1   Course Objectives

This course introduces game theoretic tools that can be used to analyze a wide variety of issues in an array of diverse fields that includes economics, politics, and biology. We begin by studying pure and then mixed Nash equilibria in strategic games. We then consider sub-game-perfect equilibria in extensive form games. Finally, we study Bayesian, and extensive form games with imperfect information. Along the way, we apply the concepts within a rich set of diverse applications (for example, Cournot/Stackelberg oligopoly with externalities or with imperfect information, electoral competition, public good contribution, auctions, bargaining). As in other economics courses, once we understand what equilibrium means in a model, we can then perform comparative static exercises in order to predict the effect of changes in underlying parameters on the equilibrium of the model.

In many courses there is a prescribed method to answer a specific question. In this course, the question always starts with a variant of "what is the prediction of the model?" but the method of obtaining the answer varies according to the model. In order to master the material you need to practice the techniques and know when to apply them. It is not enough to understand what is done in class. You need to test yourself by doing the questions. Like swimming or playing the violin, you don't improve your speed or stamina while watching others swim or play. You must do the exercises in order to do well on the tests and final exam. You must test yourself by trying previous test and exam questions without looking at the solutions provided.

2   Recommended Texts (available at the UTM bookstore)

An Introduction to Game Theory, Martin J. Osborne, Oxford University Press, 2004, available at the bookstore.

3   Course Websites: course web page + Canvas course page

1. Our course web page provides information about the course and restricted material in the form of expanded lectures. It also provides test/exam tips and topics as well as past test and exam questions and solutions.

2. Our Canvas course page provides instructions regarding how to access restricted material on our course web page. It also provides the means for me to email you. It is your responsibility to ensure your email account can receive email from Canvas.

4   Prerequisites

Prerequisites for ECO 326H5F: (1) ECO200Y5(70%) / ECO204Y5(70%) / ECO206Y5, and (2) ECO220Y5 / ECO227Y5 / (STA250H1, STA257H5 / STA256H5) / (STA257H5 / STA256H5, STA261H5 / STA260H5) / (STA257H5 / STA256H5, STA248H5 / STA258H5).

Prerequisites are strictly enforced and must be completed before taking a course. Both the lecture and the tutorial are important ingredients of the course. Please note that no accommodations can be made for students who have scheduling conflicts. By taking this course you acknowledge that you will be removed from the course at any time if you do not meet all requirements set by the Department of Economics. For further information you can consult the prerequisites page for ECO326 online in the program (economics) section of the 2019-2020 Academic Course Calendar online.
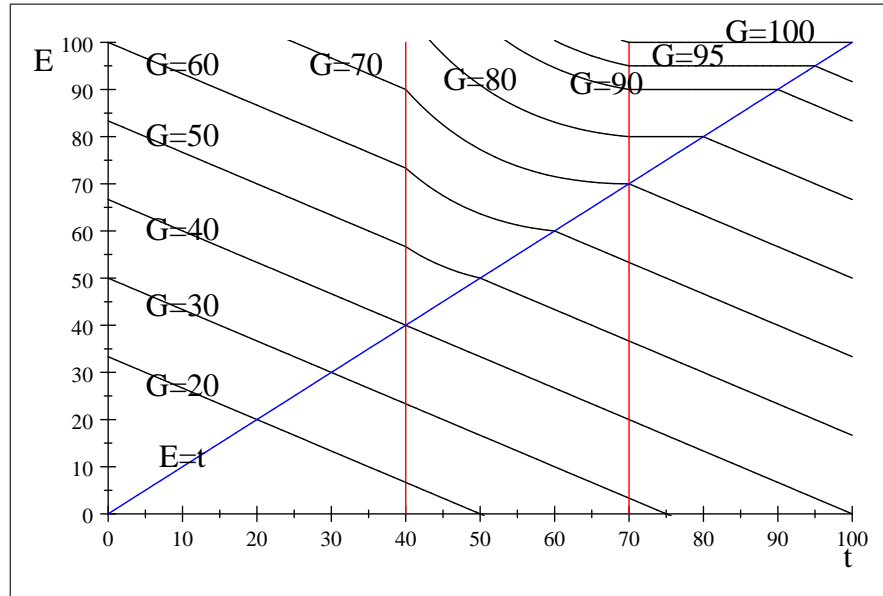
5   Grade Allocation

