UNIVERSITY OF TORONTO

Faculty of Applied Science and Engineering

CIV100S – MECHANICS

Final Examination

Thursday, 27th April 2023

Examiner: Prof. Michael Seica

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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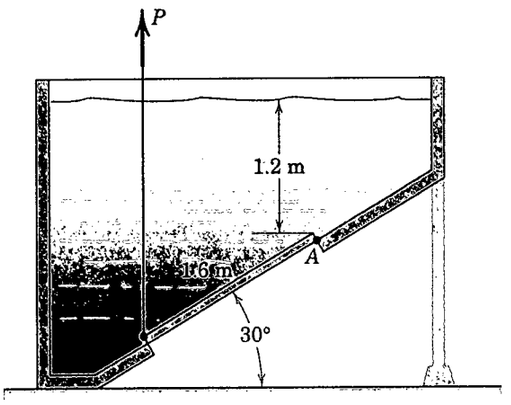
1. The cross-section of a 3.0 m-wide (in the plane of the figure), fresh-water tank with a slanted bottom is presented. A rectangular door in the bottom of the tank, 1.6 m by 0.8 m (normal to the plane of the figure), is hinged at A and can be opened by the vertical cable under a tension P, as shown. Determine the minimum tension force in the cable required to open the door. The door is fabricated from 25 mm-thick steel plate with a mass density of 7,850 kg/m^3 and the cross-sectional area of the cable is 200 mm^2.



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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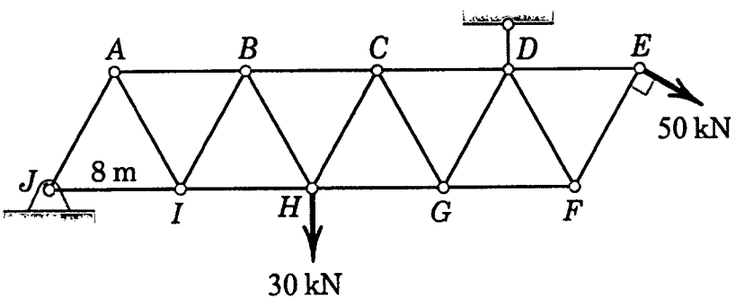
2. The truss illustrated below is composed of eight identical equilateral triangular panels having a modular size of 8 m, and is supported by a pin at *J* and a vertical cable at *D*.

a. Determine the forces in members *BC*, *CD*, *DF* and *GH*, and indicate if they are in tension or Compression. The line of action of the 50 kN force at *E* makes a 90-degree angle with member *EF*.

b. Member *CD* is a cable made from a bundle of 60 round, solid, high-strength, parallel steel wires, each wire having a diameter of 2 mm. Determine the axial stress in the cable *CD* resulting from the loading applied to the truss.

c. Determine the elongation of member *CD*. The modulus of elasticity for the cable material is 160 GPa.



Solution can be continued on Page 5

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Question 2 can be continued on this page.

Solution can be continued on Page 12

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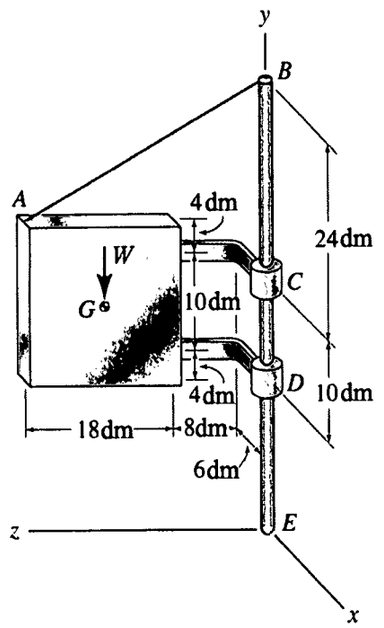
3. A heavy door seals a furnace which is used to heat-treat large metal components. Post *BE* is round and is connected to the foundation by a fixed support at *E*. The door has a weight of 20 kN which acts through point *G* located at the centre of the 18 x 18 dm door. In the closed position (shown) the door panel is parallel to the *z* axis and the hinge arm segments are parallel to the *x* and *z* axes. Determine the force supported by the cable *AB* and the reaction force components at the bearings (hinges), at points *C* and *D*. The two bearings are free to translate in the *y* direction. All dimensions are in dm (decimetres). *(Note: The decimetre is an SI unit of length equal to one tenth of a metre.)*



