Economics 242: Numerical Methods for Macroeconomists*

Jeremy Greenwood

January 2017

Time and Location: Mondays and Wednesdays, 2:00-3:30pm, McNeil 410
Grading: Three take-home exams.
Textbook: Greenwood, Jeremy. *Numerical Methods for Macroeconomists*. Available as a Study.Net TEXTPAK.
(Background–optional): Gilat, Amos. *MATLAB: An Introduction with Applications*, 5th Edition, 2015.
Programming Language: MATLAB (from Mathworks).

> There cannot be a language more universal and more simple, more free from errors and obscurities,....more worthy to express the invariable relations of natural things than mathematics. It interprets all phenomena by the same language, as if to attest the unity and simplicity of the plan of the universe, and to make still more evident that unchangeable order which presides over all natural causes. Joseph Fourier, *Analytical Theory of Heat*, 1822

> Many people have a passionate hatred of abstraction, chiefly, I think because of its intellectual difficulty; but as they do not wish to give this reason they invent all sorts of others that sound grand. They say that all reality is concrete, and that in making abstractions we are leaving out the essential. They say that all abstraction is falsification, and that as soon as you have left out any aspect of something actual you have exposed yourself to the risk of fallacy in arguing from its remaining aspects alone. Those who argue in this way are in fact concerned with matters quite other than those that concern science. Bertrand Russell, *The Scientific Outlook*, 1931.

1 Description

This course will study some of the numerical methods that are used in modern macroeconomics. The class will learn how to solve dynamic programming problems, nonlinear equations, difference equations, interpolate functions, smooth

---

*Reading list may be subjected to change.

data, and conduct Monte Carlo simulations on the computer. This will be done while studying economic problems, such as the determination of labor supply, economic growth and business cycle analysis. Calculus is an *integral* part of the course and some elementary probability theory will be drawn upon. The MATLAB programming language will be used.

TA: Pengfei Han — *Email*: pengfeih@sas.upenn.edu; *Office hours*: Fridays: 4:00-6:00 p.m (please email the day before), *Rm*: McNeil 537.

Departmental policies regarding courses are available here:
  http://www.econ.upenn.edu/undergraduate/policies

2 Grading

The course will be evaluated on the basis of three take-home exams. The third take-home exam will be handed out on Monday April 24th and is due by midnight Sunday April 30th. *No* collaboration with *any* person (either in or out of the class) is allowed for the exams. You are also *not* allowed to use programs from the web. The exams will be graded on a mixture of the skills you show in economics, mathematics and programming. More than enough time is given for each exam. A 10% penality is assessed for each day an exam is late.

Bonus Points. You can earn bonus points by listing all errors in economic logic and mathematics that you find in the class notes–keep such errors to yourself.

3 Nonlinear Equations

3.1 Application, Labor-leisure choice

- Jeremy Greenwood and Guillaume Vandenbroucke (2008). "Hours Worked (Long-Run Trends)." *The New Palgrave Dictionary of Economics*, v. 4, 2nd edition, edited by Lawrence E. Blume and Steven N. Durlauf (New York, N.Y.: Palgrave Macmillan), 75-81.

- Edward C Prescott (2004). "Why Do Americans Work So Much More Than Europeans?" *Federal Reserve Bank of Minneapolis Quarterly Review*, Vol. 28, No. 1: 2–13.

3.2 Methods

- Bisection Method

- Newtons Method

4 Deterministic Dynamics

4.1 Application, the neoclassical growth model

- Gary D. Hansen and Edward C. Prescott, "Malthus to Solow," *American Economic Review*, 92 (September 2002): 1205-17.

4.2 Methods

- Extended Path Method

- Multiple Shooting

5 Stochastic Dynamics

5.1 Application, business cycles

- Edward C. Prescott (1986). "Theory ahead of business cycle measurement." *Federal Reserve Bank of Minneapolis Quarterly Review*, 9-22.

- Jeremy Greenwood, Zvi Hercowitz and Gregory W. Huffman (1988). "Investment, Capacity Utilization, and the Real Business Cycle," *American Economic Review v.* 78: 402-417.

5.2 Methods

- Cubic Smoothing Splines

- Linearization Techniques

- Numerical Differentiation

- Monte Carlo Simulation

  - Random Number Generation

- Dynamic Programming

  - Discrete State Space Dynamic Programming
  - Markov Chains