Matching Course Request

Indiana University

Check Appropriate Boxes: Undergraduate credit ☐️ Graduate credit ☑️ Professional credit ☐

1. School/Division: SLA
2. Academic Subject Code: Econ
3. Course Number: 520 (must be cleared with University Enrollment Services) 4. Instructor: TBD
5. Course Title: Optimization Theory in Economic Analysis
6. Recommended Abbreviation (Optional): Optimization Theory in Economics
7. First time this course is to be offered (Semester/Year): Fall 2010
8. Credit Hours: Fixed at 3 or Variable from ________ to ________
9. Is this course to be graded S-F (only)? Yes ☐ No ☐
10. Is variable title approval being requested? Yes ☐ No ☐
11. Lecture Contact Hours: Fixed at ________ or Variable from ________ to ________
12. Non-Lecture Contact Hours: Fixed at ________ or Variable from ________ to ________
13. Estimated enrollment: ________ of which ________ percent are expected to be graduate students.
14. Frequency of scheduling: Annual ☐️ Will this course be required for majors? Yes ☐ No ☐
15. Justification for new course: Required for new PhD program in Economics.
16. Are the necessary reading materials currently available in the appropriate library? Yes ☐ No ☐
17. Please append a complete outline of the proposed course, and indicate instructor (if known), textbooks, and other materials.
18. If this course overlaps with existing courses, please explain with which courses it overlaps and whether this overlap is necessary, desirable, or unimportant
19. A copy of every new course proposal must be submitted to departments, schools, or divisions in which there may be overlap of the new course with existing courses or areas of strong concern, with instructions that they send comments directly to the originating Curriculum Committee. Please append a list of departments, schools, or divisions thus consulted.

Submitted by: [Signature] Date: 9-4-09

Reviewed by: [Signature] Date: 2/28/10

Data Department or Division Director:

Data of Graduate School (when required):

University Enrollment Services:

After School/Division approval, forward the last copy (without attachments) to University Enrollment Service for initial processing, and the remaining four copies and attachments to the Campus Chancellor or Vice-President.

University Enrollment Services Final White: Chancellor/Vice-President-Blue; School/Division-Yellow;
Department/Division-Pink; University Enrollment Services Advisor—White

Reset
E520 Optimization Theory in Economics
Fall 2010

Professor: Steve Russell
Office: CA523, phone: 278-7214, e-mail: srusse@iupui.edu
Office hours: TBA
Class website: Onecourse at https://onecourse.iu.edu/portal

The class has required weekly review sessions on Date TBA (one class meeting each week) taught
by a Teaching Assistant TBA.
In the early part of the semester, these sessions will focus on reviewing some basic background
mathematical concepts. Later on, the emphasis will be on solutions to problem sets, and will be also
driven by your emerging needs. The AI will also hold weekly office hours of whose schedule and
location he will inform you soon.

Objectives of the Course: The purpose of this course is to present the concepts and techniques of
mathematical optimization and some models and methods of economic dynamics. Thus the class
focuses on the tools of both modern micro- and macroeconomic theory, and more generally, on
technically equipping students for the graduate program in Economics. Note however that while most
of you will be taking the first semester graduate micro- (E521) and econometrics (E571) concurrently
with this class the sequencing of material in E520 is dictated by the intrinsic logic of the mathematical
concepts studied (it is my hope that you will eventually appreciate the presence of such logic), where
new concepts and techniques build on the ones learned to date. E521 and E571, however, have to
sequence material according to their own intrinsic logic. In many instances your demand for
understanding some techniques used in these classes (for example, Lagrange Multipliers, Kuhn-Tucker
conditions, dynamic programming) will be met by the supply of their coverage in E520 with some time
lag. The instructors in E521 and E571 will tend to emphasize intuition and applications of the
techniques used, while I shall strive to develop a detailed rigorous background. Therefore, throughout
this first semester, you should expect some inevitable difficulties of putting pieces of the puzzle
together.
There is light at the end of the tunnel, however, — all things considered, different pieces of the initially
disjoint puzzle will converge (in the long run!).
A note on pre-requisite preparation: students admitted to IUPUI Economics graduate program are
expected to have taken at least one year of calculus and a semester of linear algebra. Students coming
from other programs should be advised of the importance of this preparation for the course.

