# AER 1403
# Advanced Aerospace Structures

Syllabus Fall 2023

Institute for Aerospace Studies
UNIVERSITY OF TORONTO

## Instructor:

Craig Steeves
UTIAS Room 118
Email: csteeves@utias.utoronto.ca
Zoom: https://utoronto.zoom.us/j/6466445423

## Teaching Assistant:

Andrew Cross
Email: A.Cross@mail.utoronto.ca

## Lecture Time:

Wednesdays, 9:10 AM – 12:00 PM in the UTIAS lecture theatre. While three hours are scheduled for each lecture, most should take between two and two and one half hours.

## Course Description:

This course will provide instruction in three areas crucial to aerospace structural design: fibre composite materials, thin-walled structures and finite element methods. The course will begin with composite mechanics, fabrication and testing. Next, general theories of shells and thin walled structures, which are essential to aircraft design, will be addressed. Finally, finite element methods of use in modelling thin walled structures and composites will be described.

## Evaluation:

| | |
|---|---|
| Problem sets: | 8 x 3% |
| Projects: | 2 x 18% |
| Final exam: | 40% |

The problem sets will be a combination of written answers and computer coding that will address short, specific questions. The projects will be longer assignments on a single topic and will involve more complicated computer coding. Any late submissions of projects or problem sets will be subject to a cumulative daily penalty of up to 10% of the value of the assignment. When presenting numerical results, three, or at most four, significant figures are appropriate. All computer code that was needed to arrive at your answer **MUST** be submitted with your assignment.

## Use of External Code

Most of the assignments in this course involve writing computer code. In general, you cannot submit code for credit that you did not personally write. Doing otherwise is plagiarism. Changing variable names does not mean that you have written a piece of code.

## Collaboration Policy:

Students are encouraged to discuss all course materials, projects and problem sets with one another, including derivations and code. However, there can be no written or typed records of discussions on graded materials. In particular, code developed for the problem sets or projects may not be shared with or solicited from other students. Any takeaway from discussions must be exclusively in each student's own head. Submissions for the problem sets and projects must be prepared individually without consulting others or materials from previous years.

## Reference Textbooks:

It is not necessary to purchase these books; they are provided as suggested reference texts for various parts of the course.

Kelly: *Composite Materials* (but almost any book on composites will do)
Fung and Tong: *Classical and Computational Solid Mechanics*
Fish and Belytschko: *A First Course in Finite Elements*

## Course Outline (Subject to Change):

I. Composites
    1. Introduction to Composites
    2. Elastic Properties of Composites
    3. Strength of Composites
    4. Sandwich Panels
    5. Fabrication of Composites
II. Plates and Shells
    1. Euler-Bernoulli Beam Theory
    2. Plate Theory
III. Finite Element Methods
    1. Strain Energy
    2. Virtual Work
    3. Variational Methods
    4. Variational Equations of Motion
    5. Strong Forms and Weak Forms
    6. Linking Energy Methods to Finite Elements
    7. 1-D Elements
    8. Beam Elements
    9. Two-Dimensional Solid Element
    10. Finite Elements for Composites
    11. Solution Methods