In this course, there is one term test and one accumulative final exam. If $t \in [0, 100]$ denotes your term test grade and $E \in [0, 100]$ denotes your final exam grade then your course grade $G(t, E)$ is calculated according to the following piecewise-defined formula

$$G(t, E) = \begin{cases} 0.4t + 0.6E & \text{if} \quad t > E \text{ or } t \leq 40 \\ \left(\frac{70-t}{75}\right)t + \left(\frac{t+5}{75}\right)E & \text{if} \quad t < E \text{ and } t \in [40, 70] \\ E & \text{if} \quad t \leq E \text{ and } t \geq 70 \end{cases} \quad . \qquad (1)$$

Thus, the final grade equals at least 40% of the term test grade $+ 60\%$ of the final exam grade but it may be higher when certain conditions apply. Specifically, as stated in the first row of the formula (1) for G, if your term grade t is less than 40 OR if your final exam grade E is lower than your term grade t, then your course grade G is $0.4t + 0.6E$ which increases in t and in E. If instead, your term grade t is at least 40 and your final exam grade E is higher than your term grade t, your lower term grade is at least partly redeemable by a higher final exam grade. In particular, as stated in the second row of the formula (1) for G, if your term test grade t is between 40 and 70 and is lower than your final exam grade E (so that $E > t$), the term test mark t will receive a weight of $(70-t)/75$ and your final exam grade E will receive the weight $(t+5)/75$ so that your course grade is calculated as $t(70 - t)/75 + E(t + 5)/75$ which increases in t and E and is larger than $0.4t + 0.6E$ in this case. Lastly, as stated in the third row of the formula (1) for G, if your term test grade t is at least 70 but is lower than your final exam grade E, your course grade equals E which is larger than $0.4t + 0.6E$.

To give you another idea of the production function G as a function of the inputs $t \in [0, 100]$ and $E \in [0, 100]$, the plots in graph (2) provide, for each course grade $g \in \{20, 30, 40, 50, 60, 70, 80, 90, 95, 100\}$, the isoquant labelled $G = g$ (i.e., the set of all term test grades t and final exam grades E for which the final course grade $G = g$). Note that the area for which $E > t$ lies above the blue 45-degree line and that the shape of the isoquant depends on the level g of the course grade. When $g \in \{20, 30, 40\}$, the isoquant $G = g$ is linear and decreasing (i.e., as t increases, E decreases). When $g \in \{50, 60, 70\}$, the isoquant $G = g$ is decreasing and it is linear when either $t < 40$ (i.e., to the left of the first red vertical line) or $t > E$ (i.e. below the blue 45 degree line) but it is convex when $t \in (40, 70)$ and $E > t$ (i.e., between the two red vertical lines and above the blue 45 degree line). When $g \in \{80, 90, 95\}$, the

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isoquant labelled $G = g$ is first convex and decreasing (between the two red vertical lines and above the blue 45 degree line), then constant (to the right of the second red vertical line and above the blue 45-degree line), and then linear and decreasing (below the blue 45-degree line).

Course Grade isoquants: test and exam grades (t and E) that produce a given course grade (G)

(2)

6 Missed Test Policy

If you miss the term test without an approved reason then you are assigned a mark of 0 on the test. If you do not write the term test or its make-up, your term grade is 0. If you miss the term test due to unforeseen circumstances beyond your control, then you must submit a written explanation and supporting documentation to request an appeal to write the make-up test on the entire term's work at the end of the term. If an appeal is not received, or if the appeal is deemed unacceptable, you will receive a grade of zero for the test you missed.

Students who miss the term test due to a valid and certified reason whose appeal has been granted (that is, you missed the test due to unforeseen cir-

cumstances beyond your control, you followed the 4 steps below, and I accept your reason for missing the item) are eligible to write a COMPREHENSIVE make-up test ON THE ENTIRE COURSE MATERIAL in the last weeks of class. Students who are not able to keep up with the material should consider dropping the course. Eligible students who miss the make-up test are assigned a mark of 0 on the make-up test. If you miss the mid-term test due to an approved reason, then you must follow EACH of the FOUR steps below in order to submit your appeal to be approved to write a make-up test on the entire term's work in the final two weeks of class.

1. Within 24 hours of the missed test date, send me an email with the reason that you missed the test.

2. Within 24 hours, declare your absence online on ACORN in order to be considered for an academic accommodation for missed tests and final exams Absences include those due to illness, death in the family, or other circumstances beyond your control.

3. Within 48 hours of the missed test date, complete a Special Consideration Request online to request that the Department grant you special consideration for a missed test due to circumstances beyond your control (e.g. illness or an accident). Late requests will NOT be considered without a "letter of explanation" as to why the request is late. Note: The system only supports Microsoft Internet Explorer and Firefox for the time being so make sure that you install one of these browsers on your device.

