MATH 522

Wavelets

Fall 2008

Meeting times (lectures): TTh 9:30 - 10:45 AM at **LeConte (LC) 303B**.

Instructor: Dr**. Peter G. Binev** http://www.math.sc.edu/~binev/

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Office hours: TTh 10:50 - 12:00 AM at LeConte 425/Sumwalt 206, or by appointment.

Text: Ripples in Mathematics. The Discrete Wavelet Transform by Arne Jensen and Anders la Cour-Harbo, Springer Verlag 2001. For some topics the students will receive handouts which will compliment the material in the book.

Other books: There are several books on wavelets and some of them could be found through the web-links below. A classical book in the area is Ten Lectures on Wavelets by Ingrid Daubechies, SIAM, 1992. We shall use also materials from several other books. Here are two of them: An Introduction to Wavelets by Charles Chui, Academic Press, 1992; and Wavelets and Subband Coding by Martin Vetterli and Jelena Kovačević, Prentice Hall, 1995.

Description: The course will give an introduction to Fourier transform, wavelets and multiresolution analysis. While the basic theory will be briefly introduced, the emphasis will be given to the description of the general ideas and the numerical procedures. In addition to the theoretical material some numerical implementations in MATLAB will be considered on an elementary level. Topics include (not necessarily in the order they will be considered):

- signals and filters;
- lifting scheme;
- Haar wavelets;
- Daubechies wavelets;
- inner product spaces and orthogonalization;
- Fourier transform and Fast Fourier Transform;
- multiresolution analysis;
- numerical implementation of the wavelet transform.

Prerequisites: The students should be familiar with vector spaces and complex numbers and should have experience with at least one upper level (500) mathematical course. Formally, the prerequisites are MATH 544 or 526**.** The students who have none of these courses should contact the instructor to seek consent.

Learning Outcomes: At the end of this course students will master concepts of multiresolution analysis, digital filters, and wavelets. They will be able to interpret the outcomes of digital wavelet transform (DWT) and to design basic numerical algorithms for DWT in Matlab.

Cell Phones: All cell phones ***must be turned off*** during the class.

Homework: A few homework problems will be assigned each class. Be sure to do these problems before the next class. Some solutions will be collected.

Projects: Every student has to choose a project motivated by the computational or theoretical problems discussed in the course. Several possible themes for the projects will be suggested by the instructor in the length of the course. The last few weeks of the class will be devoted to discussions of the projects and MATLAB implementations of some of the numerical algorithms. The project in a form of a poster or short paper should be submitted before **December 2, 2008**.

Graduate Projects: The graduate students attending the class should work on larger projects which contain two parts, theoretical and computational. They should also prepare a 15-minute oral presentation.

Discussions: The homework and the projects will be discussed in class. The participation in the discussions is important part of the course.

Midterm Exam: There will be a midterm exam in a form of a test. The tentative date of the exam is **September 18**, 2008. The problems on the test will be similar to the ones from the homework and the discussions in class.

Final Exam: The final exam in a form of a test will take place on **Monday, December 8 at 2:00 PM**.

Grading: The final grade will be determined from the homework and the participation in the discussions (25%), the midterm exam (20%), the project (25%), and the final (30%).

Academic Dishonesty: Cheating and plagiarism will not be allowed. The University of South Carolina has clearly articulated its policy governing academic integrity and students are encouraged to carefully review the policy on the Honor Code in the Carolina Community (see http://www.jour.sc.edu/pages/academicintegrity/policies.html).

ADA: If you have special needs as addressed by the Americans with Disabilities Act and need any assistance, please notify the instructor immediately.

Web Materials: There is plenty of information about wavelets on the web. Here is a short list of some (mostly undergraduate) courses on wavelets:
http://math.gmu.edu/~dwalnut/teach/Math672/672f03.html
http://www.cs.kuleuven.be/~ade/WWW/WAVE/
http://ocw.mit.edu/OcwWeb/Mathematics/18-327Wavelets--Filter-Banks-and-ApplicationsSpring2003/CourseHome/
http://www.engmath.dal.ca/courses/engm6610/notes/notes.html
http://www.amara.com/current/wavebiblio.html
http://www.ifp.uiuc.edu/~minhdo/teaching/wavelets.html
http://faculty.gvsu.edu/aboufade/web/students.htm
http://www.waveletsandsubbandcoding.org/Repository/VetterliKovacevic95_Manuscript.pdf