UNIVERSITY OF TORONTO

Faculty of Applied Science and Engineering

CIV100F – MECHANICS

Final Examination – Sections 1, 2, 3, 4, 5, 6, 7, 8 and 9 (Online)

Monday, 12th December 2022

Examiner: Staff in Civil Engineering

Time allowed: 2-½ hours

First name (please write as legibly as possible within the boxes)

Last name

Student ID number

INDICATE YOUR CALCULATOR TYPE:

☐ **CASIO FX-991** ☐ **SHARP EL-W516** ☐ **OTHER:** _____

Notes:

1. **Ensure that you have all 12 pages of the examination paper. Page 12 is blank**
2. **Answer all five questions. The value of the questions is indicated below**
3. **If you need more space for a question, continue on the page indicated at the bottom**
4. **If information appears to be missing, make reasonable assumptions and state them clearly**
5. **The only calculators permitted are listed above. Please indicate your model**
6. **This is a closed-book examination. No other paper will be allowed on the desk**
7. **Turn OFF all electronic equipment and place it in your bag**
8. **Do <u>not</u> remove the staple**

DO NOT WRITE IN THIS SPACE.

1	**/10**
2	**/10**
3	**/10**
4	**/10**
5	**/10**
TOTAL	**/50**

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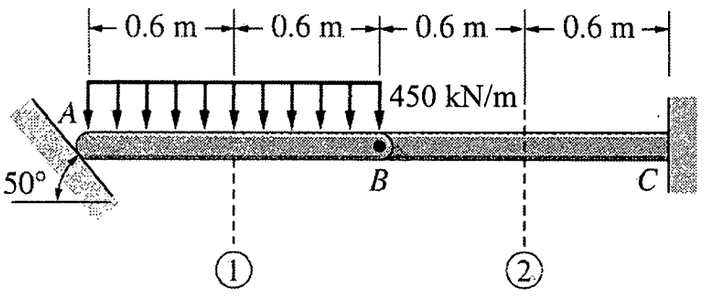
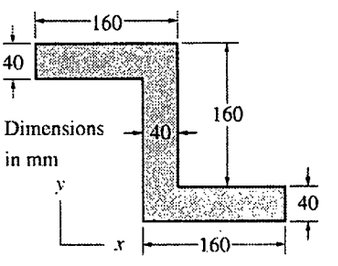
1. The steel beam depicted below is supported by a frictionless surface at *A* and a fixed support at *C*. Member *AB* is loaded by a uniformly distributed force and is pinned to member *BC* at *B*.

(a) In the space provided draw the internal-force diagrams for the beam. Indicate the values at all points marked along the beam (viz. *A*, *B*, *C*, *1* and *2*) and annotate the shape of the diagrams.

(b) The cross-section of the beam is also represented. Determine if the beam material remains elastic at all points across the section and everywhere along the beam, given that the yield stress for steel is 350 MPa.





Cross Section

Solution can be continued on Page 3

NAME: _____

Question 1 can be continued on this page.

Solution can be continued on Page 12

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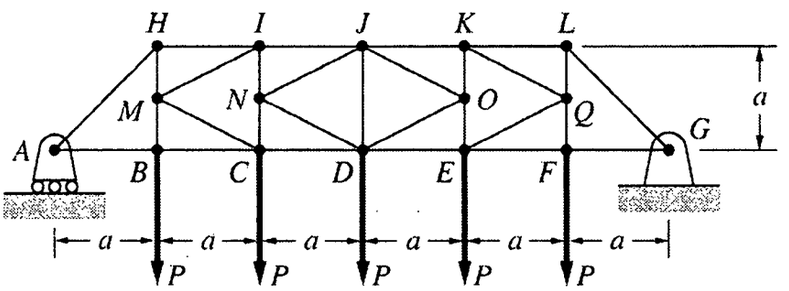
2. For the steel truss illustrated: (i) Determine the force in members *AH*, *HM*, *CD*, *IJ* and *JN*, and indicate if the members are in tension or compression. Take $P = 150$ kN and $a = 2.5$ m.

(ii) From a different loading condition, the force in member *EQ* (cross-sectional area 1,700 mm^2, modulus of elasticity 200 GPa) is 580 kN in tension. Determine the axial stress in, and the elongation of the member.



