CE 397

Wave Propagation

Unique Number: 15695

Fall Semester 2006

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Meeting times: MWF 10:00-11:00am
Meeting place: ECJ 5.416

COURSE OBJECTIVES

This is an introductory course in the theory and modeling of propagating waves. The primary objective is to expose the physics and mathematics of waves that arise primarily in elastic solids, following classical lines. A secondary objective, to be realized mostly via mini projects assigned throughout the semester, focuses on aspects of the numerical modeling of propagating waves.

COURSE OVERVIEW

The propagation of disturbances in wave-supporting media is by now a well-established field of physics and applied mechanics, owing mostly to the advances made during the 19th and 20th centuries. Depending on the character of the propagating disturbance, waves are often classified as elastic, acoustic, or electromagnetic; they are further categorized according to the medium's phase (gas, liquid, or solid), and/or the subregion within which the arise (body, surface, or material interface). Of the many types of waves that are the subject of modern physics and mechanics, this course will concentrate on a subset of elastic and acoustic waves, and their interaction with structures. The presentation will be incremental, starting with waves that could be idealized as disturbances propagating in one dimension, to waves arising and propagating in three dimensions.

Recent advances in sensor technologies and algorithmic processing aim at harnessing the information provided by propagating disturbances for purposes of condition assessment and/or system parameter identification. Part of the intent of the course is to provide the theoretical basis for better understanding the underlying physics implicated in contemporary and future assessment technologies.

A tentative list of topics to be covered includes:

- Scalar waves in one dimension (compressional waves in rods, transverse waves in a string, wave equation and its solution, traveling

and standing waves, reflection at boundaries, flexural waves in beams, dispersion, phase and group velocity, etc).
- Scalar waves in two dimensions (waves in a membrane, acoustic waves)
- Vector waves in two and three dimensions (elastic waves in solids (including soils), waves in infinite media, waves in semi-infinite media, P, SH, SV, surface waves (Rayleigh and Love), Stoneley waves, reflection and transmission at interfaces, solutions to classical problems, etc)
- Special topics (numerical modeling, radiation conditions, scattering and radiation from obstacles, fluid-solid interaction, etc)

COURSE REFERENCES

No textbook is required. Books on the subject include:

"Introduction to elastic wave propagation," A. Bedford and D. S. Drumheller, John Wiley & Sons, 1996

"Wave propagation in elastic solids," J. D. Achenbach, Elsevier Science Publishers, 1984

"Mechanics of continua and wave dynamics," L.M. Brekhovshikh and V. Goncharov, Springer Verlag, 1994

"Wave motion in elastic solids," K. E. Graff, Dover Publications, Inc., 1975

Course Logistics

On prerequisites: Desirable prerequisites include calculus, elements of ordinary and partial differential equations, basic courses in mechanics, and computing experience with Windows XP boxes and widely-used symbolic and numerical packages such as Mathematica, Maple, and Matlab.

On homework and exams: There will be approximately four mini-projects given throughout the semester to be weighed equally towards the final grade. There will be one midterm exam, but no final exam. The course grade will be assigned based on the projects and the midterm exam.