Home Assignment 1

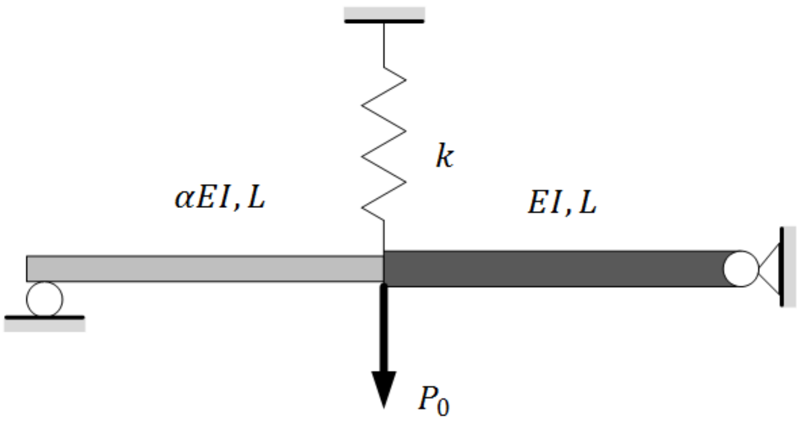
Information

The homework assignments, together with the computer workshops, are compulsory parts of the course. The assignments should be solved in groups of two or three students. The deadline of HW1 is Monday, Sept. 21, 6 pm. A total of 9 points can be obtained on HW1.

Note! If programs like Maple and Matlab are used to solve the homework assignments, print-outs from these programs must only be added as an appendix to the solution. Solutions only consisting of print-outs from Maple/Matlab will be graded with zero points.

Problem 1

Problem 1. [4 points] Two beams of equal length (length L) but with different bending stiffnesses are welded together according to the figure below. The dimensionless stiffness factor α is given in the table and is dependent on mm, where mm is the month in the personal registration number used at the front page of your submission. The beams are loaded by a point force P_0 at the welded joint. The construction is made stiffer by adding a spring connected at the weld joint with stiffness $k = \eta EI/L^3$. Determine η so that the (downward) displacement at the weld joint becomes half of the displacement without a spring. The problem must be solved by energy methods and especially Castiligiano's 2nd theorem.



mm	α
01-04	2/3
05-08	1/3
09-12	1/5

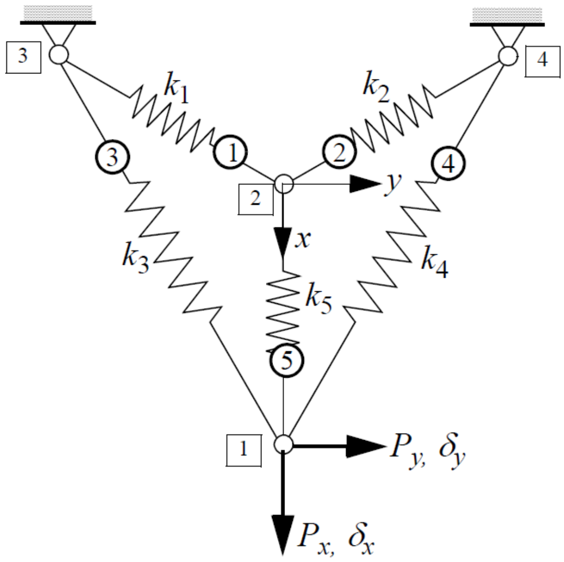
Problem 2. [5 points] A structure consisting of five springs and 4 nodes is shown in the figure below. The stiffnesses of the springs are chosen so that the structure becomes symmetric, i.e. that $k_1 = k_2$ and $k_3 = k_4$. The coordinates of the nodes are given in Table 1 to the right of the figure and the stiffnesses of the springs are given in Table 2 (dd is the day in the personal registration number that is used on the cover page). The parameters l and k in Table 1 and Table 2 have the units of length and force per length receptively. The structure is loaded with the point forces P_x and P_y at node 1. Analyze the structure according to:

(a) Determine the nodal displacement and especially the flexibility at node 1, i.e determine α_{ij} in the expression

$$\begin{bmatrix} \delta_x \\ \delta_y \end{bmatrix} = \begin{bmatrix} \alpha_{xx} \\ \alpha_{yx} \end{bmatrix} P_x + \begin{bmatrix} \alpha_{xy} \\ \alpha_{yy} \end{bmatrix} P_y$$

(b) Determine the reaction forces.

(c) In which spring(s) is the largest normal force found if $P_x = P_y = P_0$?



Node	x/l	y/L
1	1	0
2	0	0
3	$-1/2$	$-\sqrt{3}/2$
4	$-1/2$	$\sqrt{3}/2$

Table 1: Nodal coordinates

dd	$k_1/k = k_2/k$	$k_3/k = k_4/k$	k_5/k
01-10	1.0	3.0	2.0
11-20	1.0	3.0	1.0
21-31	2.0	1.0	2.0

Table 2: Spring stiffnesses

DON'T FORGET THE UNITS IN YOUR ANSWERS!

Cover page - Home assignment 1

Name and personal registration number (1):

Name and personal registration number (2):

Name and personal registration number (3):

Personal registration number

yy		mm		dd	

Summarize the answers below:

Problem 1

The vertical displcement is reduced by half using $\eta =$

Problem 2

(a) Nodal displacements, displacement vector: $\boldsymbol{D} =$

$$\begin{bmatrix} \delta_x \\ \delta_y \end{bmatrix} = \begin{bmatrix} \quad\quad\quad\quad \end{bmatrix} P_x + \begin{bmatrix} \quad\quad\quad\quad \end{bmatrix} P_y$$

(b) Reaction forces, load vector: $\boldsymbol{F} =$

(c) Normal forces are largest in the element(s):