Delft Applied Mechanics Course:
Statics

AE1-914-I

18 August 2004, 9:00–12:00

This is the English exam.

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

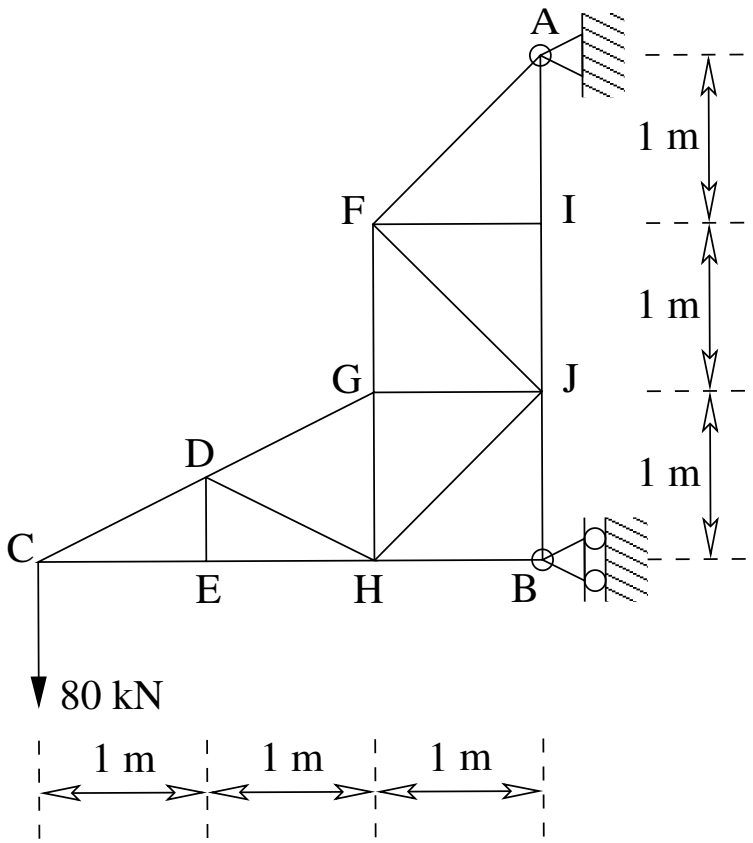
Write down your name and student number !
Answers without name and student number are not corrected.

If you are unable to calculate one of the intermediate quantities, assume the quantity to be known and clearly define the symbol used for it. Then proceed with the problem for partial credit.
Do not use numbers for unknown quantities!

Check your intermediate answers to prevent arithmetical errors

Problem 1 (Weight 2.5, approx. 40 min.)

The truss structure given in the figure is loaded by a force of 80 kN in node C.



a) Calculate the reaction forces in the supports A and B.

b) Somebody claims that bar IJ is a zero-force member. Is this correct? Motivate your answer.

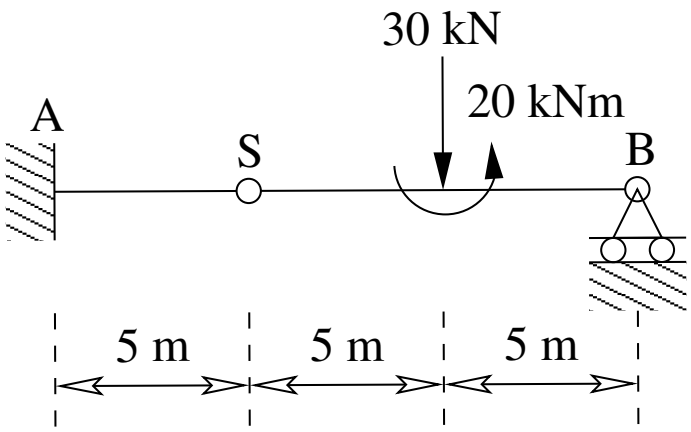
c) Indicate which bars are zero-force members.

d) Calculate the forces in all bars with the correct sign for tension and compression. Collect your results in the table provided on the answerform.

e) Draw the force polygon for node G.

