## QUIZ 1

Fall 2003-2004
(Monday, November 24, 2003)

## CIVE310 - MECHANICS OF MATERIALS <br> CLOSED BOOK, $11 / 2$ HOURS

## Name:

$\qquad$ ID\#: $\qquad$

## NOTES

- 2 PROBLEMS - 10 PAGES.
- ALL YOUR ANSWERS SHOULD BE PROVIDED ON THE QUESTION SHEETS.
- ONE EXTRA SHEET IS PROVIDED AT THE END.
- ASK FOR ADDITIONAL SHEETS IF YOU NEED MORE SPACE.
- SOME ANSWERS MAY REQUIRE MUCH LESS THAN THE SPACE PROVIDED.
- DO NOT USE THE BACK OF THE SHEETS FOR ANSWERS.
- DRAFT BOOKLET WILL BE PROVIDED; BUT DO NOT USE FOR ANSWERS.
- BOTH QUESTION SHEETS AND DRAFT BOOKLET SHOULD BE RETURNED.
- CHECK BOXES ARE FOR YOU TO CONFIRM THAT HAVE SOLVED A QUESTION

FORMULAS/EQUATIONS: GENERAL FORM (USE CAREFULLY)

| $P / A ;$ | $T c / J ;$ | $M c / I ;$ | $V Q / I t$ |
| :--- | :--- | :--- | :--- |
| $b h^{3} / 12 ;$ | $\Pi R^{4} / 2 ;$ | $2 \Pi R^{3} t$ |  |

## YOUR COMMENT(S)

## DO NOT WRITE IN THE SPACE BELOW

## MY COMMENT(S)

TOTAL:
/100

## Problem I: (70 points)



Figure I-a


Figure I-b


Figure I-c

The free-standing circular solid column monument with diameters of 0.40 m and 0.20 m as shown in Figure I-a is loaded with $P=1,000 \mathrm{kN}$ and has the following properties:

- $E=20 \times 10^{6} \mathrm{kPa}\left(\mathrm{kN} / \mathrm{m}^{2}\right)$
: Modulus of elasticity
- $\gamma=20 \mathrm{kN} / \mathrm{m}^{3} \quad:$ Weight density (about 2 times water)
- $\sigma_{y}=20,000 \mathrm{kPa} \quad$ : Yield strength in tension and compression
- $F S=2.0 \quad$ : Factor of safety

1. IGNORE OWN WEIGHT and solve for the problem as follows:

- Reaction, Force, Stress, Strain, and Displacement Diagrams. (25 points)
- Discuss safety. (5 points)
- Compute the stiffness of the system. (5 points)

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2. AGAIN IGNORING THE OWN WEIGHT, and referring to Figure I-b, what is the force $F$ in each cable which will be required to ensure that the top displacement due to $P$ in question 1 is reduced to zero. ( 15 points)
Deduce the top reaction in the system in Figure I-c, and solve as in question 1 (Reactions, Force, Stress, Strain, and Displacement Diagrams, check safety, and compare safety with question 1). (10 points)

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3. Referring to Figure I-a, show that the own weight is negligible by calculating a displacement value, using a very simple model which approximates the real model (look for a range, and not for an exact value). DARE TO APPROXIMATE AND THIS COULD BE A 3 MN QUESTION. (10 points + up to 5 bonus points to the most daring which make sense)

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## Problem II: (30 points)



Cross-Section

## Figure II

Design (find cross-section and length) the thin tubular steel shaft shown in Figure II, given the following loading, properties and constraints:

- This should be a thin tube with $t / D<1 / 20$, and Area $=\pi d \mathrm{t}$
- Ignore own weight
- $P=1,000 \mathrm{kN}$
- $E=200 \times 10^{6} \mathrm{kPa}\left(\mathrm{kN} / \mathrm{m}^{2}\right) \quad$ : Modulus of elasticity
- $\sigma_{\text {allowable }}=100,000 \mathrm{kPa}$
: Allowable strength in tension $\square$
- Elongation limited to 1 mm

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