TAM 518 – Wave Motion – Fall 2023

Instructor: Prof. Martin Ostoja-Starzewski, martinos@illinois.edu
   Department of Mechanical Science & Engineering, http://martinos.mechanical.illinois.edu/

Time, place: 3:00-4:50 pm, T and R, 410B1 Engineering Hall

Books (PDFs will be provided as needed**):**

   J.D. Achenbach (1971), *Wave Propagation in Elastic Solids*, North-Holland
   J. Billingham & A.C. King (2000), *Wave Motion*, Cambridge UP
   J. Ignaczak & M. Ostoja-Starzewski (2010), *Thermoelasticity with Finite Wave Speeds*, Oxford UP
   W.K. Nowacki (1978), *Stress Waves in Non-Elastic Solids*, Pergamon Press
   V.F. Nesterenko (2001), *Dynamics of Heterogeneous Materials*, Springer

Evaluation: 75% homework, 25% project* (reported as final exam)

Course Objective: to provide a broad perspective on wave motion topics (classical to current) from the standpoint of continuum mechanics, with an eye to applications

Course Contents:

   Wave motion of 1d,2d,3d elastic continua: finite *vs*. linearized
   (in)homogeneity, (an)isotropy, separation of scales, homogenization challenges
   PDEs: linear, quasi-linear, nonlinear
   Elastodynamics – displacement (Navier) and stress (Ignaczak) formulations, variational principles
   Poynting vector, equipartition of energy, Huygens' principle, Doppler effect, Mach cones/wedges
   Reciprocity relations
   Inhomogeneous half-space, layered media, Rayleigh, Scholte, Stoneley waves…
   Waves in rotating media
   Waveguides, beams, plates, Love wave, Lamb waves, Pochhammer-Cree theory
   Thermo-elastodynamics with parabolic or hyperbolic heat conduction
   Thermoelastic damping, visco-thermo-elastodynamics
   Waves in generalized continuum theories
   -    micropolar, gradient, non-local, odd, active/passive continua
   -    helices, chiral media, overhead transmission lines
   -    electromagneto-elasticity
   -    poroelasticity…
   Transient and impact waves in nonlinear media
   - Wavefronts, compatibility conditions, shocks, acceleration waves
   - Method of characteristics for nonlinear elastic, elasto-plastic media
   Traffic flow, traffic waves
   Burgers', Boussinesq, Korteweg de Vries equations
   Solitons in lattices, solitons in granular media, solitons in thermoelasticity
   Waves in random media
   - Waves on scalar-valued *vs*. tensor-valued random fields
   - Geometric acoustics, rays
   - Effective medium models of random media

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*Examples of projects in Fall 2021 which resulted in publications:

- Y.S. Jetti and M. Ostoja-Starzewski, "Equipartition of energy in a helix," *Math. Mech. Solids* **28**(2), 2022.
- R. Pavan and M. Ostoja-Starzewski, "Analysis of two types of harmonic waves in a Zener viscoelastic material," *Mech. Res. Comm.* **108**, 104069, 2023.