Problem 2 (Weight 1, approx. 30 min.)

The structure depicted in the figure consists of a beam AS of length 5 m connected with a pin to a beam BS of length 10 m. The structure is loaded by a force of 30 kN and a couple of 20 kNm halfway along beam BS.



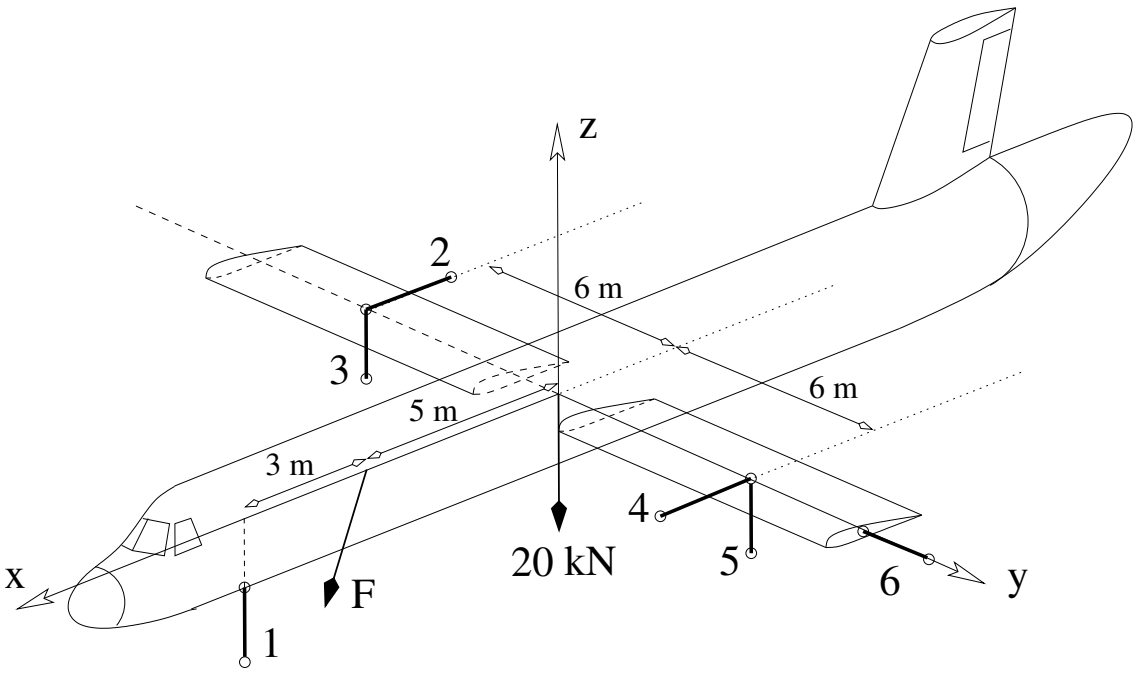
a) Using the principle of virtual work, calculate the reaction force in support B. Clearly indicate the virtual displacement field and the direction of the reaction force.

b) Using the principle of virtual work, calculate the bending moment in support A. Clearly indicate the virtual displacement field and the sign convention used.

Problem 3 (Weight 2, approx. 30 min.)

In order to certify an airplane a loading situation must be simulated. The simulated loading situation is one in which the airplane must brake hard and change direction simultaneously the moment the airplane enters the taxi lane after landing.

