== Delft University of Technology ==
University Course Applied Mechanics

Give on the upper right corner of each sheet your **NAME** *and* **STUDY NUMBER.**

Exam STATICS 2002.10.28 / 09:00-12:00

The work of a student not fulfilling the requirements to take an exam will not be judged.

Indications

Hand in only the answer sheets.
Any other sheets will not be accepted.

Mention your name and study number on every sheet.
Sheets without name and study number will not be accepted.

Mention relevant calculations on the answer sheets.
Use the blank sides of the answer sheets if necessary.
Answers without any calculation are not taken into account.

Use possible checks in order to avoid calculation errors.
The order of answering the questions is free.
N.B.: **this exam consists of 5 problems.**

The **neatness of the presentation** of the answers will be considered in the judgement.

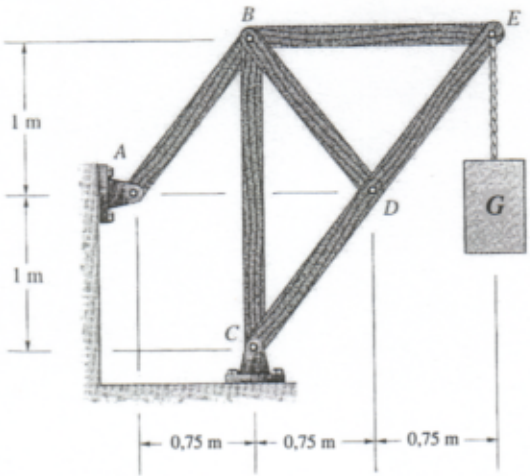
Unless otherwise stated the following holds:

Hinged joints and supports with hinges are frictionless.

The weight of the structure is not taken into account.

Problem 1 (weight 1,4 - about 25 minutes)

The truss sketched below supports a block with weight *G* in E. The joints can be considered as hinged.
The maximum allowable load of each bar is 6 kN in tension and 2 kN in compression.

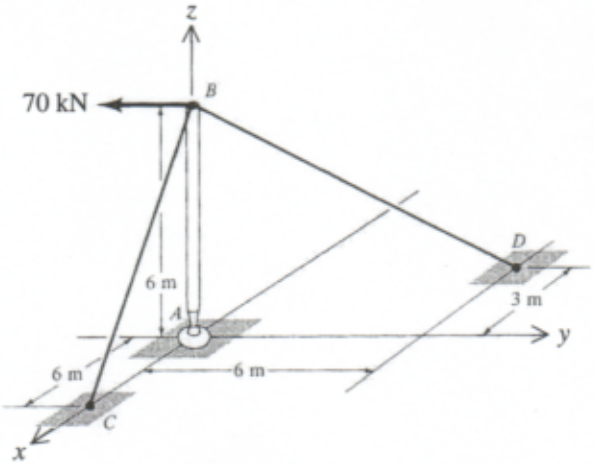


Questions:

a. Determine all member forces expressed in *G*, with the correct signs (tension positive, compression negative).
b. Determine the force polygon belonging to the equilibrium of joint C.
c. Determine the maximum weight *G* the truss can support. Which member is critical?

Problem 2 (weight 2,4 - about 40 minutes)

The vertical mast AB, loaded by a horizontal force of 70 kN in B, is supported by the cables BC and BD. The support in A is a ball-and-socket joint.



Questions:

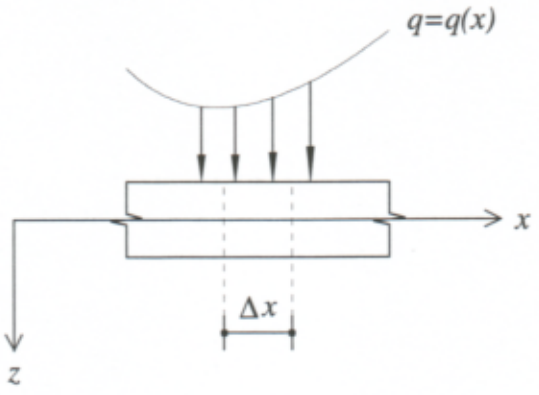
a. Show, without calculation, which of the nine reaction forces A_x, A_y, A_z, C_x, ... are zero.

b. Calculate the remaining reaction forces. Present a clear calculation.

c. Calculate the normal forces in mast AB and in cables BC and BD with the correct sign (tension positive, compression negative).

Problem 3 (weight 1,4 - about 25 minutes)

A beam is loaded perpendicular to its axis by a distributed load $q = q(x)$.

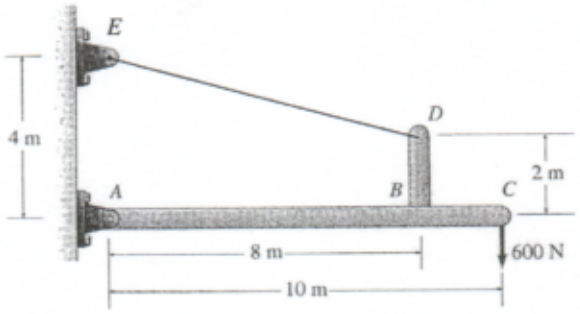


Questions:

a. Sketch the positive internal forces and moments acting on a beam element with an infinite small length Δx.
b. Derive the differential equations for the equilibrium of this beam element.
c. Derive (using the previous result) also the relation between the bending moment M in the beam and the distributed load q.

Problem 4 (weight 2,4 - about 45 minutes)

The rigid part ABCD of the structure shown in the sketch is pin supported in A and is supported by cable DE in D.
The loads and dimensions can be read from the figure.

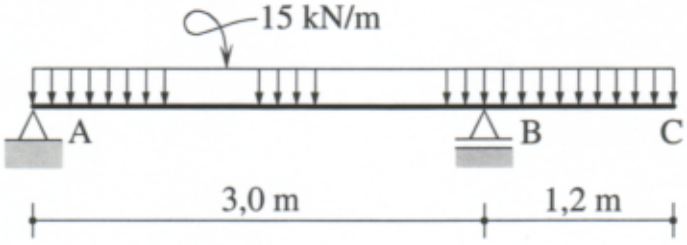


Questions:

a. Determine the (horizontal and vertical components of) the reaction forces in A and E. Sketch these forces in the directions in which they act and give their values.
b. Determine the bending moment, shear force and normal force diagram for ABC together with the deformation signs. Give the relevant values.
c. Consider point B as a free body. Sketch all forces and moments acting on this free body in the directions in which they act and give their values.

Problem 5 (weight 2,4 - about 45 minutes)

The beam with overhang supports a uniformly distributed load of 15 kN/m over its entire length. The dimensions can be read from the figure.



Questions:

a. Calculate the reaction forces. Sketch these forces in the directions in which they act and give their values.

b. Sketch the bending moment and the shear force diagram together with the deformation signs. Give the relevant values.
Sketch in points A, B and C also the tangent to the bending moment diagram and show clearly the intersections of these tangents.

c. Indicate the points of the beam where an extreme value of the bending moment can be expected.

d. Calculate the position and the value of the moments of the previous question.