Textbooks:

- Simon, Carl and Lawrence Blume. Mathematics for Economists. W.W.Norton & Co. (I'll further
  refer to it as "S-B").

  Press (referred to as "D").

Occasionally, I'll be also referring to your E521 required textbook:
- Andreu Mas-Colell et al. Microeconomic Theory. Oxford Univ. Press (I'll refer to it as "MWG").
The following textbook
-William Novshek, Mathematics for Economists. Academic Press (further referred to as"N") is good for reviewing many topics in this class. In particular, it has very useful summaries on optimization methods studied, with examples and solutions. The book is placed on reserve in the Main Library for ES20 under my name.

An additional textbook I can recommend as a more rigorous exposition of much of the class material: Angel de la Fuente, Mathematical Methods and Models for Economists. Cambridge University Press. (further referred to as "AF").

Grading:
The course grade will be based on two midterms and a final exam as well as seven homework problem sets, with the following weights attached to the components: Homework Assignments 5%, Midterm Exams 25% each, Final Exam 45%

The 1st midterm exam will be on the Date TBA in early October. The 2nd midterm exam will be on the Date TBA early to mid-November.

In addition to the summary outline of the course below please see the attached Course Plan which gives a more detailed, lecture by lecture, outline.

COURSE OUTLINE AND READINGS

1. Mathematical Preliminaries
   This class presumes basic college-level knowledge of linear algebra and multivariate calculus. I will be reviewing some key concepts very briefly at the time they are needed in the course. As already mentioned, the discussion section will also focus on review material that I have selected as the most immediately necessary. Nevertheless, I strongly recommend that in addition, unless you have already done so, you undertake an independent math review during the first two weeks of classes. The sources and topics I recommend are outlined below.

   MWG: Appendices M-C-G; N: ch. 2, 3, 5. The chapters in the Novshek’s book have a particularly convenient summary of mathematical concepts and techniques that you will need to know right from the start. Another helpful review source is your S-B textbook. Specifically, I recommend the following chapter sections in this book for the math review: 2.5 - 2.7; 3.2, 3.5; 4.1, 4.2; 7.4, 7.5; 8.1, 8.4, 8.5; 9.2; 10.1 - 10.7; 11.1 - 11.4; 12.3 - 12.5; 14.4 - 14.7, 14.8; 15.1 -15.4; 27.1, 27.2; 30.1 - 30.3.

   I emphasize the following topics and concepts for your review:

   b. Functions of several variables. Continuity, differentiation, Taylor formula, Mean Value Theorem, chain rule for differentiation of composite functions of several variables, gradient vector, directional
derivative, total differential, level curves and surfaces, Jacobian matrix, Implicit Function Theorem, convex and concave functions.

c. Basic topological concepts.
Convergence of a sequence, open sets, closed sets, interior of a set, boundary, compact sets in Euclidean spaces.

I. Introduction

c. Unconstrained optimization for differentiable functions. First- and second-order conditions of extremum. S-B: ch.3, 17; D: ch.8; N: ch.5.
d. Homogeneous functions, Euler's Theorem. S-B: ch.20; N: ch.5

II. Constrained Optimization

a. Optimization subject to equality constraints. First order conditions of extremum—Lagrange's Principle (with the application of the Implicit Function Theorem). S-B: ch.15, 18, 19, 30; D: ch.2 4; N: ch. 5, 7.
b. Lagrange multipliers: economics applications. S-B: ch.19; D: ch.1, 2, 4.
c. Second order conditions of optimum subject to equality constraints. S-B: ch.19; D: ch.8.
d. Quasi-concave and quasi-convex functions. S-B: ch. 21; D: ch. 6, 8; N: ch. 5.

Mid-term Exam 1


g. Some related facts and concepts: Separation Theorems, decentralization, duality, Pareto optimum. D: ch.6.

