UNIVERSITY OF CALIFORNIA
Department of Mechanical Engineering

ME 283

Wave Propagation in Elastic Media

Lecture: Monday and Wednesday 2:00 - 3:30 3102 Etcheverry

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Office hours: M, W 1 -3

Text: *Wave Motion in Elastic Solids*, K.F. Graff, Krieger Press.

Recomended: *Introduction to ELASTIC WAVE PROPAGATION*, A. Bedford & D.S. Drumheller, Wiley, 1996 (paperback)

References:

1. Achenbach, J.D., *Wave Propagation in Elastic Solids*, North-Holland, 1973

2. Ewing, W.M., Jardetsky, W.S., and Press, F., *Elastic Waves in Layered Media*, Mc-Graw-Hill, 1957.

3. Auld, B.A., *Acoustic Fields and Waves in Solids*, Vols. 1 & 2, Wiley-Plenum, 1967.

4. Brekhovskikh, L.M. *Waves in Layered Media*, Academic Press, 1980.

5. Kolsky, H., *Stress Waves in Solids*, Dover, 1963.

6. Coulson, C.A., *Waves*, Interscience, 1957.

7. Love, A.E.H., *The Mathematical Theory of Elasticity*, Dover, 1944

8. Aki, K., and Richards, P.G., *Quantitative Seismology: Theory and Methods*, Vols. 1 & 2, W.H. Freeman & Co., 1980.

ME 283 Wave Propagation in Elastic Media (3) Bogy

(Pre-requisite ME 185 or Appendix A of Graff or 1st Chapter of Bedford and Drumheller)

Required Text: K. F. Graff, *Wave Motion in Elastic Solids*, Ohio State University Press, 1975 (later Krieger in paperback)

Recommended Text: *Introduction to ELASTIC WAVE PROPAGATION*, A. Bedford & D.S. Drumheller, Wiley 1996 (paperback)

List of Topics

1. Waves and Vibration in strings - Here we use the simplest wave equation to introduce physical concepts and mathematical techniques.

Harmonic waves, complex representation, initial value problem for infinite string - D'Alembert's solution and solution by Fourier Analysis, steady and transient forced motion of infinite and semi-infinite string by Fourier transforms, radiation condition, inversion paths, principal value integrals, contour integrals, path distortion to satisfy radiation condition, Green's unction, reflection and transmission at density discontinuity, string on elastic base - dispersion, frequency spectrum, complex wave number, cut-off frequency, group velocity, wave packets, pulse characterized by Fourier transform, narrow band, wide band - method of stationary phase.

2. Equations, Problems, and Theorems in Linear Elastodynamics.

Strain-displacement, stress-strain, stress equations of motion, stress-traction relation, formulation of initial-boundary value problems, uniqueness theorem, solution representation in terms of Lame potentials, particular retarded potentials for arbitrary body forces, reciprocal theorem, basic singular solution, Green's functions for 1st and 2nd problems on bounded regions.

3. Waves in Infinite Elastic Media

Plane waves - longitudinal, shear (SV and SH), propagation vector, displacement vector, waves with polar symmetry, waves with spherical symmetry, solution for delta function sources, spherical cavity source.

4. Waves in a Half-space

Surface waves, the Rayleigh equation, detailed study of displacement components and phase speed, reflection of plane waves from traction free boundary, incident P and SV , mode conversion, critical incidence angles, inhomogeneous plane waves, energy flux in

time-harmonic waves, velocity of energy - group velocity, partition of energy at a free surface.

5. Waves in Joined Dissimilar Half-spaces

Interface (Stoneley) waves, reflection and refraction of incident P and SV plane waves.

6. Waves in a Layer

SH waves - traction free surface, method of rays and constructive interference for deriving dispersion relation, derivation from equations of motion. Plane strain waves, Rayleigh-Lamb frequency equations for symmetric and anti-symmetric, asymptotic results for short and long wavelengths, complete discussion of frequency-wave number diagrams for complex k, significance of imaginary branches for edge boundaries, the Lame modes.

7. Torsionless Axisymmetric Waves in an Infinite Cylinder (Pochhammer-Chree).

Derivation of frequency equation, similarities to Rayleigh-Lamb equation, short and long wavelength approximations.

8. Forced Motion of Half-space

Transient problem for uniform normal stress, time harmonic tractions, (plane strain), Lamb's problem, general solution by Fourier transforms, branch cuts and integration contours, far field displacements, line source, application of steepest-descent method, transient normal load, inversion by Cagniard-de Hoop method, axisymmetric transient problems, Pekeris' solution for concentrated surface source, Pekeris's solution for buried source.

10. Waves in Layered Media.

The propagator matrix approach of Gilbert and Backus and of Dunkin. Accuracy problems for large frequency-thickness. Reflection coefficients for n layers on a half space. Non-specular reflection of bounded beams from the surface of a layered elastic half space submerged in water. Depression curves for one and two layers on a half space.

9. Numerical solution of wave equations – Random walk methods.

Recent research results on numerical solution of wave equations using random walk methods. Concept of random walks and solutions of partial differential equations. Brownian motion, Weiner processes, Feinmann-Kac formulas, Ray methods, Eikonal equations, complete transport equation.. Random walk solutions on cylindrical and spherical domains, on wedges and cones, for Lame equations of elastostatics, Diffraction by a plane sector.