Selected Topics in Numerical Analysis

Applied and Comp Math 929

Section: G100

Term: 2012 Spring

Instructor: Professor Nilima Nigam
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Discussion Topics: This course is a mathematical introduction to appoximation theory, with a focus on spectral
methods. The emphasis will be on both the analysis and the implementation of these methods. At the heart of both these methods is the same idea- the approximation of the solution by a (truncated) series expansion in terms of trial functions . Spectral methods (this course) use basis functions which are infinitely differentiable global functions, while finite element methods
(APMA 990) use localized (typically polynomial) trial functions. We introduce these ideas systematically.

Topics covered
We will begin the term by establishing some useful approximation results in Hilbert spaces, which will help us eventually describe rates of convergence of our approximations.

We will examine the Galerkin and collocation spectral methods (the former are easier to analyse,
the latter are easier to use) for ordinary and partial differential equations. We shall use trigonometric bases, as well as orthogonal polynomials.

For both sets of methods, we study issues of stability, accuracy and convergence. Implementation
issues will be investigated via examples, with the students expected to implement substantial examples by the end of the term. Youll gain first-hand experience in using and analysing these methods. Applications include eigenvalue problems, simple linear 2nd order PDE, Schr¨odingers equation, hydrodynamic stability, and some nonlinear boundary value problems.

Grading: There will be 6 assignments, a project, and a final examination in the course.

Required Texts:

Recommended Texts: There are no prescribed textbooks for this course, though we will draw on material from many
texts:
- Spectral methods in Matlab by L.N. Trefethen,
- Spectral methods in fluid dynamics by Canuto, Hussaini, Quarteroni and Zang,
- Spectral methodd for time-dependent problems by Hesthaven, Gottlieb and Gottlieb.

Materials/Supplies:

Prerequisite/Corequisite: A good (advanced undergraduate/beginning graduate) background in linear algebra, partial differential
equations and numerical analysis/scientific computing. Coding will be done in Matlab, though youre welcome to use whichever programming language you like. Part of the assessment will be based on the design and implementation of an example to ChebFun, a Matlab suite of spectral method software. http://www2.maths.ox.ac.uk/chebfun/examples/

Notes: Academic integrity

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This is an obvious statement: All work you hand in must be your own. You may work with each other while learning, and indeed this is encouraged. However, I am interested in YOUR academic progress. Therefore, when you hand in any material, it must be your effort. If you are
having trouble with assignments, come and see me so we can go over material you are stuck on.

You must cite any references, websites and other sources you use; quoting anyone without attribution
is considered plagiarism. Copying pieces of code without attribution is also plagiarism. There are NO exceptional circumstances in this regard. It is better not to hand in an assignment,
than to cheat.

I have zero-tolerance for academic dishonesty. I may, at my discretion, perform MOSS tests on work you hand in. You should also familiarize yourself with SFUs academic dishonesty policies.

THE INSTRUCTOR RESERVES
THE RIGHT TO CHANGE ANY OF THE ABOVE INFORMATION.

Students should be aware that they have certain rights to confidentiality concerning the return of course papers and the posting of marks. Please pay careful attention to the options discussed in class at the beginning of the semester.