

MATH 23b, SPRING 2002  
THEORETICAL LINEAR ALGEBRA AND MULTIVARIABLE  
CALCULUS II

**Course Head:** John D. Boller, SC 320, 495-5377, [bo1ler@math.harvard.edu](mailto:bo1ler@math.harvard.edu)

**Course Meetings:** MWF from 11-12 in Emerson 210. Additional weekly problems sessions will be led by the course assistant(s), and you are encouraged to visit me in my office hours, TBA.

**Prerequisites:** Math 23a, or a good theoretical background in linear algebra and the topology of  $\mathbb{R}^n$ .

**Topics:** (For Math 23a and 23b) The Real Numbers, the structure of Euclidean space, Finite and Infinite-Dimensional Linear Algebra including eigenvalues and eigenvectors of matrices and systems of linear differential equations, Functions of Several Real Variables including differentiation and integration of such, the Classical Theorems of Vector Analysis, etc.

**Goals:** Besides learning the content described above and in the more detailed list below, it is one of the main goals of the course that the student learn to read, understand, and construct mathematical proofs and learn the nature of mathematical argument.

**Exams and Grades:** There will be one midterm exam (20%) and one final exam (30%) and several short in-class quizzes (counted as a portion of the homework grade), but by far the greatest portion of your work (in terms of time-commitment and grade) will be devoted to homework (50%).

**Texts:** There are two required texts, “Linear Algebra” by Georgi E. Shilov and “Advanced Calculus of Several Variables” by C. H. Edwards, Jr. which are available at the COOP. These will form the basis of our investigations, but there will also be an extensive bibliography of other works put on reserve in Cabot Library and the Birkhoff Mathematics Library. Please see the bibliography on a separate sheet.

Learning to read mathematics texts is an integral part of the course. Some authors have clearer expositions of certain topics, and some arguments make more sense to different readers, and you are encouraged to explore topics presented in different manners. If you find an author you like, you are encouraged to follow his or her development of the material, but the course as a whole will follow the texts listed above.

**Homework:** Homework problems/proofs are the essential part of this course. You will spend more time on homework than on any other aspect of the course, and it is weighted accordingly.

Your homework is due at 5 P. M. on the due date in the Mathematics Department mailboxes outside SC 325. Your course assistant will return your corrected homework to you within the following week. He/she will also put homework solutions on reserve at Cabot Library, and we expect to have solutions available on the website.

You are strongly encouraged to keep up to date with the homework, otherwise you will find that you do not get all you should out of the classes, and it will become increasingly difficult to catch up again.

You are encouraged to collaborate on homework problems! Mathematics is not a go-it-alone subject, and you should work together in groups, consult with the course assistant(s), and meet with me about any homework problem or any aspect of the course. The only requirement is that, after collaboration to determine a good line of argument, you write up the solutions *yourself*. This cannot be emphasized enough as the shortest route to success in mathematics is to develop the ability not just to do it but to communicate it, and the best way to develop this skill is to write proofs and work problems

**Approximate Syllabus:** In the spring semester, we will chapters 2–5 of Edwards and chapters 6, 7, and 10 from Shilov.

Edwards	Ch. 2	Multivariable Differential Calculus
Edwards	Ch. 3	Successive Approximation and Implicit Functions
Edwards	Ch. 4	Multiple Integrals
Edwards	Ch. 5	Line and Surface Integrals; Differential Forms and Stokes' Theorem
Shilov	Ch. 6	The Canonical Form of the Matrix of Linear Operator
Shilov	Ch. 7	Bilinear and Quadratic Forms
Shilov	Ch. 10	Quadratic Forms in Euclidean and Unitary Spaces