesday
- Reading Days begin Thursday

Final Exam: April 28th, 12:30pm to 2:30pm, during assigned UF final exam slot

If you have a conflict in final exams, as per UF policy:

- If two exams are scheduled at the same time, assembly exams take priority over time-of-class exams.
- When two assembly exams or two time-of-class exams conflict, the course with the higher number will take priority. Instructors giving make-up exams will make the necessary adjustments.

If the conflicting course has a code of less than 4400, contact that instructor to arrange a makeup.

***Attendance Policy, Class Expectations, and Make-Up Policy***

While not graded, attendance is required. You are responsible for the material covered in lecture. This course covers a fairly large amount of material in one semester and attendance is crucial to avoid falling behind. You may obtain notes from your classmates, but class is most effective when attended in person, and quizzes must be completed in class unless otherwise stated.

If you do not notify me in advance that you will be absent for a UF approved reason or afterwards with proof of extenuating circumstances on a day you are selected to present a problem set solution you will receive a 0 for that problem set.

Late work will be accepted at a letter grade penalty per day. Work without a name will receive a one letter grade penalty, but this should not be an issue with all assignments submitted via Canvas.

- The problem sets, readings, and quizzes are intended to prepare you for the exams. Similarly to Intermediate Microeconomics this course involves intuition that can be difficult to grasp; practice is key. The course is designed with the assumption that you are practicing examples of the material, if you do not complete the quizzes and problem sets yourself you will not be prepared for the exams.
- Problem sets are due at the beginning of class on Canvas and students will be selected at random without replacement to present solutions. I will assist you if you are unsure of the answer but presenting answers is not optional.
- It is your responsibility to inspect your uploads on Canvas and make sure your problem set submission is legible, complete, and a usable file- corrupted files will receive a 0.
- Quizzes are on alternate weeks to when the problem sets are due, first individually and then a second time with groups of up to 4. This is intended to encourage study groups but both quizzes will count as the final grade is an average of the two attempts; you are responsible for the materials in the lectures and readings which will prepare you for the quizzes. Your lowest quiz grade will be dropped. Skipping the first attempt of a quiz and completing it only with your group is an automatic 0.
- While collaboration on problem sets and group quizzes is allowed this is again intended as a study tool; your classmates are a valuable resource but if you do not work through the problems yourself it is easy to falsely think you understand the material.
  - I have seen students blindly copy incorrect answers from each other, not engage with the material, and go on to do poorly on the exams. If you cannot put pencil to paper and work the problems yourself, you are not going to be able to during exams.

Laptops are not recommended for note taking as course notes will heavily rely on diagrams that are easier to draw by hand. Quizzes on Canvas can be taken on laptops or smartphones with a web browser or the Canvas application.

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.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

Excused absences must be consistent with university policies in the Undergraduate Catalog and require appropriate documentation. Please notify me in advance if you will be absent during a quiz or exam or when a problem set is due if at all possible. Additional information can be found here:  
<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>

***Evaluation of Grades***

| <b>Assignment</b> | <b>Percentage of Final Grade</b> |
|-------------------|----------------------------------|
| Problem Sets      | 15%                              |
| Quizzes           | 10%                              |
| Midterm Exam 1    | 25%                              |
| Midterm Exam 2    | 25%                              |
| Final Exam        | 25%                              |
|                   | 100%                             |

***Grading Policy***

| <b>Percent</b> | <b>Grade</b> | <b>Grade Points</b> |
|----------------|--------------|---------------------|
| 90.0 - 100.0   | A            | 4.00                |
| 87.0 - 89.99   | B+           | 3.33                |
| 80.0 - 86.99   | B            | 3.00                |
| 77.0 - 79.99   | C+           | 2.33                |
| 70.0 - 76.99   | C            | 2.00                |
| 67.0 - 69.99   | D+           | 1.33                |
| 60.0 - 66.99   | D            | 1.00                |
| 0 - 59.9       | E            | 0.00                |

Grades will not be rounded, an 89.99 is a B+. A curve will be implemented on exams only if the class average is below 70, which has not yet been necessary in a year and a half of teaching this course. Quizzes will also be curved if the average is below 70%. The homework and quizzes are intended as a buffer in addition to preparing you for the exams.

