Delft Applied Mechanics Course: Statics

AE1-914-I

January 28, 2005, 9:00–12:00

This is the English exam.

Only the answer sheets will be collected Any other sheets will be rejected.

Write down your name and student number ! Answers without name and student number are not graded.

Check your intermediate answers to prevent arithmetical errors

Problem 1 (Weight 1.0, approx. 20 min.)

A cable is attached to a horizontal roller in A and to a hinge in D and is loaded in B and C. There is a horizontal force of 10 kN in horizontal direction acting on the support in A as drawn in the figure.



- a) Determine the cable forces in the sections AB, BC and CD.
- **b)** Determine the forces F_1 and F_2 .
- c) Determine the reaction forces and draw them in the figure on the answer sheet in the right direction.
- N.B.: The questions may be answered in a different order.

Problem 2 (Weight 2.0, approx. 35 min.)

The structure in the figure consists of a part AS and a part SBCDE which are connected by a hinge in S. The structure is clamped in A and is supported by a horizontal roller in C. A horizontal force of 50 kN is applied at point E and a vertically distributed force of 20 kN/m is applied at segment CD.



- a) Using the principle of virtual work, calculate the reaction moment in support A. Clearly indicate the virtual displacement field and sign convention used.
- **b)** Using the principle of virtual work, calculate the reaction force in support C. Clearly indicate the virtual displacement field and sign convention used.
- c) Using the principle of virtual work, calculate the bending moment in the structure just *right* of B. Clearly indicate the virtual displacement field and sign convention used.

Problem 3 (Weight 2.5, approx. 45 min.)

A massless pole CD in the y-z plane is secured by two cables AC and BC. The pole is supported by a hinge in D. Point C is loaded by a vertical load of 140 kN. The position of C is (0, 6, 12) meter.



- **a)** Calculate the vertical reaction force D_z in point D.
- **b)** Calculate the force F_{CD} in the pole and the reaction forces D_x and D_y in D.
- c) Calculate the reaction forces in A and B in the x-, y- and z- direction.
- d) Calculate the cable-forces F_{AC} and F_{BC} .
- e) Draw all components of the reactions in A, B and D in the figure on the answer sheet in the right direction and collect all the answers in the table.

N.B.: The questions may be answered in a different order.

Problem 4 (Weight 2.5, approx. 45 min.)

The structure ASB as shown in the figure (note that S is a hinge) is loaded by a uniformly distributed loaded on section SD.



- a) Calculate the reaction forces and draw them in the figure on the answer sheet as they act on the structure in reality.
- b) Calculate the forces in the hinge S.
- c) Draw the bending moment diagram (*M*-diagram) of the structure with the correct deformation symbols. Clearly indicate the characteristic values and draw the tangents when necessary.
- **d)** Draw the shear force diagram (V-diagram) of the structure with the correct deformation symbols. When necessary, make use of the slopes of the bending moment diagram. Clearly indicate the characteristic values.
- e) Determine the shear force V_{AC} and the normal force N_{AC} in section AC.
- **f)** Consider force equilibrium of point C. Draw all forces in C in the blown up picture on the answer sheet and demonstrate by using a force polygon that the forces are in equilibrium.

Problem 5 (Weight 2.0, approx. 35 min.)

The truss structure in the figure is loaded by two forces. The structure is supported by a hinge in A and a horizontal roller in G.



- a) Determine the reactions in A and G and draw them in the figure on the answer sheet as they act on the structure in reality.
- b) Indicate the zero-force-members in the figure on the answer sheet
- c) Determine the forces in the members AB, AC, JK, DK, DE, EG and GK, using the correct signs for tension or compression. Collect the results in the table on the answer sheet.