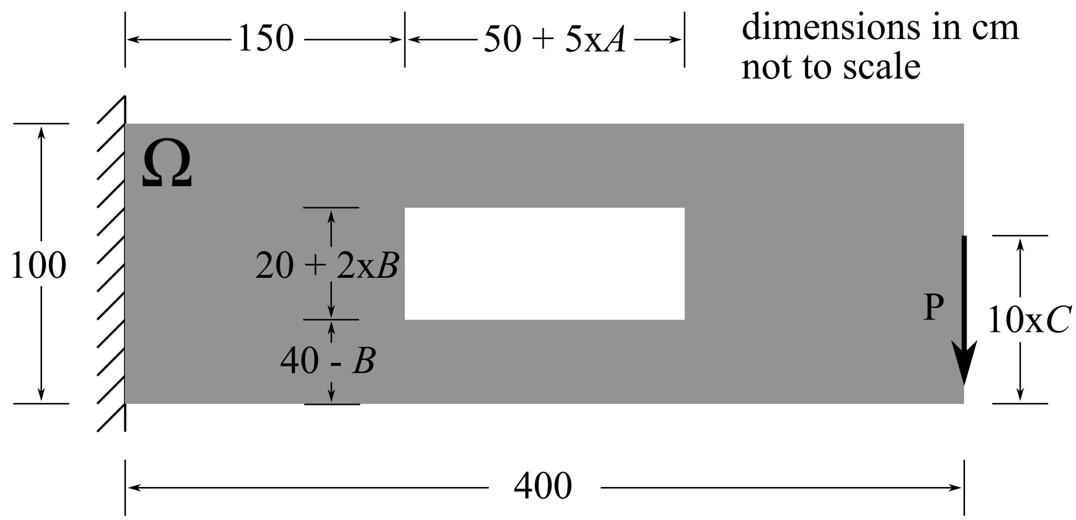
Institute for Aerospace Studies
UNIVERSITY OF TORONTO

AER 1410: Project 1
Due: 5 March 2024

It is desired to design an aluminum cantilever beam of maximum stiffness that has a central cutout so that the solid material occupies the shaded region Ω shown below. The **shaded area** can be at most 30% filled with material. The cantilever must support the load P at the location indicated. The dimensions and loading conditions of the region Ω are determined in the following fashion: take the final three digits of your student number. These three digits are labelled, respectively, A, B and C. The digits A and B are used in the determination of the total width and total height of the cutout, according to the dimensions shown in the drawing (in cm). The digit C is used in the determination of the location of force P. The cantilever is 10 cm thick in the out-of-plane direction.



The goal of the project is to write a topology optimization code that minimizes the compliance of this cantilever. For the basic solution, employ the SIMP method with sensitivity filtering to reduce mesh dependence and checkerboarding. You may reuse as much of Sigmund's 99-line topology optimization code as you wish, but if you need to make modifications or write additional code, **it must be your own**. Identify clearly any code that you add that is not from Sigmund. You may not share code with your colleagues. Once you have a code that solves this problem, address the items below.

For a complete project, the following must be provided:

1. An image of a design for the cantilever generated by the final iteration of a topology optimization code that you have written or modified;

2. An animation of the evolution of the design during the topology optimization process;

3. A discussion of any problematic features in the optimized design;

4. A drawing of a cantilever design **that can be manufactured**; and

5. Assuming the cantilever is made of aluminum 7075-T6 and the load P is 15 kN, the deflection at the point at which the load P is applied.

The following items are each worth 4% of the grade on this project, so you may choose to omit any or all of them on that basis.

6. Rather than using passive elements, generate a mesh that conforms to the geometry of the beam.

7. In addition to the applied load P = 15 kN, account for the gravitational load on the beam. Gravity acts downward in the diagram.

8. Implement a Heaviside projection filter such that fewer than 0.1% of elements have intermediate density.

To complete this project, you must submit a **single archive file** (such as .zip) through Quercus by 5 March 2024 11:59 PM:

1. your code, fully commented, in a Matlab .m-file or, if using another language, in a state that can be run;

2. an animation of the primary optimization (maximum 5 MB); and

3. a report in .pdf form, including words, equations and pictures necessary to address and explain your approach to the items above.

This project is worth 18% of your final grade for AER 1410.