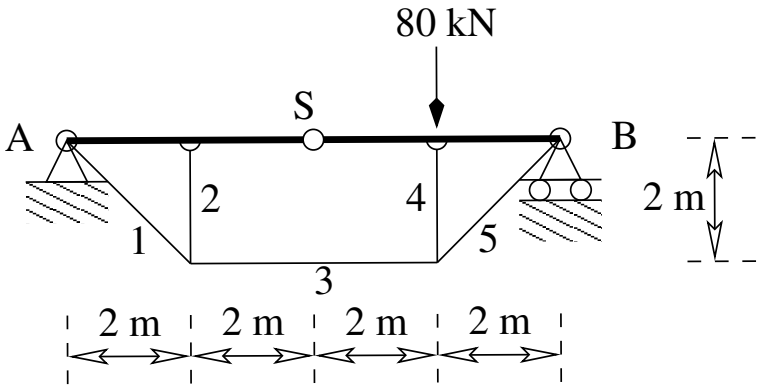
The airplane is supported by six two-force members situated where the nose and main landinggear are to come. The sixth two-force member is placed at the end of and along the wing. De dimensions are given in the figure. The airplane is loaded by a force **F** of which the components are given as $F_x = 36$ kN, $F_y = 24$ kN en $F_z = -80$ kN. The origin of the coordinate axes lies in the center of gravity of the airplane. The weight of the airplane equals $W = 20$ kN.



a) Calculate the forces in the six two-force members with the correct sign for tension and compression.

Problem 4 (Weight 2.5, approx. 40 min.)

The structure ASB given in the figure is loaded by a force of 80 kN halfway along beam BS. The dimensions are indicated in the figure.



a) Calculate the reaction forces in the supports A and B.

b) Calculate the connection forces in pin S and the normal force in bar 3 with the correct sign for tension or compression.

c) Calculate the forces in the remaining bars with the correct sign for tension or compression.

d) Disconnect beam ASB from its surroundings and draw all forces acting on it.

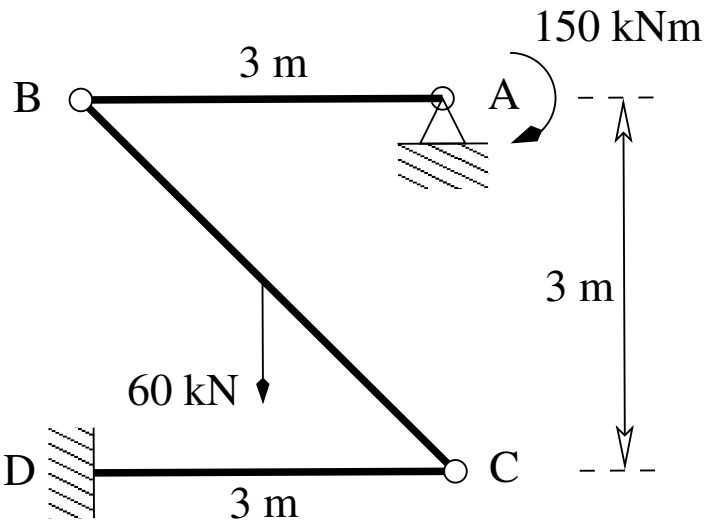
e) Draw the bending moment diagram (M-diagram) of beam ASB with the deformation signs.

f) Draw the shear force diagram (V-diagram) of beam ASB with the deformation signs.

g) Draw the normal force diagram (N-diagram) for beam ASB with the correct sign for tension and compression.

Problem 5 (Weight 2, approx. 40 min.)

The structure given in the figure consists of two horizontal beams AB and CD of length $L = 3$ m connected with pins to a diagonal beam BC. The latter is at an angle of 45° with respect to the horizontal beams and is loaded halfway along its length by a vertical force of 60 kN. The structure is loaded in A by a moment of 150 kNm.



a) Is beam BC a two-force member? Motivate your answer.

b) Calculate the connection forces in pins B and C and the reaction forces and moments in A and D.

c) Draw the bending moment diagram (M-diagram) of the entire structure with the deformation signs.

d) Draw the shear force diagram (V-diagram) of the entire structure with the deformation signs.

e) Draw the normal force diagram (N-diagram) of the entire structure with the correct signs for tension and compression.