III. Value Functions in Economics. Envelope Theorems

Reading: S-B: ch.19, 22; D, ch.5-8; MWG: Appendix M.L; N: ch.7, 8.

a. Maximum and minimum value functions in Economics. Theorem of the maximum.
b. First-order Envelope Theorems. Examples of their application to static and dynamic economic models: microeconomic identities; Bellman's equation and Euler equations.

IV. Introduction to Dynamic Optimization

a. Dynamic Programming Method. Solving finite- and infinite-horizon dynamic programming problems (deterministic and stochastic cases). Bellman's Equation: value function as a fixed point of a mapping: D: ch. 11; N: ch. 11; Sargent's: ch.1; Intriligator's: ch.13; MWG: Appendix M.N.

Mid-term Exam 2

c. Stability of dynamical systems and their linearization. Systems of first order linear difference equations. AF: ch.9.2, 10.1-10.3; N: ch.10.


Application to simple models of economic growth. S-B: ch.23-25; D: ch. 10; Intriligator\textsuperscript{7}.
ch.13.

\textsuperscript{7}See the list of recommended additional readings below.

Final Exam

Recommended Additional Readings

1. Additional sources on optimization.
   (Placed on reserve for this class, contains a helpful chapter on dynamic programming).
   (Chapter 1 on the applications of dynamic programming).

2. Advanced (optional) reading on some topics of this course. Matrices:
   Dynamic Programming:
   Optimal Control:
We are aware that certain items are required for syllabi which are not included in the attached syllabus for the matching course in Bloomington. When the course is taught and the IUPUI syllabus prepared, we will insert the required information as found below.

**Grading Scale**

<table>
<thead>
<tr>
<th>Letter grade</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>A+</td>
<td>97-100</td>
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<tr>
<td>A</td>
<td>93-96.99</td>
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<tr>
<td>A-</td>
<td>90-92.99</td>
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<td>C+</td>
<td>77-79.99</td>
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<tr>
<td>C</td>
<td>73-76.99</td>
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Attendance is required. Students who are ill should inform the instructor in advance that they will miss class except in cases of emergency. Absences lasting more than one class should be documented by a physician.

Late work will be penalized one letter grade.

Make-up exams will be offered only for illness or emergency documented by a physician or other reliable source.

**Americans with Disabilities Act**

If you need any special accommodations due to a disability, please contact Adaptive Educational Services at (317)-274-3241. The office is located in Joseph T. Taylor Hall (UC), Room 137.

**Computer Activity**

Students should be advised that, ultimately, you are responsible for activity on your computer accounts. Please be careful to log off public computers whenever the computer will be unattended and do not leave laptops unattended.

**Academic Misconduct** (from the Code of Student Rights, Responsibilities, and Conduct)

1. Cheating

A student must not use or attempt to use unauthorized assistance, materials, information, or study aids in any academic exercise, including, but not limited to, the following:

   a. A student must not use external assistance on any "in-class" or "take-home" examination, unless the instructor specifically has authorized external assistance. This prohibition includes, but is not limited to, the use of tutors, books, notes, and calculators.
b. A student must not use another person as a substitute in the taking of an examination or quiz.

c. A student must not steal examinations or other course materials.

d. A student must not allow others to conduct research or to prepare work for him or her without advance authorization from the instructor to whom the work is being submitted. Under this prohibition, a student must not make any unauthorized use of materials obtained from commercial term paper companies or from files of papers prepared by other persons.

e. A student must not collaborate with other persons on a particular project and submit a copy of a written report which is represented explicitly or implicitly as the student’s individual work.

f. A student must not use any unauthorized assistance in a laboratory, at a computer terminal, or on field work.

g. A student must not submit substantial portions of the same academic work for credit or honors more than once without permission of the instructor to whom the work is being submitted.

h. A student must not alter a grade or score in any way.

2. Fabrication

A student must not falsify or invent any information or data in an academic exercise including, but not limited to, records or reports, laboratory results, and citations to the sources of information.

