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

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

Exam STATICS 2003.08.26 / 09.00-12.00

The work of a student who does not fulfill the requirements for taking an exam will not be marked.

Notes

Only hand in the answer sheets.
Any other sheets will not be accepted.

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

Write relevant calculations on the answer sheets.
Use the blank sides of the answer sheets if necessary.

Answers without calculation are not taken into account.

Provide the answers with units when applicable.

Use possible checks in order to avoid calculation errors.
The order of answering the questions is free.

N.B.: **this exam consists of 6 problems.**

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

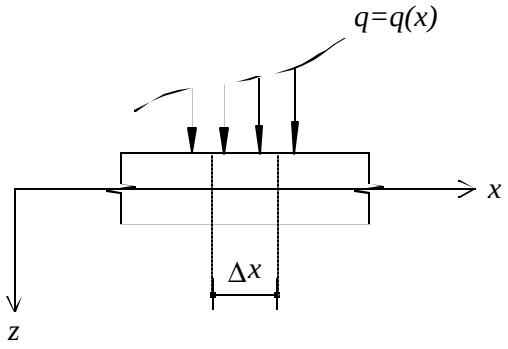
Unless otherwise stated the following holds:

Pulleys, hinged joints and supports with hinges are frictionless.

The weight of the structure is not taken into account.

Problem 1 (weight 1,0 - about 20 minutes)

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

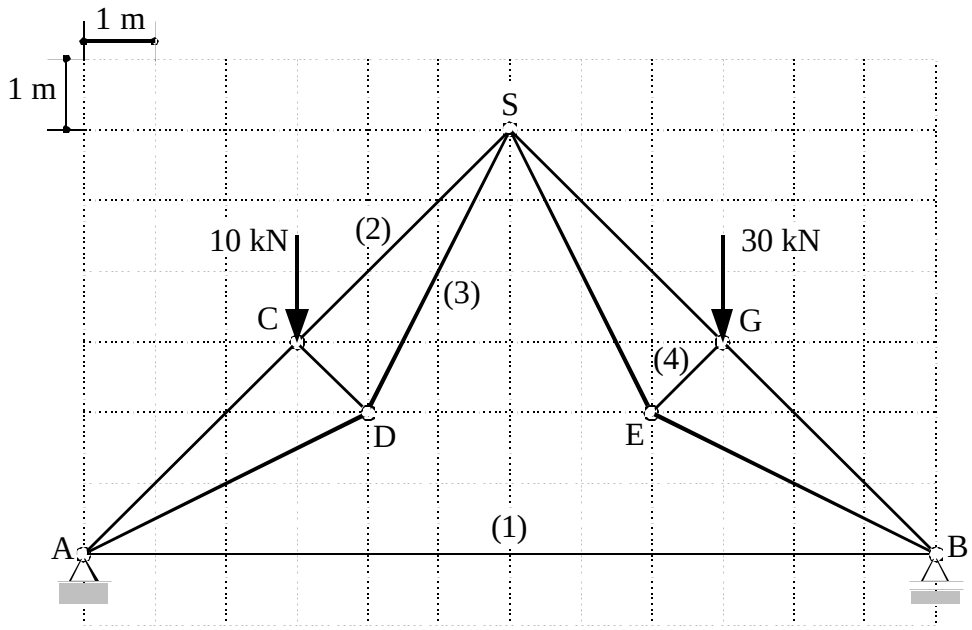


Questions:

a. Sketch the positive internal forces and moments acting on a beam element with an infinitesimal 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 2 (weight 1,8 - about 30 minutes)

The truss represented in the figure below has a hinged support in A and a roller support in B.
Dimensions can be read from the figure using the grid, the grid distance is 1 m. The loads can be read from the figure as well.



