King Abdullah University of Science and Technology KAUST

Mathematical methods for seismic Imaging - Course Syllabus

Course Number: ErSE360

Course Title: Mathematical methods for seismic Imaging

Academic Semester:	Spring	**Academic Year:**	2015/ 2016
Semester Start Date:	Jan 24, 2016	**Semester End Date:**	May 19, 2016

Class Schedule: Tuesday

Classroom Number:

Instructor(s) Name(s): Tariq Alkhalifah
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COURSE DESCRIPTION FROM PROGRAM GUIDE

This course will be devoted to mathematical algorithms and methods for seismic imaging. We will learn how to extrapolate wavefields efficiently and accurately. Distribution, sampling, and representation theorems are among the mathematical concepts covered in the course. We will also look at scattering and inverse scattering theory and relate them to the imaging process. To simplify the understanding of these concepts, we will look at them, as well, under the high frequency asymptotic assumption as we focus on solutions to the eikonal and dynamic ray tracing problems.

COMPREHENSIVE COURSE DESCRIPTION

This course will be devoted to mathematical algorithms and methods for seismic imaging. We will first focus on high frequency asymptotic methods looking into kinematic and dynamic ray tracing. We will learn how to extrapolate wavefields efficiently and accurately. This includes looking at finite-difference, spectral, pseudo-spectral methods among other methods. We will look into the stable and accurate implementation of the imaging condition and its variations for velocity analysis. We will also look at numerical methods for inverting for the velocity model using seismic imaging.

TENTATIVE SCHEDULE:

Week 1 (Jan. 27th): The components of seismic imaging and its history.

Week 2 (Feb. 2nd): Distribution Theory (MMSI, Appendix A)

Week 3 (Feb. 9th): The wave equation (a hyperbolic PDE)

Week 4 (Feb. 16th): Solving the wave equation: Green's functions (MMSI, 28-41, Appendix B)

Week 5 (Feb. 23rd): High-frequency asymptotics (MMSI, 5-12, 99-103, 113-116, Appendix E 435-438)

Week 6 (Mar. 1st): Numerical solutions of the eikonal equation (notes 2)

Week 7 (Mar. 8th): Ray tracing (notes 3)

Week 8 (Mar 15th): Dynamic ray tracing: amplitudes (MMSI, Appendix E 438-457, MMSI, 281, notes 4)

Week 9 (Mar. 22nd): The theory of Data mapping (MMSI, 311-330)

Week 10 (Mar. 29th): Project development

Week 9 (Apr. 5th): Spring break

Week 10 (Apr. 12th): Fast Fourier methods and sampling theory

Week 11 (Apr, 19th): Wavefield extrapolation (space/time)

Week 12 (Apr. 26th): Spectral Methods (notes 7)

Week 13 (May 3rd): Various topics, Project presentaions

Week 14 (May 10th): Project presentaions

Week 15 (May 14th): Project report submission

GOALS AND OBJECTIVES

Learn the mathematical tools needed for seismic imaging. This includes the numerical methods involved, and in depth analysis of the wave equation solutions.

REQUIRED KNOWLEDGE

ErSE260 and some C programming.

REFERENCE TEXTS

Mathematics of Multidimensional Seismic Imaging, Migration, and Inversion, N. Bleistein, J. K. Cohen, and John W. Jr. Stockwell (offered by the library and electronically).

Imaging the Earth Interior by Jon Claerbout (online)

METHOD OF EVALUATION

Graded content
The grade will be divided equally between 8 Homework assignments and a final project. The grading of the final project will be on the reproducible report that includes codes and text.

COURSE REQUIREMENTS

Assignments

8 Homework assignments and a final project.

Course Policies

Late submission penelty, 20% of the grade

Additional Information

NOTE
The instructor reserves the right to make changes to this syllabus as necessary.