4. Within one (1) week of your online request, submit all supporting original documentation (e.g. Verification of Student Illness or Injury form, accident report, etc.) to the DROP BOX located outside Room 3274, Innovation Complex Building. Please Note: Supporting documentation is required. In addition, if you missed your test for a reason connected to your registered disability, the department will accept documentation supplied by the UTM AccessAbility Resource Centre. Please see

   (a) Verification of Student Illness or Injury forms: Documentation MUST show that the physician was consulted within ONE day of the test date. For example, if you missed a test due to a valid medical reason, then you must provide a signed and detailed copy

of the College's Official Medical Form to the Department of Economics within one week of the missed test in which the doctor explicitly states that the doctor has independent evidence (other than your word) that your illness rendered you incapable of writing the test. A statement (such as, "This patient tells me that he was feeling ill on that day.") that merely confirms a report of illness made by the student is NOT acceptable. The doctor must explicitly state that the doctor has independent evidence (other than your word) that your illness rendered you incapable of writing the test Verification of Student Illness or Injury forms can be found at the Office of the Registrar's online

(b) If support has been obtained from someone other than a practitioner listed on the U of T Verification of Student Illness or Injury form then a Verification of Extenuating Circumstances form is acceptable and is available online

(c) Other documentation can include, but is not limited to: letter of support from AccessAbility, automobile collision or police reports, death certificate, and supporting documentation from employers, lawyers and other related personnel.

(d) ROSI declarations are not accepted as supporting documentation.

(e) If your reason for absence is due to a last minute flight due to a family emergency (illness/death etc.) you must provide your flight itinerary INCLUDING the date the flight was purchased as well as boarding passes in addition to proof of death/illness/accident.

(f) It is your responsibility to ensure your email account is working and able to receive emails. Claims that a Departmental decision was not received will NOT be considered as a reason for further consideration.

(g) Holidays, pre-purchased plane tickets, family plans, your friend's wedding, lack of preparation, or too many other tests/assignments are not acceptable excuses for missing a test.

(h) For religious observances please see section on Religious Observances in this syllabus.

Please note that the written explanation and documentation that you submit represents an appeal from you, requesting the opportunity to account

for that portion of the grade in some other manner. If an appeal is not received, or if the appeal is deemed unacceptable, you will receive a grade of zero for the item you missed. If the appeal is granted–that is, your reason for missing the item is considered acceptable by the professor–then a mechanism for accounting for the grade value of the missed item will be used.

Consult the Office of the Registrar should your absence be lengthy or affect multiple courses.

In the event of a missed exam, please refer to the Deferred Exam instructions. Proper documentation will be required. Consult the Office of the Registrar should your absence be lengthy or affect multiple courses.

7 Tentative Course Outline: Lectures and Assignments (Subject to Change)

Each textbook question # tells you where in the text to find the question: for example, question 57.2 refers to the second example or exercise on page 57.

If the solution to a question is not currently available to students but might become available during the term, then the question number is in plain text, like 57.2.

If the solution to a question will not be made available to students then the question number is in plain text with two asterisks, like 67.1**. These are harder questions for those students who want a challenge. Students do not have to do questions like 67.1** for test or exam purposes.

If the solution to a question is currently available in a lecture on our course web page, then the question number is in emphasized text, like *72.3*. The web address for our course is available near the top of this syllabus. I will give instructions in class on how to obtain the username and password.

If the solution to a question is currently available on the textbook solutions web page then the question number is in bold text, like **44.1**. The web address is available on our course web page. As above, please obtain the username and password from me in class. Please maintain a back-up.

If the solution to a question is currently available on both the textbook solutions web page and in a lecture on our course web page, then the question number is in bold text with an asterisk, like **36.1** *.

Week	Topics	Ch.	Textbook questions
1	Game Theory	1	**5.3**, **6.1**
2	Strategic Games	2	**16.1***,*18.1*,**20.1***,*27.1*,
	Nash Equilibrium		*27.2*,*30.1*,**31.1***,*31.2*,
			33.1,**34.1***,*34.2*
	Best Response		**34.3***,**37.1***,**38.1***,**38.2***,
			41.1,*42.1*,*42.2*
3	Dominated Actions		*44.1*,**47.1**,**47.2**,*48.1*,
			49.1,49.2,**50.1**,50.2,
	Symmetric Games		**51.2**,**52.2**
	Cournot Oligopoly	3	**58.1**,59.1,59.2,60.1,
			60.2,61.1,62.1**,63.1
	Bertrand Oligopoly		**67.1**,67.2,**68.1**,**68.2**,69.1**
4	Electoral Competition		**73.1**,74.1,*74.2*,*75.1*,
			75.2**,**75.3**,**76.1**
	War of Attrition		**79.1**,79.2,80.1,80.2,
	Auctions		84.1,**85.1**,86.1,**86.2**,**87.1**,
			88.1,90.1,90.2**,**90.3**,91.3
4-6	Mixed Equilibria	4	**101.1**,**106.2***,**110.1**,**111.1**
	(4.1-4.8)		**114.1***,*114.2-114.4*,**117.2***,
			118.1,118.2**,118.3**,**120.2***
			121.2,**127.1***,**127.2**,128.1,
			130.2,**130.3**,**132.2**,*132.3*
15-18 Oct	**READING WEEK**		
25 Oct	**Term Test**	**1-4**	as above