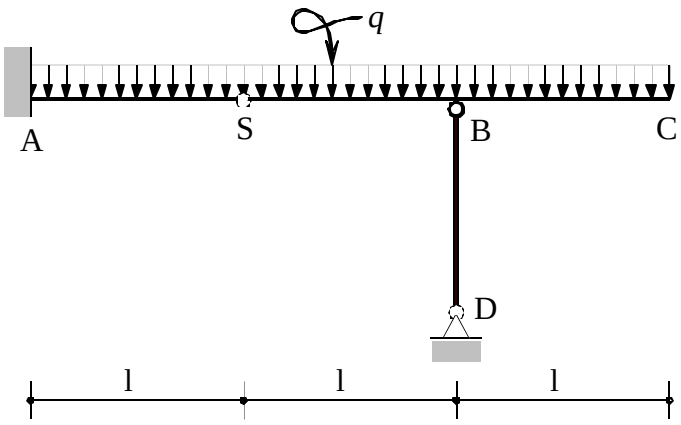
Questions:

a. Determine the horizontal and vertical component of the reaction forces in A and B. Sketch these forces in the figure in the directions in which they act and give their values.
b. Determine by means of the method of sections the force in bar (1). Clearly indicate the section used.
c. Determine by means of the method of sections the force in bar (2). Clearly indicate the section used.
d. Determine by means of the method of sections the force in bar (3). Clearly indicate the section used.
e. Determine the force in bar (4). The choice of method is free.
f. Assemble the previous results in the table with the correct signs for tension and compression[1].

[1] Tension positive, compression negative.

Problem 3 (weight 2,0 - about 30 minutes)

The girder ASBC, represented in the figure below, is clamped in A and supported in B by bar BD. The girder has a hinge in S. Dimensions can be read from the figure.
The girder supports a uniformly distributed load q over its total length.

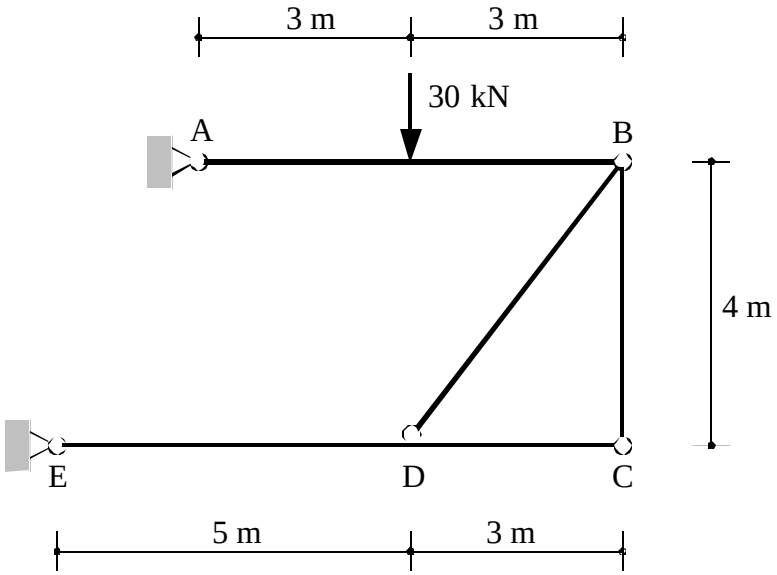


Questions:

a. Determine the reaction forces in A and D. In the figure, sketch these forces in the directions in which they act and give their values.
b. Sketch for ASBC the shear force diagram and give their va lues. Clarify by means of the deformation signs (or plus and minus sign) the directions in which the shear forces act.
c. Sketch for ASBC the moment diagram and give their values. Clarify by means of the deformation signs (or plus and minus sign) the directions in which the moments act. Sketch in A, B and C the tangents to the moment diagram and show clearly the intersection of these tangents.

Problem 4 (weight 2,0 - about 35 minutes)

The structure represented in the figure below is made up by bars AB, BC, BD and CDE connected by hinges as displayed in the figure. Dimensions and loading can be read from the figure.



Questions:

a. Determine the reaction forces in A and E. In the figure, sketch these forces in the directions in which they act and give their values.

