Objectives:

- Determine internal moments and forces
- Draw shear force and bending moment diagrams
- Evaluate allowable shear and normal stresses
- Design a beam

Your task this week is to propose the cross-section design (configuration) of a 3-meter long cantilever beam with a tip load $P = 12$ kN as illustrated in the figure below.
To design your beam, you have the following material available (note that you do not need to use all of them in your design):

- 4 planks of wood with dimensions $t = 60$ mm, $b = 240$ mm and $L = 3000$ mm. The wood has an allowable shear stress $\tau_{allow} = 1.5$ MPa and an allowable normal stress of $\sigma_{allow} = 10$ MPa.
- Glue that can withstand a maximum shear stress of 1.5 MPa.
- 200 nails, each with a shear strength of 2.0 kN.

When designing your beam, you need to select the arrangement of the wood planks and how they are attached to each other. The figure above illustrates one possible configuration, where four planks are horizontally aligned, the two middle planks are glued together and the other two planks are attached using nails: one row of 50 equally spaced nails on the top and another row of 50 equally spaced nails on the bottom.

a) Perform all the relevant calculations and determine if the design configuration above satisfies all the design constraints. You need to check the allowable stresses $\sigma_{allow}$ and $\tau_{allow}$, and the choice of glue and nails.

b) Now your goal is to produce at least one design that satisfies all the design constraints, using the available material.