Week	Topics	Ch.	Textbook questions
25 Oct	**Term Test**	**1-4**	as above
8	Extensive Games	5	156.2,161.1
	Nash Equilibrium		**163.1**,*163.2*
	SPE		**164.2**,**168.1**,173.2,
			173.3,173.4,**174.1**,**174.2**
			176.1,*177.1*,*177.2*,**177.3**
			179.1,*179.2*,**179.3**
9	Ultimatum Game	6	**183.1-.2**,181.3,183.4**,185.1,
			185.2**,**186.1**,187.1
	Stackelberg Duopoly		**189.1 ***,191.1,192.1
	Buying Votes		196.1-196.3,**196.4**
	A Race		**198.1**,201.1,201.2,202.1**
			203.1
10	Bargaining (16.1-16.2)	16	**468.1 ***,**468.2 ***,*473.1*,*473.2*
11	Bayesian Games	9	276.1, 277.1,282.1,282.2
			282.3,284.1,287.1,288.1
			290.1,291.1,294.1,294.2
			296.1,299.1,299.2,306.1
			307.1
12	Extensive Games	10	316.1,317.1,318.2,319.3
	with Imperfect Information		320.1,320.2,322.1,331.1
			331.2,335.1,335.2,340.1
			342.1,346.1,350.1,350.2

8 Equity Statement

Please read the Statement on Equity, Diversity and Excellence available [online](#).

9 Academic Rights

Please read the statement on Academic rights available in Section **1.A.(viii) Equity and Academic rights Information**, available [online](#).

10   Academic Integrity/Honesty and Academic Offenses

It is your responsibility as a student at the University of Toronto to familiarize yourself with, and adhere to, the Code of Student Conduct, available online (from the U of T Mississauga website (Registrar > Academic Calendar > Codes and Policies) or in your print version of the Academic Calendar, and to the Code of Behaviour on Academic Matters, available online (from the U of T Mississauga website (Registrar > Academic Calendar > Codes and Policies) or in your print version of the Academic Calendar. This code includes policies about Academic Honesty available online. The UTM Academic Integrity website is here.

The above codes on such academic matters are taken from a series of University of Toronto policies written to help students understand the university's rules and decision-making structures. To view these policies, please click here

You are responsible for reading the information in the above sites. As a student it is your responsibility to ensure the integrity of your work and to understand what constitutes an academic offence. If you have any concerns that you may be crossing the line, always ask your instructor. Ignorance of the rules does not excuse cheating on tests or exams. Any student caught cheating in any way (including but not limited to (a) using or possessing any unauthorized aids (there are no authorized aids on ECO 326 tests or exams so for example, no cheat sheets, cell phones, computers, electronic devices, or external printed information) on an exam or test, (b) using someone else's answers during an exam or test, (c) misrepresenting your own or someone else's identity, and (d) falsifying or altering any institutional documents, grades, or submitted documentation) is subject to academic discipline ranging from a mark of zero on the test or examination to dismissal from the university as outlined in the academic calendar. Any student assisting in such misconduct is also subject to academic penalties. When students are suspected of cheating on tests or exams the matter is dealt with in a formal and serious manner as the University of Toronto treats these cases very seriously.

11 Accessibility

Students who require accommodation (due to permanent or temporary physical or mental health issues) are advised to visit the AccessAbility Resource Centre as early as possible to have their needs assessed, as it may take some time to process the application.

For more information please see AccessAbility Resource Centre online

12 Religious Observances

Please read the statement on Religious observances as noted in the Policy on Scheduling of Classes and Examinations and Other Accommodations for Religious Observances available online

To request academic accommodation for a test due to religious reasons, students must both send me an email and submit a Special Consideration Request online and supporting documentation at least 3 weeks prior to the test.