08/29/2019

Information Sheet
MATH464 Fall 2019
Transform Methods for Scientists and Engineers

Instructor: Radu Balan
Lectures: Tuesday, Thursday, 3:30pm-4:45pm, in MTH ~~0303~~ 0402.
Office Hours: Thursdays, 5:00pm-6:15pm; in MTH 2308
Contact Information: Email **rvbalan@math.umd.edu** , Math Building, Room 2308, x55492 / CSCAMM , Room 4131 , x51217

MATH 464 is an introduction to transform methods used in science and engineering applications. Lectures cover topics including: Fourier transform, Fourier series, Laplace transform. Poisson summation, and sampling. Optional Topics: Distributions and operational calculus, PDEs, Wavelet transform, Radon transform. Applications: Imaging, Speech Processing, PDEs of Mathematical Physics, Communications, Inverse Problems.
Prerequisite: MATH 246
Recommended Textbook: *A First Course in Fourier Analysis*, David W. Kammler, Cambridge University Press 2007
Additional Reading Materials:
Introduction to the Mathematics of Medical Imaging, Charles L. Epstein, SIAM 2008
Analysis, Elliott H. Lieb and Michael Loss, AMS 2001.
Harmonic Analysis and Applications, John J. Benedetto, CRC Press 1996

Grading. There will be one mid-term exam (100 points – includes Fourier analysis and Sampling theory), homework assignments (for a total of 100 points), and a final exam (200 points - cumulative). Students are allowed one single-sided formula sheet during the mid-term, and one double-sided formula sheet during the final.
Exam dates: Mid-term (tentatively) on Tuesday, October 15, 3:30pm-4:45pm. Final exam: Tuesday, December 17, 10:30am-12:30pm.
Review Sessions. There will be two optional review sessions before exams.
Homeworks. Homework must be submitted on the date assigned. Homework must be prepared without consulting any other person. You may however consult any written reference. In this case you should cite the reference. Results taken from the reference should be (re)stated to the notation used in the course. Explanations should be given in complete English sentences. Written work must be legible and clear.
Academic Integrity. You are expected to adhere to the University's Code of Academic Integrity, available on the University's web site, at: https://www.shc.umd.edu
Students with Disabilities: If you have a documented disability and wish to discuss academic accommodations with me, please contact me as soon as possible.
Religious Observances. If you will be absent from class because of religious observances, please submit a list of the dates of your absences within a couple of days.

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Syllabus
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Recommended Textbook: *A First Course in Fourier Analysis*, David W. Kammler, Cambridge University Press 2007

1. Introduction
    a. Sets, Functions, Continuity, Integrability
    b. Motivating Examples: Heat Equation, Image Processing

2. Fourier analysis
    a. Definition for L^1 functions
    b. Plancherel Theorem. Extension to L^2
    c. Inversion formulae
    d. Algebraic and Analytic properties of Fourier transform
    e. Fourier Series
    f. Pointwise convergence results
    g. Fourier Transform for other spaces of functions.

3. Sampling Theory
    a. Bandlimited functions
    b. The Shannon-Kotel'nikov-Whittaker sampling formula
    c. Poisson Summation Formula
    d. Application: A/D Convertors

4. Generalized Functions (Tempered Distributions)
    a. Test functions. Properties
    b. Tempered Distributions: convolution, products
    c. Tempered distributions: Fourier Transform and Differential Calculus

5. Applications to Partial Differential Equations
    a. Heat equation
    b. Wave equation

6. Windowed Fourier Transform
    a. Local information content: time and frequency localization
    b. Spectrograms and Short-Time Fourier Transforms
    c. Applications to Audio Signal Processing

7. Continuous Wavelet Transform
    a. Analysis and Synthesis Formulae
    b. Scalograms and examples