Solution can be continued on Page 5

NAME: _____

Question 2 can be continued on this page.

Solution can be continued on Page 12

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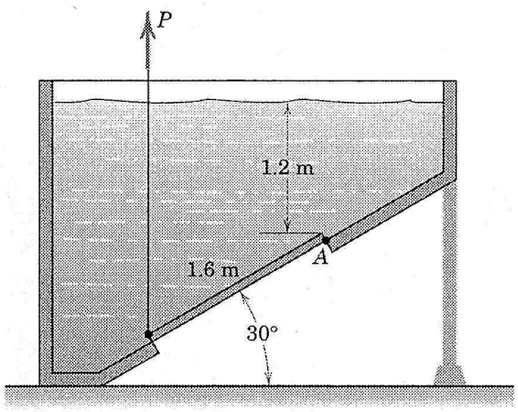
3. The cross-section of a 3.0 m-wide (in the plane of the figure), fresh-water tank with a slanted bottom is presented. A rectangular door in the bottom of the tank, 1.6 m by 0.8 m (normal to the plane of the figure), is hinged at A and can be opened by the vertical cable under a tension P, as shown. Determine the minimum tension force in the cable required to open the door. The door is fabricated from 16 mm-thick steel plate with a mass density of 7,850 kg/m^3.



Solution can be continued on Page 7

NAME: _____

Question 3 can be continued on this page.

Solution can be continued on Page 12

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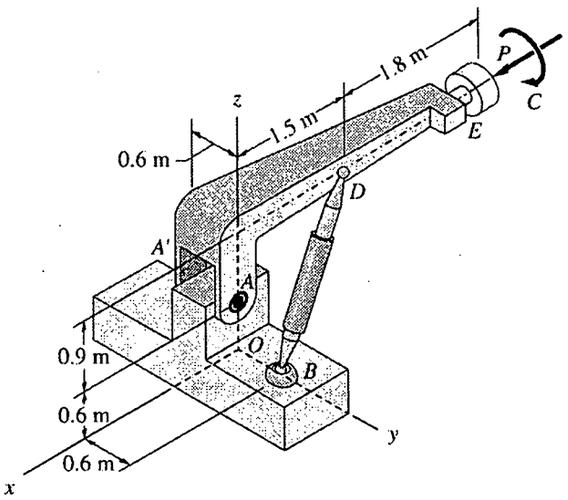
4. The arm *ADE* of the boring machine is attached to a rigid support by pins at *A* and *A'* (not visible). *DE* is parallel to the *x*-axis. The arm is also supported by the hydraulic cylinder *BD* which has a ball-and-socket joint at each end. The applied loading consists of a force $P = 6.2$ kN and a couple $C = 4.8$ kNm, both acting at the boring tool *E*. Neglecting the weight of the members, determine the force in the cylinder *BD* (provide both the magnitude and the Cartesian vector expression).



Solution can be continued on Page 9

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Question 4 can be continued on this page.

Solution can be continued on Page 12

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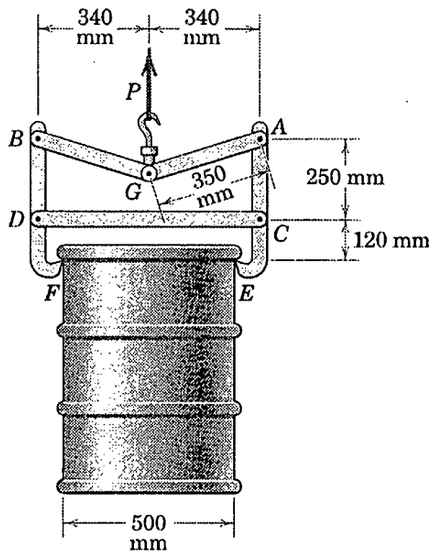
5. A lifting device for transporting steel barrels is presented. The mass of a barrel is 155 kg, while the mass of the lifting device can be neglected. Calculate the magnitude and direction of the total forces exerted on the barrel at *E* and *F*.



Solution can be continued on Page 11

NAME: _____

Question 5 can be continued on this page.

Solution can be continued on Page 12

NAME: _____

All Questions can be continued on this page. Indicate clearly which question is shown.