Instructions

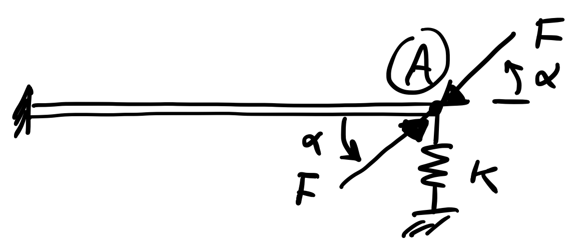
- Remove everything from your desk except this question paper, blank paper, pens, and campus card.
- Number all pages of your solution consecutively in the upper right-hand corner and indicate the total number of pages used. Example: 1 of 7, 2 of 7, etc.
- Write your name on this question paper.
- Before proceeding with the derivations, write down all the steps that you are going to take and explain the whys and hows.
- Explain your answers clearly and concisely.
- Report all necessary derivations. Examples: 1) show the step-by-step procedure that you have followed to derive a boundary condition or a governing equation; 2) show starting and ending points in the derivation of the integration constants (do not show the in-between steps).
- Show "sanity checks" to prove the soundness of your derivations every time it is necessary to do so. Example: all integration constants must be checked for consistency as well as all final results... obviously, do not limit yourself to these checks only.
- This question paper must be returned together with your solution papers (do not separate it from them). If not returned, the exam will not be graded.
- Use only blue or black ink pens. No work written in pencil will be graded.
- Assessment of fundamental knowledge: as a fourth year engineering student, you are supposed to know certain things and procedures (how to derive boundary conditions, how to solve a differential equation, how to justify procedures and solutions...) Errors regarding these aspects in a question or part of a question, will be rewarded with zero points for that question. Beware of unjustified boundary conditions, the sum of dimensionally inconsistent quantities and other similar abominations as they take away points.

Follow the instructions or points will be deducted.

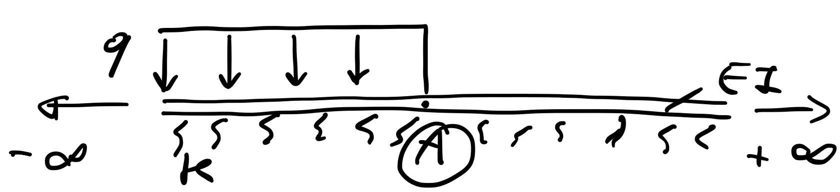
Questions

1. This set of questions must be answered on this question paper. Write clearly using block letters (do not use cursive).
   (a) Family name, first name, student number:
   (b) Indicate your M.Sc. degree program: ☐ regular TUD student ☐ exchange student
   (c) Did you join TU Delft for an M.Sc. degree program?
      i. Specify your prior education:
   (d) If you are an exchange student, specify your country of origin and home university:
   (e) Indicate your track:
   ☐ Hydraulic Engineering ☐ Building Engineering ☐ Structural Engineering
   ☐ Transport & Planning ☐ Water Management ☐ Geo-Engineering
   ☐ Other (please specify):
   (f) Class attended: ☐ all ☐ most ☐ half ☐ some ☐ none

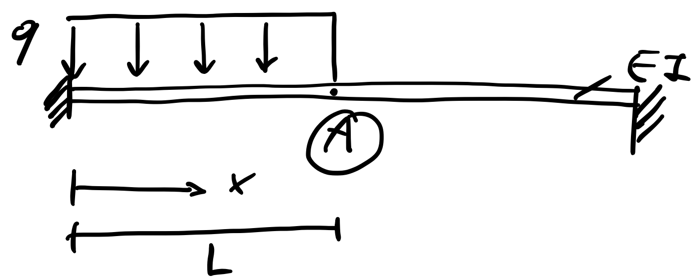
[20%] 2. This set of questions must be answered on this question paper. For each one of the statements below, write whether the statement is true or false.
   (a) A shear beam is stiffer than a Bernoulli-Euler beam with the same length, cross sectional area, and material. true ☐ false ☐
   (b) The internal force at A is equal to zero. true ☐ false ☐



   (c) Consider the beam below. It's an infinite Bernoulli-Euler beam resting on elastic soil; the load is applied on half of its length. The Dirichlet boundary condition at A is $v(A) = 0$. true ☐ false ☐



(d) Consider the beam below. The boundary condition at A is $V(L) = qL$. true □ false □



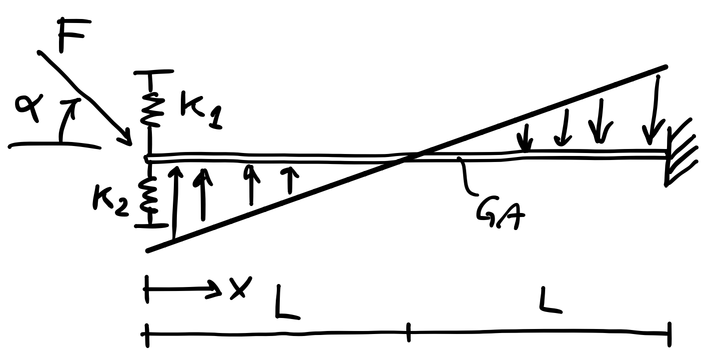
(e) For $\boldsymbol{K}$ to be a meaningful stiffness matrix in the matrix displacement method, its diagonal entries cannot be negative. true □ false □

[20%] 3. Explain your answers, briefly, to the previous question.

[10%] 4. (a) What matching conditions do you know? Limit your answer to one line.

(b) What is a matching condition and why is it different from a boundary condition? Limit your answer to three lines.

[30%] 5. Compute the displacement at $x = L$ for $\alpha = 0,\ 30,\ 90,\ 180$ degrees in the shear beam depicted below using the differential equation and the matrix displacement method with two equally-spaced elements. The distributed load has intensity q at both ends. Derive all necessary equations.



[20%] 6. Compute the vector of nodal equivalent forces for the shear beam element depicted below. Derive all missing information if not already derived previously.