Re-sit Exam
SOLID MECHANICS (NASM)
February 17, 2014, 18:30–21:30 h

This exam comprises four problems, for which one can obtain the following points:

Question	# points
1	1+1+1=3
2	1
3	1+1+2=4
4	2+1=3

The final grade is calculated as $(\#\,\text{points} + 1)/1.2$.

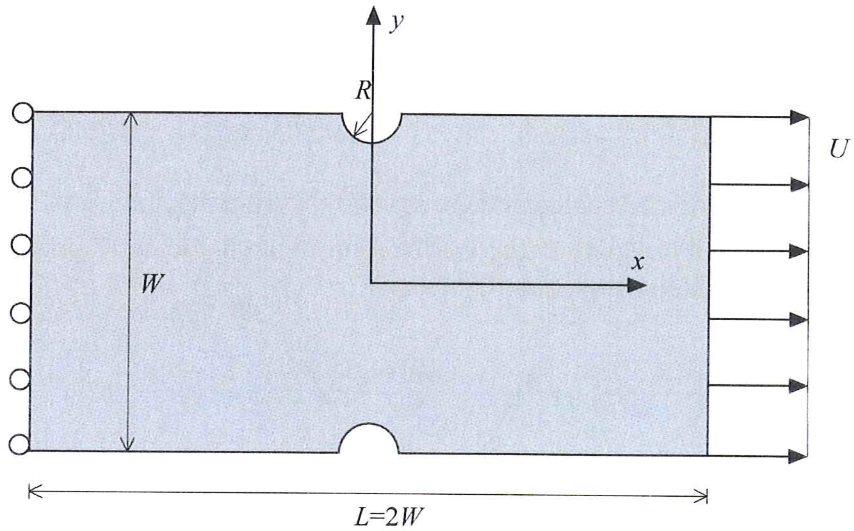
Question 1

a. Is the following statement correct or not, and why? The hydrostatic pressure in an isotropic linear elastic material with a Poisson ratio of $\nu = 1/2$ is always zero.

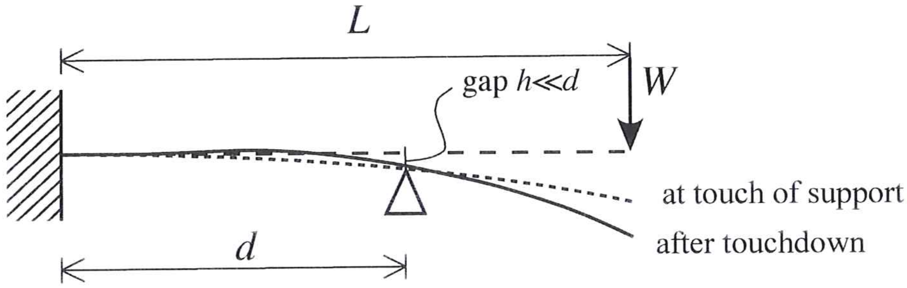
b. According to Mohr's circle, the three principal stresses $\sigma_1 > \sigma_2 > \sigma_3$ define three maximum shear stresses τ_1, τ_2, τ_3 in planes at 45° relative to subsequent sets of three principal stress directions. Can the hydrostatic stress be computed from these maximum shear stresses?

c. A slender beam has a rectangular cross section with cross section $b \times h$. It can be bent in two ways: parallel to h or parallel to b. Given the same applied bending moment M, which of the two orientations gives rise to the largest stress anywhere in the beam?

Question 2 A rectangular notched plate is subjected to tension as indicated in the figure below. To study this problem one does not need to analyze the entire specimen, but one may exploit the symmetries in the problem. Make a clear sketch of the smallest region one can consider and stipulate the boundary conditions.



Question 3 A cantilever of length L with bending stiffness EI is pushed down by a force at its end. As the tip deflection W increases, the beam touches a pivot that is located at a small distance h below the beam, at a distance d from the clamped end. After touch down the beam can be deflected further with the pivot serving as a simple support, but the stiffness —end force divided by end displacement— has changed. We analyze this change in a number of steps.



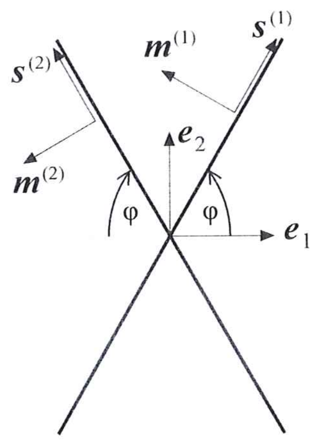
a. At which end deflection W does the beam touch the support?

b. For the behaviour after the pivot has been touched, the gap h can be neglected (that is, from now on let $h \rightarrow 0$). Formulate the boundary conditions for continued pushing down.

c. Determine the relation between end deflection and end force. How does the ratio of stiffnesses before and after touchdown at the pivot depend on the position d?

PS. You may either solve the beam equation or use the 'forget-me-nots'.

Question 4 A crystal is oriented such that there are two slip systems, $\left(\boldsymbol{s}^{(1)}, \boldsymbol{m}^{(1)}\right)$ and $\left(\boldsymbol{s}^{(2)}, \boldsymbol{m}^{(2)}\right)$, oriented symmetrically with respect to the $\boldsymbol{e}_1$-direction by an angle φ. Consider the situation where the slips on both systems are equal, $\gamma^{(1)} = \gamma^{(2)}$.



a. Determine the principal directions as well as the principal values of the plastic strain tensor.

b. What is the stress state that could have led to such a plastic deformation? Is this state unique?