MECH 410X/500B - Advanced Engineering Analysis - Spring 2022

Instructor: Professor Gwynn Elfring (email: gelfring@mech.ubc.ca)
Lectures: T Th 9:30am-11:00am
Course page: *Canvas* & *Piazza*

Academic prerequisites: MECH 358

Synopsis: No matter how large the Reynold's number becomes we still cannot neglect inertia, why? How do we determine the optimal shape of a ramp to maximize the speed of an object rolling down it? How do we solve for the shape of a droplet? Why does water flowing out of a tap break up into droplets? How do we estimate the dependence of an engineering design on parameters, without solving all the physics using a computer?

Many questions (including all those above) and problems in engineering require (more) advanced mathematical methods to understand and tackle. This course aims to introduce a number of mathematical methods and tools used in the study of mechanics.

Course Goals: To develop a functional understanding of the mathematical methods used in advanced engineering analysis (with an emphasis on continuum mechanics).

Textbook: *None is required the following are good references:*
Bender, Országh, *Advanced mathematical methods for scientists and engineers*, Springer.
Boas, *Mathematical methods in the physical sciences*, Wiley.
Hinch, *Perturbation methods*, Cambridge University Press.
Leal, *Advanced transport phenomena*, Cambridge University Press.
Pozrikidis, *Introduction to theoretical and computational fluid dynamics*, Oxford University Press.
Strogatz, *Nonlinear dynamics and chaos*, Cambridge University Press.
Weinstock, *Calculus of variations*, Dover.

Course topics and timeline:
[1] Sturm-Liouville theory; eigenfunctions, basis functions and function spaces
[2] Series solutions for linear PDE
[3] Fourier transforms and the FFT
[4] Greens functions and boundary integrals
[5] Calculus of variations and extrema
[6] Stability and dynamical systems
[7] Scaling, asymptotics and perturbation methods
[8] Selected topics (time permitting)

Course Evaluation:
Assignments (25% of course grade);
Midterm exam (25% of course grade);
Final Exam (50/40% of course grade);
Research project for graduate students (10% of the grade);
The project is to be chosen by the student, in collaboration with the instructor, to reflect the students interests while utilizing subject matter from the course for background. The goal is learn how to scan recent research literature then how to read a technical paper, synthesize the relevant content and finally how to present it to the class at an appropriate level. A 10 page (maximum) report and a 10 min presentation are required deliverables.