MA (BMA) 574

Time: 11:45-12:35 MWF
Place: SAS 2102
Instructor: Ralph Smith
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Text (Optional): *Mathematical and Experimental Modeling of Physical and Biological Processes* by H.T. Banks and H.T. Tran, CRC Press, 2009.

Computing: We will use MATLAB and Maple.

Grades: The gradescale is: 90-100 A-,A; 80-89 B-,B,B+; 70-79 C-,C,C+; 60-69 D-,D,D+; below 60: F. The grades are based on the following coursework:

Homework and Projects:	60 %
Midterm Exam:	15 %
Final Exam (April 29, 8:00-11:00):	25 %

Course Topics:

- Acoustics and Fluids
  - Acoustics and wave phenomena
  - Fluid principles: Euler and Navier–Stokes models
  - Experiments: Non-Newtonian fluids, speed of sound measurement
- Materials Concepts and Structural Models
  - Fundamentals of elasticity and viscoelasticity
  - Structural models for rods and beams
  - Smart material applications
  - Laboratory experiment: beam vibrations
- Numerical Solution Techniques for PDE
  - Finite difference techniques
  - Galerkin and finite element methods
- Surrogate and data-driven models
  - Regression-based and Gaussian process models
  - Dynamic mode decomposition models

Learning Outcomes: By the end of the course, students will be able to:

- Construct solve models for linear acoustic phenomena and understand basic mathematical concepts pertaining to the physics of music.

- Construct analytic and numerical solutions for acoustic phenomena and employ these models for parameter calibration and model verification.
- Construct models for nonlinear fluids phenomena including the Euler, Burgers' and Navier–Stokes equations. Construct analytic solutions for Poiseuille flows; model and understand the physics regarding Bernoulli's principle.
- Construct basic models for hemodynamics and blood flow.
- Construct and numerically solve models for rod, membrane and beam phenomena using Newtonian and variational principles from mechanics. Understand the equivalence between mathematical weak model formulations and models constructed using Lagrangian principles.
- Construct surrogate models for complex processes that retain the fundamental underlying behavior while providing the computational efficiency required for model calibration and uncertainty propagation.

Academic Integrity and Disabilities Information: This is provided at the following web sites:
`http://www.ncsu.edu/provost/academic_regulations/integrity/reg.htm`
`http://www2.ncsu.edu/ncsu/stud_affairs/counseling_center/dss/`