If you feel there is an error in an assigned grade, you may submit a written request via email with the specific error(s) outlined with an explanation of why the readings, lectures, problem sets, and quizzes did not prepare you for these question(s) or why your answer is correct and the entire assignment will be regraded. Assignment grades will not otherwise be altered.

Extra credit will be offered for completing the reminder survey for faculty evaluations; it will not be offered on an individual basis.

Substitute work will not be offered except in cases of excused absences or other accommodations. If an assignment without a name can be identified, it will be accepted at a letter grade penalty. If ownership is disputed and cannot be identified it will not be accepted.

Makeup exams must be prearranged and only for UF approved conflicts.

More information on UF grading policy may be found at:  
<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

In the interests of fairness I will not deviate from the syllabus. It is your responsibility to attend class, complete the problem sets and quizzes, study, and make a rational assessment of your chances before the withdrawal period closes.

If you are struggling with the material or think you do not understand, seek help from me or your study group- do not wait for the exam or ask for extra credit after the fact.

### **Email**

Most of our one-on-one communication will occur via email. There are two important course policies regarding email:

- 1) I expect that you are reading your email at least once per day, and
- 2) All emails that you send must follow basic rules for professional correspondence. If you are unsure of what constitutes professionalism, feel free to ask or simply err on the side of caution.

### ***Students Requiring Accommodations***

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

**Present your accommodation letter to me as early in the semester as possible to allow time for accommodations to be arranged.**

### ***Course Evaluation***

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>.

### ***University Honesty Policy***

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (<https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

### ***Software Use***

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

### ***Student Privacy***

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>

## **Campus Resources:**

### Health and Wellness

#### **U Matter, We Care:**

If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) or 352 392-1575 so that a team member can reach out to the student.

**Counseling and Wellness Center:** <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

#### **Sexual Assault Recovery Services (SARS)**

Student Health Care Center, 392-1161.

**University Police Department** at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

### Academic Resources

**E-learning technical support**, 352-392-4357 (select option 2) or e-mail to [Learning-support@ufl.edu](mailto:Learning-support@ufl.edu).  
<https://lss.at.ufl.edu/help.shtml>.

**Career Resource Center**, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

**Library Support**, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

**Teaching Center**, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.  
<https://teachingcenter.ufl.edu/>.

**Writing Studio, 302 Tigert Hall**, 846-1138. Help brainstorming, formatting, and writing papers.  
<https://writing.ufl.edu/writing-studio/>.

**Student Complaints Campus:** [https://www.dso.ufl.edu/documents/UF\\_Complaints\\_policy.pdf](https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf).

**On-Line Students Complaints:** <http://www.distance.ufl.edu/student-complaint-process>.

In response to COVID-19, the following practices are in place to maintain your learning environment, to enhance the safety of our in-classroom interactions, and to further the health and safety of ourselves, our neighbors, and our loved ones.

- If you are not vaccinated, get vaccinated. Vaccines are readily available at no cost and have been demonstrated to be safe and effective against the COVID-19 virus. Visit this link for details on where to get your shot, including options that do not require an appointment: <https://coronavirus.ufhealth.org/vaccinations/vaccine-availability/>. Students who receive the first dose of the vaccine somewhere off-campus and/or outside of Gainesville can still receive their second dose on campus.
- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated. Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.



- Sanitizing supplies are available in the classroom if you wish to wipe down your desks prior to sitting down and at the end of the class.
- Hand sanitizing stations will be located in every classroom.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email [covid@shcc.ufl.edu](mailto:covid@shcc.ufl.edu)) to be evaluated for testing and to receive further instructions about returning to campus. UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the [UF Health Screen, Test & Protect website](#) for more information.
  - Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work.
  - If you are withheld from campus by the Department of Health through Screen, Test & Protect you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- Continue to regularly visit [coronavirus.UFHealth.org](https://coronavirus.UFHealth.org) and [coronavirus.ufl.edu](https://coronavirus.ufl.edu) for up-to-date information about COVID-19 and vaccination.