

Université d'Ottawa  
Faculté de génie

Département de  
génie civil



uOttawa

L'Université canadienne  
Canada's university

University of Ottawa  
Faculty of Engineering

Department of  
Civil Engineering

CVG 3141  
Mechanics of Materials II

**FINAL EXAMINATION**

**Length of Examination: 3 hours**

**December 15<sup>th</sup>, 2005, 14:00**

Professor: Dr. B. Martín-Pérez

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Family Name: \_\_\_\_\_

Other Names: \_\_\_\_\_

Student Number: \_\_\_\_\_

Number of booklets submitted: \_\_\_\_\_

Signature: \_\_\_\_\_

**OPEN BOOK EXAM.**

If you do not understand a question, clearly state an assumption and proceed.

Programmable calculators or other electronic devices are not allowed.

At the end of the exam, when time is up:

- Stop working and turn your exam upside down.
- Remain silent.
- Do not move or speak until all exams have been picked up, and a TA or the Professor gives the go-ahead to leave.

1. (25 marks)

The rectangular beam in Figure 1 is subjected to a concentrated load  $P = 120$  N at the tip of the overhang. The dimensions of the cross section are  $b = 100$  mm and  $h = 20$  mm, and the elastic modulus of the material from which the beam is made is  $E = 70$  GPa. Ignoring the weight of the beam itself, determine the following:

- a. The maximum normal stress due to bending; ( $\sigma_x = 36$  MPa)
- b. The maximum shear stress due to bending; and, ( $\tau_{xy} = -0.09$  MPa)
- c. The deflection and rotation at point C. ( $\delta_c = 171 \times 10^{-3}$  m,  $\theta_c = 103 \times 10^{-3}$  rad =  $5.90^\circ$ )

2. (25 marks)

A rectangular aluminium tube of 5 mm thickness is subjected to two torques as shown in Figure 2. Given that the modulus of rigidity  $G = 27$  GPa, determine the following:

- a. The average shear stress in the tube at points A and B; and, ( $\tau_A = 1.04$  MPa,  $\tau_B = 2.08$  MPa)
- b. The angle of twist at point C. ( $\phi_C = 5.40 \times 10^{-3}$  rad =  $0.31^\circ$ )

3. (25 marks)

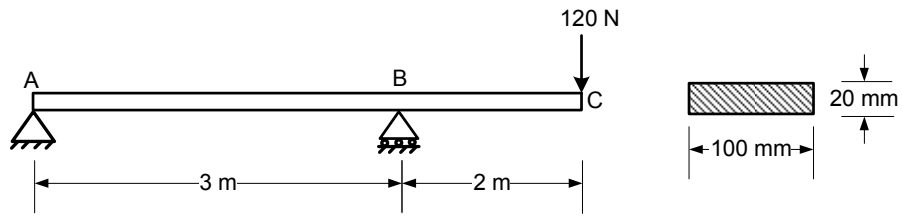
A force  $P$  is applied to the web of the cantilever beam as shown in Figure 3. If  $e = 250$  mm, determine the height  $h$  of the right flange so that the beam will deflect downward without twisting. The member segments have the same thickness  $t$ . ( $h = 171$  mm)

4. (25 marks)

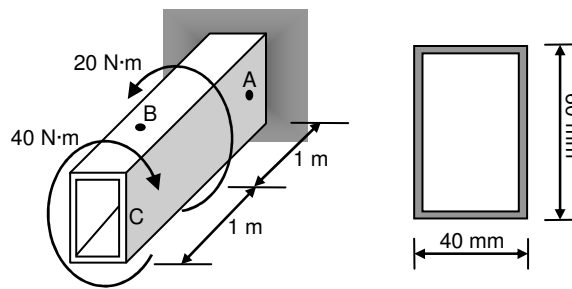
The beam illustrated in Figure 4 is made from an elasto-plastic material for which  $\sigma_y = 200$  MPa. Determine the magnitude of force  $P$  that causes the moment:

- a. To be the largest elastic moment; ( $P = 25$  kN)
- b. To be the largest plastic moment; and, ( $P = 37.5$  kN)
- c. To yield 50% of the cross section. ( $P = 34.4$  kN)

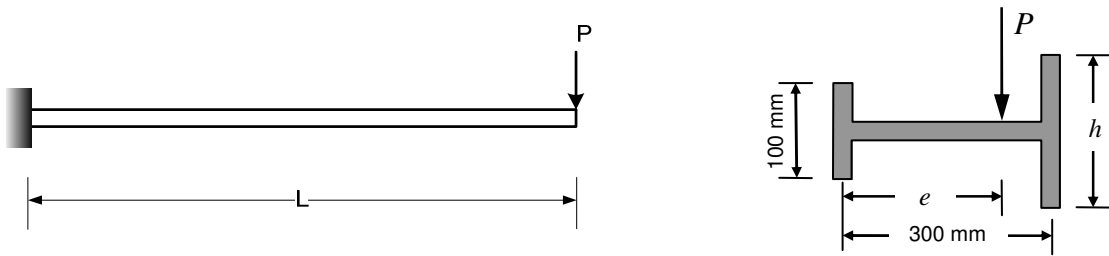
**FIGURES**



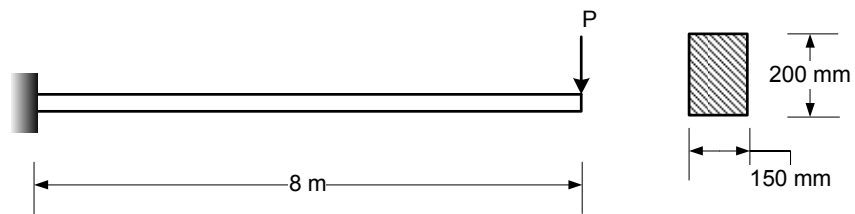
**Figure 1**



**Figure 2**



**Figure 3**



**Figure 4**