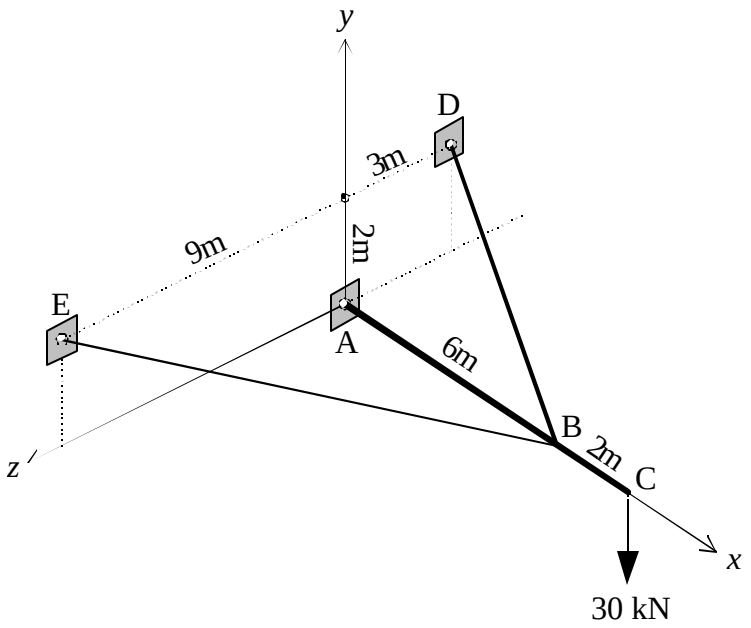
It is allowed to change the order of questions b and c.

b. Determine and sketch the moment and shear force diagram of bar EDC and give their values. Clarify by means of the deformation signs (or plus or minus sign) the directions in which the moments and shear forces act.

c. Determine the normal force in BC and BD with the correct signs (tension positive, compression negative).

Problem 5 (weight 2,0 - about 35 minutes)

Beam ABC is situated in the horizontal plane, supported in A by a ba**l**-and-socket joint and in B by cables BD and BE. Dimensions can be read from the figure.
The beam is loaded in C by a vertical force of 30 kN.



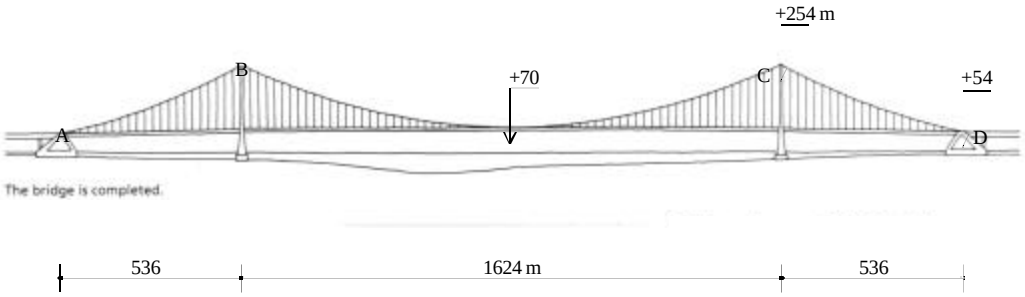
Questions:

a. Determine the (horizontal and vertical components of the) reaction forces in A. In the figure, sketch these forces in the directions in which they act and give their values.

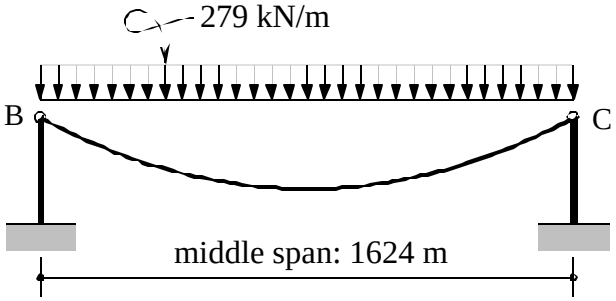
b. Determine the (horizontal and vertical components of the) reaction forces in E and D. In the figure, sketch these forces in the directions in which they act and give their values.

c. Determine the normal force in the cables BD and BE.

Problem 6 (weight 1,0 - about 30 minutes)



In the figure above the dimensions of the suspension bridge over the Storebaelt (Great Belt) in Denmark can be read. The load in the cable due to its weight, bridge deck and other loads due to traffic can be regarded as a uniformly distributed load of 279 kN/m.



Questions:
Determine as a result of the uniformly distributed load of 279 kN/m :

a. The horizontal component of the cable force in middle span BC
b. The maximum cable force in the middle span. Where does this maximum force occur?