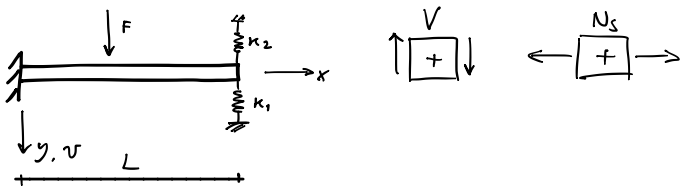
Instructions

- 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.
- Avoid killer mistakes. One killer mistake is worth 50% of the total exam points. Some examples of killer mistakes: 1) unjustified boundary conditions, correct or wrong; 2) the sum of dimensionally inconsistent quantities.
- Follow the instructions on this question paper 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. The rest of the exam will be checked only if all the answers are correct.
   (a) The principle of superposition does not hold for cables. true ☐ false ☐
   (b) In the equation of the Euler-Bernoulli beam on elastic soil, the soil constant k has the dimension of a force over a length. true ☐ false ☐
   (c) Consider a system of two springs in series, both with stiffness k, loaded by a displacement u. The displacement in each spring equals the applied displacement. true ☐ false ☐
   (d) Consider the beam below. The boundary condition at the right end of the beam is $V(L) = -v(L)k_2 + v(L)k_1$. true ☐ false ☐



(e) In the matrix displacement method, all diagonal entries have to be non-negative.
true ☐ false ☐

(f) A homogeneous boundary condition means that the quantity on the right-hand side is equal to zero. true ☐ false ☐

(g) At a clamped end of a Timoshenko beam one has to enforce two boundary conditions: one for the rotation and one for the deflection. The rotation is expressed as the sum of shear and bending components and has to be set to zero.
true ☐ false ☐

(h) The sum of the entries in each column of the stiffness matrix of a bar element is equal to zero because the bar is in equilibrium. true ☐ false ☐

(i) The principle of superposition cannot be applied to beams on elastic foundations because the solution contains exponential and trigonometric functions.
true ☐ false ☐

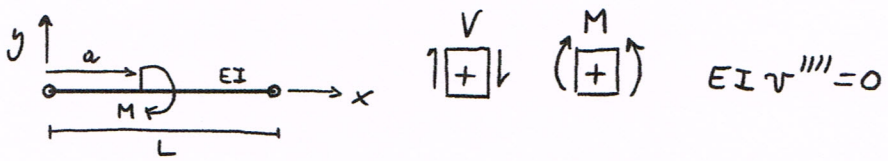
(j) In the matrix displacement method, spring contributions must be added to the vector $\boldsymbol{f}$ since they are basically a boundary condition true ☐ false ☐

[10%] 3. Explain your answers to the previous question. Use a couple of lines for each answer.

[10%] 4. What is the physical meaning of a generic entry k_{ij} in the stiffness matrix of a generic element? Do not explain how an entry is computed, and limit your answer to a couple of lines.

[10%] 5. Matching conditions are of two types. Is it always necessary to specify both? Why? Limit your answer to half page.

[20%] 7. Compute the vector of nodal equivalent forces for



Derive all missing information.