Solution can be continued on Page 7

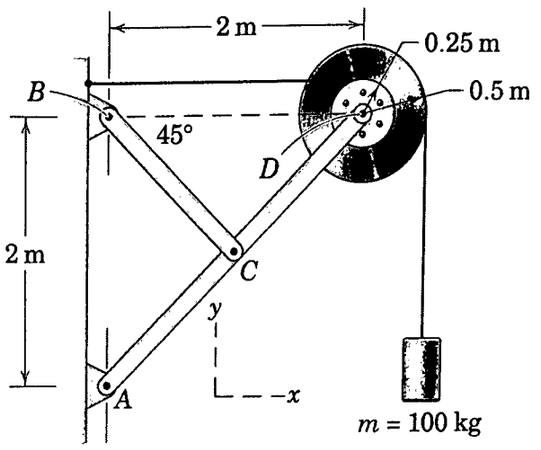
NAME: _____

Question 3 can be continued on this page.

Solution can be continued on Page 12

NAME: _____

4. Calculate the x- and y-components of the reaction forces at the pin supports at A and B. The cables are wrapped securely around the two concentric, frictionless pulleys, which are fastened together.



Solution can be continued on Page 9

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Question 4 can be continued on this page.

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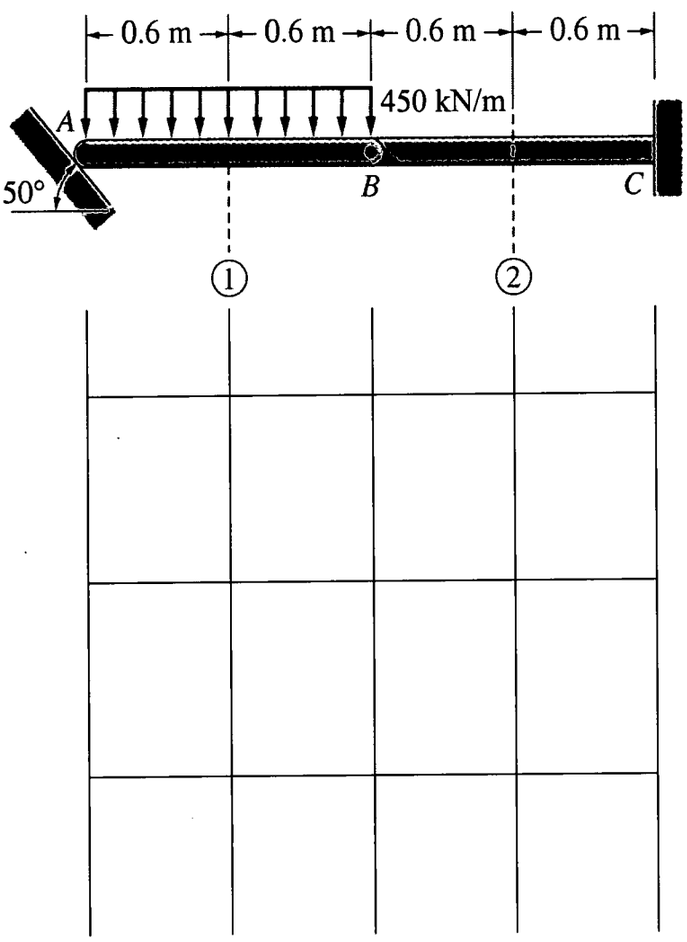
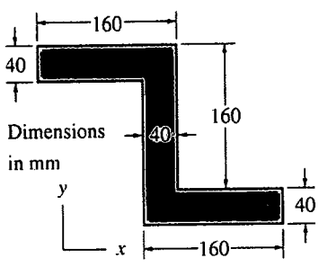
5. The steel beam depicted below is supported by a frictionless surface at *A* and a fixed support at *C*. Member *AB* is loaded by a uniformly distributed force and is pinned to member *BC* at *B*.

(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 the second moment of the area of the cross-section corresponding to the axis of bending.





Cross Section

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Question 5 can be continued on this page.

Solution can be continued on Page 12

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