Answer Sheet Introduction to FEM

Practical 1, Group: …

Student name	Student number

Before you start, read the practical preparation manual carefully!
Only fill in the answers for nodes and elements that apply to your specific problem. This answer sheet may contain more elements/nodes than needed.

1. Determine the displacements and reaction forces in the nodes.

node	u_x [mm]	u_y [mm]
1		
2		
3		
4		
5		
6		
7		

node	F_x [kN]	F_y [kN]
1		
2		
3		
4		
5		
6		
7		

2a. Check whether the sum of the forces equals zero (display the entire equation!).

sum	equation	[kN]
ΣF_x		
ΣF_y		

2b. Check whether the sum of the moments equals zero (display the entire equation!).

sum	equation	[kNm]
ΣM_z		

The truss forces can be calculated in two different ways to determine whether the results are correct.

3a. Determine the elongation Δl of the truss elements. Use the rotation matrices to rotate the element deformations into the local coordinate system.

elem.	Δl [mm]
1	
2	
3	
4	
5	

elem.	Δl [mm]
6	
7	
8	
9	

elem.	Δl [mm]
10	
11	
12	
13	

3b. Redo the calculation of question 3a using the initial and final coordinates of the nodes and the Pythagoras rule.

elem.	Δl [mm]
1	
2	
3	
4	
5	

elem.	Δl [mm]
6	
7	
8	
9	

elem.	Δl [mm]
10	
11	
12	
13	

3c. The answers of questions 3a and 3b are different. Using rotation matrices, the elongations are slightly off. Explain why:

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3d. Calculate the strains $\varepsilon = \Delta l / l_0$ using the elongations from question 3a.

elem.	ε [-]
1	
2	
3	
4	
5	

elem.	ε [-]
6	
7	
8	
9	

elem.	ε [-]
10	
11	
12	
13	

3e. Determine the stresses $\sigma = E\varepsilon$ using the strains from question 3d.

elem.	σ [MPa]
1	
2	
3	
4	
5	

elem.	σ [MPa]
6	
7	
8	
9	

elem.	σ [MPa]
10	
11	
12	
13	

3f. Determine the truss forces $F = A\sigma$ using the stresses from question 3e.

elem.	F [kN]
1	
2	
3	
4	
5	

elem.	F [kN]
6	
7	
8	
9	

elem.	F [kN]
10	
11	
12	
13	

4a. Determine the truss forces using the local stiffness matrix and the local displacement vectors $[K_{ei}]\{U\}$ using MATLAB.

elem.	F [kN]
1	
2	
3	
4	
5	

elem.	F [kN]
6	
7	
8	
9	

elem.	F [kN]
10	
11	
12	
13	

4b. Do the answers of questions 3f and 4a agree? Why does that make sense?

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