

The Australian National University
School of Economics

ECON2127 – *Mathematics for Economists B*
ECON8014 – *Mathematical Techniques in Economics II*

Semester 2, 2009

Course description

The foundations of economic theory are based on mathematical models. Thus, a thorough understanding of the economic content of such models is not possible without a clear understanding of the mathematical concepts that underpin the modelling. The objective of this course is to prepare students for advanced courses in economic theory, such as the ones required of students enrolled in Honours, Masters and PhD programs, by discussing fundamental tools and concepts of mathematics on which these courses are based. The common thread in our approach will be the analysis of dynamical systems and of dynamic optimisation methods. On a more fundamental level, we will attempt to understand the corresponding techniques by analysing how and why they can be derived from certain basic assumptions using standard mathematical ideas and results.

Learning outcomes

In order to satisfy the requirements of this course, students will need to acquire a thorough understanding of the mathematical concepts introduced during the semester, and will need to demonstrate that they can apply the corresponding tools and ideas to unfamiliar problems. Note that just memorising the steps used to solve examples discussed in lecture and assigned tutorial problems will not lead to a clear understanding of these concepts, and will not prepare students to tackle the problems they will be required to solve in the exams.

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Lectures Monday, 2-3pm, Arndt Lecture Theatre 1
Thursday, 5-7pm, Arndt Lecture Theatre 1

The first lecture will take place on Thursday, 23 July, i.e., the Monday lecture of the first week is cancelled!

Tutorials Tutorial sign up will be via the ETA system – to sign up, follow the instructions given at <http://teaching.fec.anu.edu.au/eta.asp>. Tutorials will be scheduled on Monday or Tuesday. The first tutorial will take place during the second week of class. *One additional tutorial session will be scheduled on the Friday of the last week of the semester.*

Website <https://webct.anu.edu.au/login/>

All relevant course material will be posted on the WebCT site for ECON2127. Please follow the *Lecture Log* link on that site for a list of topics covered, associated readings, lecture slides and tutorial problems. The lecture log will be updated throughout the semester, and will also include information about exam times and locations. The lecture slides used in class will be posted on the Lecture Log before the respective lectures. Please print out a copy of these slides and bring them to class. Note that the slides are incomplete and do not contain graphs and various explanations, so you should not expect to be able to follow the lectures without attending class.

The tutorial problems corresponding to each week's lectures will be discussed in the tutorials during the following week. Even though you are not required to submit answers to the tutorial problems, you will only benefit from the tutorials if you seriously attempt to solve the problems *before* they are discussed in the tutorials. *I strongly recommend you to form study groups, and to meet each week to work together on the tutorial problems.* (Some studies have shown that working in study groups can significantly increase students' performance in mathematics courses!)

How to learn the material

You have only learned a new concept when you can demonstrate that you understand it well enough to apply it successfully to an unfamiliar problem. This is especially true of mathematics. Thus, in order to learn the material in this course, you will need to focus both on understanding the theory and on solving the corresponding problems. Working on the problems will show you when you have not yet fully understood the theory. (Yes, you have to actually work on the problems yourself, and not just copy down provided solutions and memorise them.) When doing so, *you should always think carefully about how the problems relate to the theory, and how the theory is applied in every particular example.*

Some additional suggestions that should improve your performance are to always do a preliminary reading of slides and references before lectures, work carefully through your slides, notes and references after the lectures, and work on tutorial problems before attending the tutorials. Do not get discouraged if things get difficult, and ask for help if you do not understand something. The lecturer and tutor are happy to answer your questions, provided that you keep up with the material, attend lectures, do the reading, and make a serious attempt at answering the tutorial problems.

Primary references

There is no single textbook that covers all the material we need at an appropriate level. We will therefore use various chapters from a number of different books as references. Most of these chapters will be available in electronic format from the university library electronic reserve. You are however expected to own a copy of the book by Blanchard, Devaney and Hall.

- Sheldon Axler, *Linear Algebra Done Right*, 2nd edition, Springer, 1997 (**AXL**)
- Kenneth A. Ross, *Elementary Analysis: The Theory of Calculus*, Springer, 1980 (**ROS**)
- P. Blanchard, R.L. Devaney, and G.R. Hall, *Differential Equations*, 3rd edition, Cengage Brooks/Cole, 2006 (**BDH**)
- Carl P. Simon and Lawrence Blume, *Mathematics for Economists*, W.W. Norton, 1994 (**SBL**)
- Charles M. Grinstead and J. Laurie Snell, *Introduction to Probability*, Second Revised Edition, American Mathematical Society, 1997 (**GSM**) [pdf version freely available at http://www.dartmouth.edu/~chance/teaching_aids/books_articles/probability_book/book.html]
- James R. Norris, *Markov Chains*, Cambridge University Press, 1997 (**NOR**)
- P.R. Kumar, *Dynamic Programming*, ch. 63 in *The Control Handbook*, W.S. Levine, ed. (**KUM**)
- Daniel Leonard and Ngo Van Long, *Optimal Control Theory and Static Optimization in Economics*, Cambridge University Press, 1992 (**LVL**)

Additional references and further readings

The following books are not required for the course, but are recommended as further reading for those interested in pursuing additional study in mathematics and mathematical economics. They should all be accessible for a student who performed well in the course.

- Ethan D. Bloch, *Proofs and Fundamentals: A First Course in Abstract Mathematics*, Birkhäuser, 2000
- Efe A. Ok, *Real Analysis with Economic Applications*, Princeton University Press, 2007
- Carl D. Meyer, *Matrix Analysis and Applied Linear Algebra*, SIAM, 2000

- Rangarajan K. Sundaram, *A First Course in Optimization Theory*, Cambridge University Press, 1996 (**SUN**)
- John Stachurski, *Economic Dynamics: Theory and Computation*, MIT Press, 2009
- M.W. Hirsch, S. Smale, and R.L. Devaney, *Differential Equations, Dynamical Systems, and an Introduction to Chaos*, Elsevier/Academic Press, 2004

Course outline

1. Preliminaries: Polynomials and sequences (*AXL ch.4; ROS ch.2*)
 2. Difference equations (*BDH ch.8*)
 3. Euclidean spaces (*SBL chs.10-12*)
 4. Markov chains (*GSN ch.11; NOR ch.1*)
 5. Dynamic programming (*KUM*; optional: *SUN ch.12*)
- Midterm exam (week 8)**
6. Review of integration (*Notes*)
 7. Differential equations (*BDH chs.1-3, 5*)
 8. Optimal control theory (*LVL ch.4*)

Assessment Midterm Exam (40%)
 Final Exam (60%)

The midterm exam will be scheduled in week 8 of the semester, and will take place on Thursday, during lecture hours. It will only be redeemable if the class mean for the midterm is less than 45% of the highest attainable score, in which case the midterm weight will be transferred to the final exam for students who score higher on the final exam. In any case, whether the midterm is redeemable or not, the final exam will cover all topics discussed during the semester.

Students who achieve an overall mark for the course between 45% and 49% will have the option of taking a supplementary exam. The date, time, and location of this exam will be announced on the School of Economics website later in the semester. A student who passes the supplementary exam will be regarded as having passed the course with a result of PS or 50%. A student who fails the supplementary exam will be regarded as having failed the course with a result of N plus the original mark.

General information and codes of conduct

It is your responsibility to familiarise yourself with the various University policies, procedures, and rules. For more information please refer to the following URLs and the additional links therein:

http://cbe.anu.edu.au/schools/eco/General_information.html

<http://academichonesty.anu.edu.au/>