AE 522: Dynamic Response of Materials
Spring 2013

Instructor: Prof. John Lambros

Class Hours: Monday and Wednesday 10 am-11:50 am, 104 Talbot Lab

Office: 310 Talbot Lab
Ph: 333-2242
Fx: 244-0720
lambros@illinois.edu

Office Hours: None

Required Textbook: None

Recommended Textbooks:

J. D. Achenbach, "Wave propagation in elastic solids", North-Holland, Amsterdam, 1990.
M. A. Meyers, "Dynamic behavior of Materials", Wiley, New York, NY, 1994
Zukas et al., "Impact dynamics", Krieger, Malabar, FL, 1992

References:

H. Kolsky, "Stress waves in solids", Dover, New York, 1963
B. A. Auld, "Acoustic fields and waves in solids", Wiley, New York, 1973
A. H. Nayfeh, "Wave propagation in layered anisotropic media", North-Holland, Amsterdam, 1995
L. Cagniard, "Reflection and refraction of progressive seismic waves", McGraw-Hill, New York, 1962.
L. B. Freund, "Dynamic fracture mechanics", Cambridge University Press, Cambridge, 1990
M. J. P. Musgrave, "Crystal acoustics; introduction to the study of elastic waves and vibrations in crystals", Holden-day, San Francisco, 1970

Grading:		
	Homework	20%
	Midterm	20%
	Lab report	20%
	Final (oral)	40%

Course Outline

Introduction:	Definition, applications and uses.
Uniaxial stress waves:	Equation of motion, x-t diagrams, Reflection at boundaries, Impedance mismatch.
Uniaxial strain waves:	Transverse stress, Method of characteristics.
Three dimensional waves:	Longitudinal and shear waves, Rayleigh, Stoneley waves Plane waves in 2D, Reflection and refraction.
Wave guides:	Dispersion, Phase and group velocities, Vibrating beams, Love waves, Plate problems, 3D bar problems (Pochhammer-Chree).
Spherical waves:	Impact of half spaces (Boussinesq and Lamb problems), Impact of quarter spaces (unloading waves).
Inelastic waves:	Elastic-plastic wave propagation, Hugoniot elastic limit, Wave propagation in rate dependent solids, One dimensional shock waves, Rankine-Hugoniot relations, Equation of State (EOS).
Dynamic testing techniques:	Split Hopkinson Bars, Plate impact technique, Recovery and pressure-shear tests, Other methods (Taylor test, Expanding ring etc.).
Strain rate dependence:	Metals vs. Polymers, Empirical relations, Physically based relations, Thermomechanical coupling.
Adiabatic shear bands:	Thermomechanical coupling, 1D models, Thermoelasticity, Thermoplasticity, Hyperbolic heat conduction.
Waves in anisotropic media:	Bulk waves in anisotropic solids, The Christofel equation, Material symmetry, Slowness and energy flow surfaces, Interaction with a boundary (Snell's law), Rayleigh waves, Reflection and refraction, Strain rate effects in composite materials.
Dynamic fracture:	Review of near tip fields, initiation and growth criteria, Equation of state, Crack branching, Terminal speed Plasticity.