

# MATH-6600 METHODS OF APPLIED MATHEMATICS

Fall 2009

Professor Kapila

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Homepage

<http://eaton.math.rpi.edu/faculty/Kapila/home.html>

## Class Hours

T F 12:00 - 1:50 pm, Low 3116

## Office Hours

T R, 3:30 - 5:00 pm, 319 Amos Eaton Bldg.

My door is always open; feel free to stop in any time. I shall be happy to help you if I am not otherwise engaged.

## Topics

- Introduction and review (2 lectures)
- Linear vector spaces (3 lectures)
- Eigenvalues and eigenvectors in discrete systems (3 lectures)
- Eigenvalues and eigenfunctions in continuous systems (14 lectures)
  - Sturm-Liouville theory, orthogonal expansions and Fourier series
  - Green's functions
  - Integral equations
- Calculus of variations (4 lectures)

Applications will be drawn from equilibrium and dynamic phenomena in science and engineering.

The time allotted to each topic is tentative and we may modify the schedule if needed as the course proceeds.

## Pre-requisites

Familiarity with differential equations (ordinary and partial) at the level of MATH-2400, and with elementary linear algebra and multivariable calculus at the level of MATH-2010 is required. Ability to use Matlab and a computer algebra system such as Maple will be helpful.

## Learning Outcomes

The central message that the course intends to convey is twofold: (i) that a linear vector space is a convenient and unifying framework within which to study linear problems, and (ii) that eigenvalues and eigenvectors are the primary tools for constructing solutions to linear problems. Specifically, successful completion of the course should enable you to

- identify properties of an abstract linear vector space,
- identify conditions under which a problem has no solution, a unique solution, or many solutions,
- use eigenvalues and eigenvectors to construct exact or approximate solutions to linear problems involving discrete, differential and integral operators,
- demonstrate the sense in which an approximate solution is close to the exact solution, and
- present written solutions to mathematical problems in a clear, concise and coherent fashion.

### Homeworks

Approximately eight homeworks will be assigned at regular intervals, marked and returned. The problems will require pencil-and-paper mostly, with some use of Matlab and Maple. Your score in the homework will depend on mathematical correctness (80%) and clarity of presentation (20%). Posted solutions will be a good template for writing your own solutions. Writing solutions in LaTeX is strongly recommended.

### Examinations

Two midterm tests and a comprehensive final examination are planned. Approximate dates of the tests are October 9 and November 20. Syllabus for each test, and any change in a test date, will be announced well in advance of each test.

### Grade

The course grade will be determined by performance in the homework (40%), the two midterm tests (15% each) and a final examination (30%).

The numerical scores will be converted at the end of the term into letter grades according to the following scale:

$A(93 - 100)$ ,  $A^-(89 - 92)$   
 $B^+(85 - 88)$ ,  $B(81 - 84)$ ,  $B^-(77 - 80)$   
 $C^+(72 - 76)$ ,  $C(68 - 71)$ ,  $C^-(64 - 67)$   
 $D^+(59 - 63)$ ,  $D(50 - 58)$  (not available to graduate students)  
 $F(0 - 49)$

Thus your grade is based entirely on your own performance; class average does not play a role, nor does your need to get a certain grade to stay in school or remain on financial aid enter the picture.

Appealing Grades If you are not satisfied with your grade in an assignment or test, feel free to discuss it with me. If the matter is unresolved, you may appeal to the department Head.

### Academic Integrity

Student-teacher relationships are built on trust. For example, students must trust that teachers have made appropriate decisions about the structure and content of the courses they teach, and teachers must trust that the assignments that students turn in are their own. Acts, which violate this trust, undermine the educational process. The Rensselaer Handbook of Student Rights and Responsibilities defines various forms of Academic Dishonesty and you should make yourself familiar with these.

Collaborative learning is encouraged. Feel free to work with your peers; this may be done while reviewing the texts, classnotes, or attempting homework assignments. However, **each student must write his or her own homework solutions**. Collaboration does not extend to copying someone else's attempt and handing it in as your own. The first time this occurs, you will receive a grade of zero for that assignment. If it happens again, you will be reported to the Dean of Students.

Collaborating on an examination is not permitted. If I suspect cheating, I shall ask for an explanation. If your explanation is unsatisfactory, you will be given a grade of zero and reported to the Dean of students.

### Text

The subject matter of the course is classical and is covered in numerous books. No specific text has been assigned, but some optional texts are available in the book store and others are put on reserve in the library. On the first day of class we shall have a brief discussion about the texts that should allow you to make a reasonable choice.

*Optional texts available in the book store:*

Keener: Principles of Applied Mathematics, 2nd ed., Perseus

Hildebrand: Methods of Applied Mathematics, Dover

Weinstock: Calculus of Variations, Dover

Herron: PDEs in Fluid Dynamics, Cambridge

Porter: Integral Equations, Cambridge

*Items on reserve in the library:*

Keener: Principles of Applied Mathematics, 2nd ed

Strang: Introduction to Applied Mathematics

Courant & Hilbert: Methods of Mathematical Physics, vol I

Weinstock: Calculus of Variations

*Other selected references:*

Dettman: Mathematical Methods in Physics and Engineering, Dover

Friedman: Principles and Techniques of Applied Mathematics, Dover