ME 712: Applied Mathematics in Mechanics – Fall 2019

Professor Douglas P. Holmes – *dpholmes@bu.edu*

Lecture - Four Credits
122 FLR
Tuesday & Thursday
11:00a.m. – 12:45p.m.

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Office Hours: Tues. 1:00p.m.– 3:00p.m.

Prerequisites: Linear algebra, Differential equations.

Course Description:
The goal of this course is to give students an introduction to mathematical tools for solving difficult mathematics problems that arise in engineering science and mechanics. Students will learn the process of applied mathematics, which will enable them to take a hard problem, and gain insight into its important characteristics. Analytical theory, approximate techniques, and numerical methods will be used in a complementary manner to solve challenging engineering problems. Students will learn dimensional analysis and scaling, perturbation methods applied to polynomial and differential equations, variational calculus, integral equations, and concepts of stability and bifurcation. Students will apply these methods to mathematical problems in solid mechanics, fluid mechanics, thermodynamics, and dynamical systems.

Goal: The construction, analysis, and interpretation of mathematical models to help us understand the world we live in.

Objectives:

1. Establish some of the **basic mathematical tools** relevant to problems in mechanics.
   - Dimensional analysis & scaling.
   - Perturbation methods.
   - Variational calculus.
   - Differential geometry.

2. Establish the mathematical ideas underlying **model development**. Topics include:
   - Kinetics.
   - Diffusion.
   - Continuum Mechanics.
   - Solid & Fluid Mechanics.

Learning Outcome: Completion of this course will enable you to **derive** and **analyze** mathematical model relevant to problems in theoretical and applied mechanics.

Grading: Homework assignments and class participation (20% total), midterm exam (35%), and a project (45%).

Recommended Texts:

Introduction to the Foundations of Applied Mathematics - *M.H. Holmes*
Applied Mathematics - *J.D. Logan*
Two great books that are most closely aligned with the course objectives.

Practical Applied Mathematics - *S. Howison*
A great collection of case studies that utilize applied mathematics.

Perturbation Methods - *E.J. Hinch*
Perturbation Methods in Fluid Mechanics - *M. van Dyke*
Excellent depth on an extremely important topic.

Scaling, self–similarity, and intermediate asymptotics - *G.I. Barenblatt*
A classic. Dense but essential.

The Variational Principles of Mechanics - *C. Lanczos*
Buy any book by Lanczos.