



# Université d'Ottawa • University of Ottawa

Faculté de génie  
Génie Civil

Faculty of Engineering  
Civil Engineering

## CVG 2140 / 2540: Mechanics of Materials / Résistance des Matériaux I

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### Final Exam/ Examen Final

Mr. Darek Baingo / Dr. Richard Frenette

April/ Avril 19, 2004

Time / Temps: 3 hours.

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OPEN BOOK. Attempt all problems. Calculators are allowed. Marks are as shown for each question. A total of 100/100 points is possible. Clearly indicate the **coordinates** you are using and the **reference** (source) for the formulae that you are using.

LIVRE OUVERT. Essayez de répondre à toutes les questions. Les calculatrices sont permises. Les points sont indiqués pour chaque question. Un total de 100/100 points est possible. Identifiez clairement le **système de coordonnées** que vous utilisez de même que les **références** des équations que vous utilisez.

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Name of the student / Nom de l'étudiant: \_\_\_\_\_

Student Number / Numéro d'étudiant: \_\_\_\_\_

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*(En français à la page suivante)*

1. A 12.5m long steel cylinder supports a  $2\text{m}^3$  concrete bloc with geometrical and material properties illustrated in Fig. 1. Calculate by how much the steel cylinder will shorten under both the concrete block weight and its own weight (25 pts).
2. Considering the simply-supported beam illustrated in Fig. 2, calculate the principal stresses and their orientation at a point C located at a distance of  $h/4$  from the bottom of the cross-section. Take  $F = 10\text{kN}$ ,  $L = 4\text{m}$ ,  $h = 5\text{cm}$  and  $b=h/2$  (25 pts).
3. The aluminum frame in Figure 3 consists of a rigid beam  $AC$  supported by two circular tube columns  $BD$  and  $CE$ . The beam is attached to the columns at points  $B$  and  $C$  by means of pinned connections. Column  $BD$  has a length of 1.5 m and is pinned at joint  $D$  while column  $CE$  with a length of 2 m is rigidly fixed at point  $E$ . The cross sections of both columns have an outside diameter of 40 mm and a wall thickness of 4 mm. The modulus of elasticity is 70 GPa. Provided that the factor of safety with respect to buckling is 2.5, determine the allowable uniformly distributed load  $w$  that can be supported by the frame between points  $B$  and  $C$  (25 pts).

4. A steel beam with a total length of 8 m is loaded as illustrated by Figure 4. A clockwise moment of 18 kN·m ( $M_0$ ) is applied at support  $A$  while a 15 kN vertical load ( $P$ ) acts on the overhang at  $C$  (25 pts).
- Draw the shear-force and bending-moment diagrams, clearly indicating the extreme values and units (7 pts).
  - Derive an equation for the deflection curve of the beam (8 pts).
  - Determine the slope of the deflection curve at the free end  $C$  and calculate the location and value of the maximum absolute deflection of the beam. Assume that  $E = 200$  GPa and  $I = 105 \times 10^6$  mm<sup>4</sup> (10 pts).

*(In English on previous page)*

- Un cylindre d'acier de 12.5m de long supporte un bloc de béton de 2m<sup>3</sup>. Les propriétés géométriques et des matériaux sont illustrées à la Fig. 1. Calculez quel sera le raccourcissement du cylindre d'acier sous le poids du bloc de béton et sous son poids propre.
- En considérant la poutre sur appuis simples illustrée à la Fig. 2, calculez les contraintes principales et leur orientation au point  $C$  situé à une distance  $h/4$  de la fibre inférieure de la section. Prenez  $F = 10$ kN,  $L = 4$ m,  $h = 5$ cm et  $b=h/2$  (25 pts).
- (25 pts).
- (25 pts).

# FIGURES

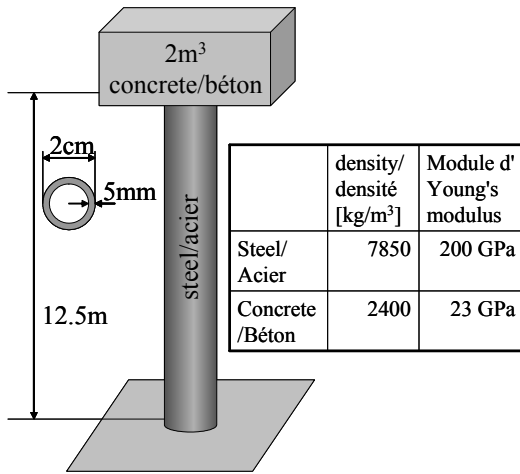


Figure 1

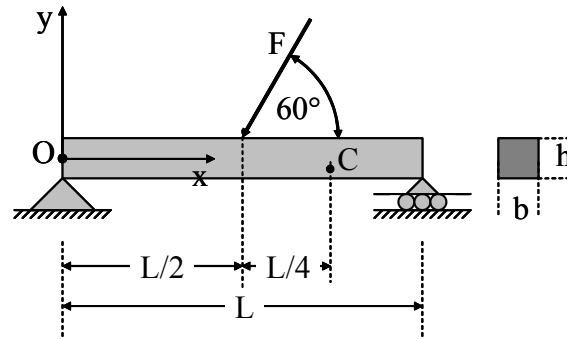


Figure 2

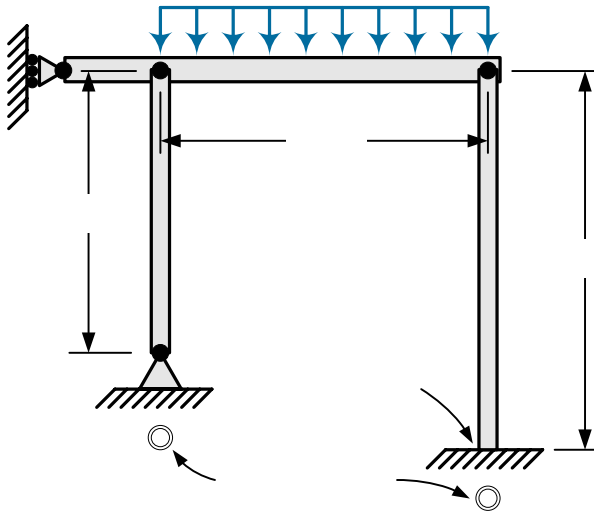


Figure 3

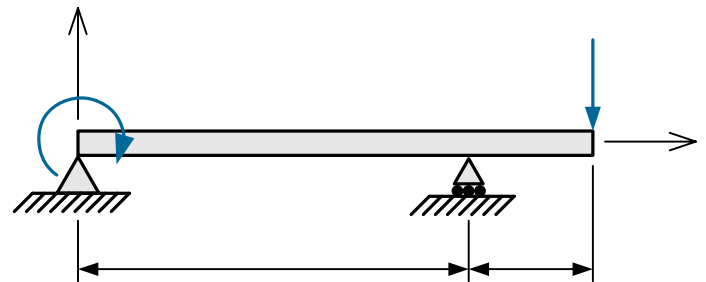


Figure 4