Syllabus

Course Description: In this course, you will learn about the mathematical foundations underlying modern economics, with a particular focus on both static (one-period) and dynamic (intertemporal) optimization.

Contact info: My name is Jeremy Sandford, and I am an assistant professor in the economics department at UK. Please call me Jeremy. My email address is jeremy.sandford@uky.edu. My website is jasandford.com. It has a detailed schedule, which I will update after each class, and information on homeworks and exams.

Office Hours: By appointment. You may also stop by when you see my door open, with Mondays, Wednesdays, and Fridays being the most likely times to find me there. If you have questions that you believe will take more than a few minutes, please email me at least a few hours ahead of time and we will make an appointment.

Homework: There will be approximately 9 homework assignments. A subset will be collected, and a subset of those will be graded by me, for correctness and effort exerted.

You will spend most of your time for this course on the homeworks. They will be hard. You should work in study groups to compare answers and try to reach more correct answers together. You should come talk to me about the problems after this process has played out.

You are also free to copy assignments from classmates or answer keys and turn them in as your work. However, if you do this, it is vanishingly unlikely that you will do well on exams, earn a passing grade in the course, or pass prelims. Carefully study the weight given to homework in determining the course grade relative to exams before electing this path.

A word of advice: spend time working on the clarity and logical structure of your answers to homework problems. There should generally be more English words than mathematical symbols (though there will be plenty of the latter, too). Work on writing complete answers, which would inform a reader not only what you think the answer is, but why you think it is so.

Exams: There will be two midterms and a final exam. The midterm exams are on Tuesday, September 27 and Thursday, October 27, in class. The final exam is Tuesday December 13th from 10:30am-12:30pm. It is not possible to take any of the three exams at a different time, short of debilitating extenuating circumstances discussed as far in advance as possible with me. The most likely outcome of missing an exam for such a reason would be receiving a grade of incomplete this semester, and having a chance to take next year's corresponding Eco 590 exam for this semester's credit. If you will not be available for any of these exam times, please do not take this course.

Course materials: The course has two required books, "A First Course in Optimization Theory" by Rangarajan Sundaram, and "Mathematics for Economists" by Carl Simon and Lawrence Blume. The former

will follow the specific topics I do in class more closely, while the latter is a little more student-friendly, and has broader coverage. Both are good books. Two other commonly used books for this course are "Fundamental Methods of Mathematical Economics," by Wainwright and Chiang and "Mathematical Methods and Models for Economists," by de la Fuente. You should consult any of these books as you feel it is necessary.

Additionally, any of the serious first-year microeconomics books (such as Mas-Colell, Jehle and Reny, and Varian) have mathematical appendices that can be quite useful for students in this class, especially in that they are written to get straight to the point, abstracting from important foundational details.

I will not generally assign specific readings, particularly given that this semester it is somewhat unlikely I will follow a book closely (doing so results in a course that is a bit more nuanced about mathematical foundations than is necessary for our purposes). It is ultimately your responsibility to make sure you have a working understanding of topics covered in class, as well as foundational topics that I may not cover at all in class.

Grading: Course grades will be determined by a weighting of homework assignments (10%), two midterms (25% each), and one final exam (40%).

Econ PhD students will receive course grades as follows:

- **A:** Excellent work, and your performance in this course suggests that you are likely to pass prelims and become a successful grad student.

- **B:** Acceptable work, but your performance in this class suggests there is room for improvement before you are ready to pass prelims and otherwise excel as a grad student at UK.

- **C:** Work suggestive of general confusion, and your performance in this course suggests you are not yet on a path that will lead to your passing prelims and thriving as a UK grad student.

- **F:** Your performance suggests that you are not serious about becoming a competent economist

Students who are not econ PhD students may be graded on a different scale, depending on their background (i.e. I would expect more out of a finance PhD student than an undergraduate). Roughly, the standard I will apply is A for "would be an excellent econ grad student to have at UK" B for "strong effort, and good results given constraints" and C for "didn't work out very well".

While this university does not give plus/minus grades, nor grades such as "AB" or "BC," I will use such grades if necessary, and will also report them to other graduate faculty as needed, though they will not appear on your university transcript.

Time commitment: We will be covering a lot of material that is of non-trivial difficulty, and you will completing about 9 homeworks, in addition to studying for exams. As such, this will be a time-intensive course. A Ph.D. student who gets an excellent course grade will probably have spent at least 10 hours/week working on this course outside of class, and most likely more.

Scope of class: I will assume at least a mechanical knowledge of an undergraduate calculus sequence. If you feel you need to review this material, chapters 1-5 of the Simon and Blume book would be a good place

to start. Though linear algebra is very important in economics, particularly for your econometrics and macro classes, we will not cover much linear algebra in this course. The material in Simon and Blume, chapters 6-11 is an excellent review of the topics covered in an undergraduate linear algebra course. Finally, I do not intend to cover every defintion, lemma, and step-by-step proof in class; this would make for an extremely boring class. This means you will have to absorb various definitions, etc. from readings over the course of the semester in order to get a full understanding of the material. There should be no presumption that something not mentioned in class is unimportant to know.

Contingencies: Should the university cancel any of our class meeting because of inclement weather, they will be made up, most likely on the following Friday afternoon.

Academic dishonesty: I will pursue the maximum penalty for any cheating on exams.

Topics Covered

Topic	Subtopics	reading
Foundations	What is a set?	**S:** 1.1, 1.2, 1.4, 1.6
	What is a function?	A1-A4
	Basic topology: convex, open,	**SB:** 29, A1
	closed, compact sets, etc	
Unconstrained optimization	Weierstrass extreme value theorem theorem	**S:** 2, 3, 4
	Weierstrass theorem and first order conditions	**SB:** 17, 30.1, 30.4
	Necessity versus sufficiency of FOC	
	Comparative statics	
	Numerical methods	
Constrained optimization	Gradients and directional derivatives	**S:** 5, 6
	Theorem of Lagrange	**SB:** 18, 19, 22
	Theorem of Kuhn and Tucker	
Concave optimization	Concavity and quasiconcavity in economics	**S:** 7, 8
	Identifying concave functions	**SB:** 21
	Simplifying theorems of Lagrange and	
	Kuhn and Tucker under concavity	
Dynamic optimization	Finite-horizon intertemporal optimization	**S:** 11, 12
	Dynamic programming	
	Infinite horizon intertemporal optimization	
	Guess and verify	
	Contraction mapping theorem	
Applications	Expected utility	TBD
	Moral hazard models	
	Labor search models	
	TBD	

S=Sundaram, SB=Simon and Blume

Each topic will take from 2-5 class meetings. This list is preliminary. It is quite likely that we will not cover every topic listed above, and that we will cover topics which are not listed. I will maintain an updated schedule on my website, jasandford.com, which will list the actual topic on each class day, as well as any additional readings that may be required.