3. Plagiarism

A student must not adopt or reproduce ideas, words, or statements of another person without appropriate acknowledgment. A student must give credit to the originality of others and acknowledge an indebtedness whenever he or she does any of the following:

a. Quotes another person’s actual words, either oral or written;

b. Paraphrases another person’s words, either oral or written;

c. Uses another person’s idea, opinion, or theory; or
d. Borrow facts, statistics, or other illustrative material, unless the information is common knowledge.

4. Interference

a. A student must not steal, change, destroy, or impede another student's work. Impeding another student's work includes, but is not limited to, the theft, defacement, or mutilation of resources so as to deprive others of the information they contain.

b. A student must not give or offer a bribe, promise favors, or make threats with the intention of affecting a grade or the evaluation of academic performance.

Faculty Action
If I learn that one of my students has committed an act of academic misconduct, I am required to hold an informal conference with the student. The conference should be prompt and private. If I conclude that the student is responsible for the misconduct, then I am authorized to impose an appropriate academic sanction (i.e., lower or failing grade on the assignment, assessing a lower or failing grade for the course).

After reporting the information to the Dean of Students, I will review the information to determine if additional sanctions should be applied. Sanctions are outlined in the Code of Student Rights, Responsibilities, and Conduct. This document appears on the web at the following address:

http://life.iupui.edu/rights/docs/CodeofConduct.pdf

Learning Objectives for E520

Linear Algebra
Students should

(1) acquire a basic understanding of systems of linear equations, including properties, types of solutions, and applications to practical problems. They should become familiar with the use of linear algebra to represent linear equation systems.
(2) learn basic linear-algebraic and vector operations (addition, multiplication, etc.), including their properties and the mathematical foundations thereof.

(3) become familiar with the graphical interpretation of vectors and vector operations, including their use to help solve problems that are partly graphical in nature.

(4) learn procedures, based on linear algebra, for solving systems of linear equations, including Gaussian elimination and Cramer's rule. They will need to learn more advanced linear-algebra operations that are required for these solution procedures, such as evaluation of determinants and matrix inversion. Finally, they should acquire a basic understanding of the mathematical foundations of these procedures and operations.

Functions and derivatives

Students should

(5) review the basic definitions and properties of functions of one and many variables. This review should emphasize the use of functions to provide mathematical representations of economic or related processes.

(6) become familiar with basic concepts used to understand and analyze functions, including sequences and limits, closed and open sets, and continuity.

(7) review the basic theory of derivatives of functions of one or many variables (partial derivatives), including definitions and applications. This review should emphasize the usefulness of derivatives as a tool for analyzing economic models.

(8) review and extend their knowledge of rules for differentiating various classes of functions, and for differentiating functions under special circumstances. They should acquire a basic understanding of the mathematical foundations for these rules, and they should practice their use extensively.

(9) become familiar with a few basic theorems in functional analysis, including the Intermediate Value Theorem, the Mean Value Theorem and the Implicit Function Theorem.
(10) learn procedures for implicit differentiation (applications of the IFT). They should acquire an understanding of the usefulness of implicit differentiation for analyzing the properties of economic models, including and especially for comparative statics analysis. They should also become familiar with the use of linear algebra as a tool for conducting analyses requiring implicit differentiation.

**Optimization Theory**

Students should

(11) review basic concepts in the theory of procedures for identifying maxima and/or minima of functions of one variable, including the first- and second-derivative tests and the Extreme Value Theorem. They should be exposed to examples that illustrate the practical applications of single-variable optimization theory, and they should practice identifying maxima and minima extensively.

(12) learn analogous concepts and procedures for multivariate optimization theory. These procedures should include the use of linear algebra for conducting second-derivative tests, and the related concepts of (semi)definite matrices and eigenvalues/vectors.

(13) explore the use of implicit differentiation and related procedures to analyze the results of optimization analyses, including the Envelope Theorem.

(14) become familiar with the theory and practice of constrained optimization, including the Lagrange multiplier method and the Kuhn-Tucker Theorem. They should become acquainted with the many economic applications of constrained optimization theory, particularly in demand theory.