Math 684/5, Harmonic Analysis and Wavelets
Fall 2013 and Winter 2014

Class Time:	MWF 3-3:50p.m. in 210 Deady Hall
Instructor:	Dr. Marcin Bownik
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Background and goals. The course is an introduction to harmonic analysis on Euclidean spaces (first term) and wavelets (second term). In the first term I am planning to introduce students to core techniques of harmonic analysis such as:

(1) Fourier transform, Schwartz class, and tempered distributions,
(2) Marcinkiewicz and Riesz-Thorin Interpolation Theorems,
(3) Hardy-Littlewood Maximal Function,
(4) Hilbert transform, Riesz transforms, and Calderón-Zygmund singular operators,
(5) Littlewood-Paley theory and multiplier theorems,
(6) Hardy H^p spaces, atomic decompositions,
(7) H^1-BMO duality, John-Nirenberg theorem,
(8) Weighted inequalities and Muckenhoupt A_p weights,
(9) $T1$ theorem of David-Journe.

The last three topics will be covered very lightly due to time constraints. In the second term I am planning to cover constructions of wavelet bases and their applications in the study of function spaces:

(1) Multiresolution analysis,
(2) Construction of 1D Meyer and Daubechies wavelets,
(3) Higher dimensional constructions of wavelets,
(4) Besov and Triebel-Lizorkin spaces,
(5) Characterization of function spaces by wavelet coefficients.

Prerequisites. Math 616/7/8 Real Analysis.

Grading. There will be a couple of homework assignments each term. There will be no exams. In Winter term each student will give an oral presentation on a topic of his/her choice related to this course.

Textbooks. I will not follow any particular book for a longer period of time. Instead, I will use parts of the following books: [3, 4, 5, 6, 8, 11, 12] in Fall and [1, 2, 7, 9, 10, 13] in Winter.

References

[1] M. Bownik, *Anisotropic Hardy spaces and wavelets*, Mem. Amer. Math. Soc. **164** (2003), no. 781, vi+122 pp.

[2] I. Daubechies, *Ten lectures on wavelets*, SIAM, Philadelphia, PA, 1992.

[3] J. Duoandikoetxea, *Fourier analysis*, Graduate Studies in Mathematics, 29. American Mathematical Society, Providence, RI, 2001.

[4] J. García-Cuerva, J. Rubio de Francia, *Weighted norm inequalities and related topics*, North-Holland Mathematics Studies, 116. North-Holland Publishing Co., Amsterdam, 1985.

[5] L. Grafakos, *Classical Fourier analysis*. Second edition. Graduate Texts in Mathematics, 249. Springer, New York, 2008.

[6] L. Grafakos, *Modern Fourier analysis*. Second edition. Graduate Texts in Mathematics, 250. Springer, New York, 2009.

[7] E. Hernández, G. Weiss, *A first course on wavelets*, CRC Press, 1996.

[8] Y. Katznelson, *An introduction to harmonic analysis*, Cambridge Univ. Press, 2004.

[9] Y. Meyer, *Wavelets and operators*, Cambridge Univ. Press, 1992.

[10] M. Pinsky, *Introduction to Fourier Analysis and Wavelets*, Brooks/Cole 2002.

[11] E. Stein, *Harmonic analysis: Real-variable Methods, Orthogonality, and Oscillatory Integrals*, Princeton Univ. Press, 1993.

[12] E. Stein, G. Weiss, *Introduction to Fourier analysis on Euclidean spaces*, Princeton Mathematical Series, No. 32. Princeton University Press, 1971.

[13] P. Wojtaszczyk, *A Mathematical Introduction to Wavelets*, Cambridge Univ. Press, 1997.