F. Niemeyer, U. Simon

Lab Report 2015/16

You may work together in groups of two or max. three students to have more fun.

Steps to do:

A) Perform your own little bending ***experiment***.
   a. Measure the deflection.
   b. Check the linearity of your beam by repeating the experiment choosing a different load. Discuss the results.

B) Perform an ***FEA*** corresponding to your experiment (with one of the loads). Determine the deflection.

C) Use the Simple Beam Theory to calculate the beam deflection ***analytically***.

D) Write a lab report covering A, B & C. Discuss the results and their differences.

E) Send it to us via email (ulrich.simon@uni-ulm.de AND frank.niemeyer@uni-ulm.de). Please include the e-mail addresses of all members of the group in CC. Due date is

December 20th 2015, 12:00 AM (midnight)

Hints regarding A) "Bending Experiment"

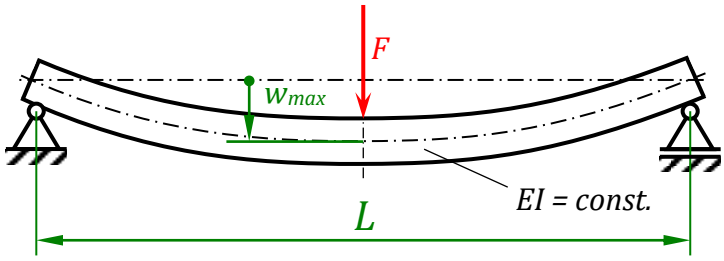
1) You have to find a beam-like object that you can load in a three-point bending with a known (measurable) force to such an extent that you are able to measure the deflection easily. Examples:
   - Take a thin flexible ruler preloaded by the weight of an empty water glass and then increase loading by filling the glass with water. Measure the additional deflection resulting from the weight of the water. You may determine the weight of the water just by measuring its volume.
   - Another possibility is to go to a hardware/home improvement store (e.g. "Bauhaus", "Praktiker") and find a beam and load it with your own body weight. You may also find tools in the store to measure the deflection of the beam. If you perform the experiment inside the store without breaking anything, you *probably* won't have to buy anything…

2) Measurements: In addition to the maximum deflection w_{max} of the beam (at the center) you have to determine the following parameters for steps B) and C):
   - Length, height and thickness of the beam
   - Material properties of the beam (Internet)
   - Force acting on the beam
3) If possible take a little photo of your experiment!

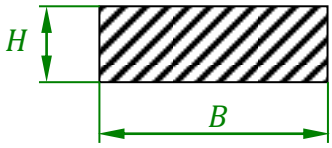
Hints regarding B) "Finite Elements Analysis"

1) Perform the FE analysis, similar to exercise 1 of lab 1.
2) Create a screen shot of the deflection contour plot (similar to Figure 15 in the script of exercise 1) with
   - a deformation scale factor of 1.0
   - applied boundary conditions visible.

Hints regarding C) "Analytical Solution"



Cross section of the beam



This is the analytical formula for the beam deflection

$$w_{\max} = \frac{L^3}{48\,EI} F$$

where:

L	– Length of the full beam
E	– Young's modulus
$I = BH^3/12$	– Axial second moment of area for a rectangular cross section

F – Force acting on full beam
w – Deflection of the beam

Hints regarding D) "Lab Report"

The lab report should consist of the following parts:

- A ***title page*** containing names (surname in capitals), matriculation numbers and e-mail addresses of ***all*** group members.
- Brief description of the ***experiment*** together with a photo or drawing.
- ***Analytical*** calculation and result.
- ***FEA*** result: A hardcopy (screen shot) of the deflection plot is sufficient.
- Summary in form of a ***Table*** with parameters and results like shown below.
- Short ***discussion***: Compare the different results and give possible reasons for differences.

Parameters		
Variables	*Unit*	*Value*
Length *L* (half length of the full beam!)	…	…
Height *H*	…	…
Thickness *B*	…	…
Moment of area *I*	…	…
Young's modulus *E**	…	…
Poisson's ratio *v**	…	…
Force *F*	…	…
	–	…
	…	…
Results: deflection w_{max} from…		
… Experiment	…	…
… FEA	…	…
… Analytical calculation	…	…
* Indicate here in the footer of the table the name of the beam material and where you got the material parameters from.		