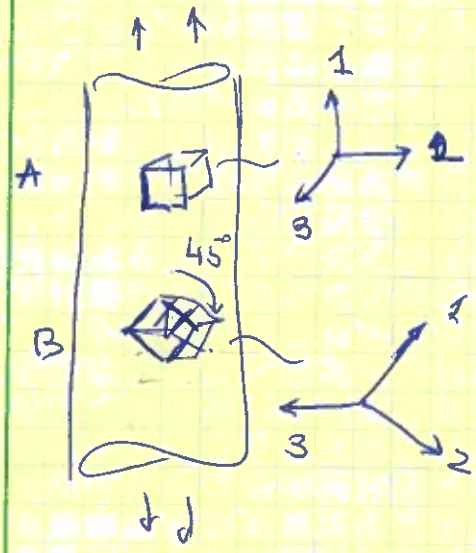
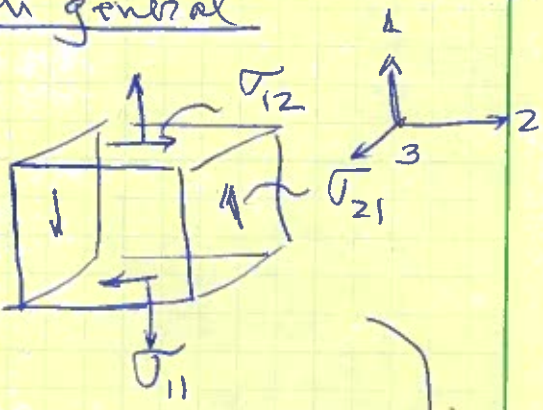
Multiaxial loading, Stress state, Strain, and Principal Stresses & Strains



$\sigma_{12} = \sigma_{21}$ (required by mechanical equilibrium)

In general



Note that A & B have the same loading but the description of the stress state depends on the orientation of the cube element

A.

B.

Orientation determines the stress tensor

$\Updownarrow$

2 directions

Note that "stress" requires two vectors

σ_{ij} — Direction of the force.

- The plane on which the force is acting
- The direction of the force.

You should now be able to understand the σ_{11}, σ_{12} notation

Principal Stress:

- Coordinate orientation such that the stress state can be described by σ_{11}, σ_{22}, σ_{33} are called the principal stress directions

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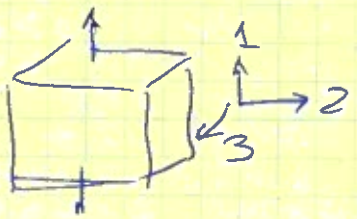
- Principal strains are similarly described by

  $$\epsilon_{11}, \epsilon_{22} \& \epsilon_{33}$$

- Usually we write as $\sigma_1, \sigma_2, \sigma_3$ & $\epsilon_1, \epsilon_2, \epsilon_3$

Note in Case A



$\sigma_1 = \sigma_a$ (applied stress)

$\sigma_2 = \sigma_3 = 0$

However:

ϵ_1 = tensile strain

$\epsilon_2 = \epsilon_3 \neq 0$.

(non zero transverse strain)