ME 712: Applied Mathematics in Mechanics – Fall 2019

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

Lecture - Four Credits
202 PHO (Zoom ID: 996 5093 8659)
Tuesday & Thursday
11:00a.m. – 12:45p.m.

Office: 730 Commonwealth Ave., EMA 213
Phone: (617) 358-1294
Office Hours: Tues. 1:00p.m.– 3:00p.m.
Office Hours: Zoom ID: 996 5093 8659

Prerequisites: Linear algebra, Differential equations.
Learning from Anywhere: *Synchronous* learning available at Zoom ID: 996 5093 8659 – **email me for Zoom password**
Asynchronous learning available via our YouTube Channel: https://tinyurl.com/yygxy7rs
Office Hours at Zoom ID: 996 5093 8659 – **same password as course password**

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.
   - Linear stability analysis *(if time permits)*
   - 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:

Class Notes - *D.P. Holmes*
Available on the course website: https://www.bu.edu/moss/courses/

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.

Academic Conduct & Student Performance:

1. **Academic Honesty:** In engineering, just as in humanities, science, and social science disciplines, plagiarism is unacceptable. Original thought is highly valued in engineering and is expected from students in this course in preparing and completing all course assignments. Students must follow the COE Academic Conduct Code: www.bu.edu/academics/eng/policies/academic-conduct/. Any violation of this conduct code will be reported to the COE Academic Conduct Committee.
2. **Working Together:** Students are permitted to consult with each other regarding approaches to solving problems in these assignments. If you consult with another person or webpage, please write "Consulted with <person's name> in preparing this assignment."
3. **COVID 19 & BU Community Health Expectations:** Masks are required and face coverings must be worn over the mouth and nose at all times when in public spaces on campus, including classrooms. Students should be prepared to show proof that they are compliant with health attestations and testing in order to attend class. All students are expected to follow all university guidelines with respect to daily symptom checks, testing, social distancing, and mask wearing when they leave their dorm or home. For a detailed description of official BU policies regarding COVID, please visit: http://www.bu.edu/dos/policies/lifebook/covid-19-policies-for-students/
4. **Mental Health:** Diminished mental health, including significant stress, mood changes, excessive worry, or problems with eating and/or sleeping can interfere with optimal academic performance. The source of symptoms might be strictly related to your course work; if so, please speak with me. However, problems with relationships, family worries, loss, or a personal struggle or crisis can also contribute to decreased academic performance. BU provides mental health services to support the academic success of students. Getting help is a smart and courageous thing to do – for yourself *and* for those who care about you.
5. **Inclusion:** I consider this classroom to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.
6. **Financial Security:** Any student who has difficulty affording groceries or accessing sufficient food to eat every day, or who lacks a safe and stable place to live, and believes this may affect their performance in the course, is urged to contact the Dean of Students for support. Please notify the professor if you are comfortable in doing so. This will enable me to provide any resources that I may possess.
7. **Accommodations for Students with Documented Disabilities:** If you are a student with a disability or believe you might have a disability that requires accommodations, requests for accommodations must be made in a timely fashion to Disability & Access Services, 25 Buick St, Suite 300, Boston, MA 02215; 617-353-3658 (Voice/TTY). Students seeking academic accommodations must submit appropriate medical documentation and comply with the established policies and procedures http://www.bu.edu/disability/accommodations/