

# Sample questions

December 13, 2025

Disclaimer: this list of questions is not comprehensive; they are unlikely to appear verbatim on the exam, and are provided solely as illustrative examples.

- Compare the principle of virtual work with the principle of complementary virtual work
- Derive and discuss the indefinite equilibrium equations
- Derive the principle of virtual work starting from the indefinite equilibrium equations and the corresponding boundary conditions
- Derive the principle of complementary virtual work starting from the indefinite equilibrium equations, the definition of the strain tensor and the corresponding boundary conditions
- Discuss the de Saint-Venant's solution for torsion
- Discuss the de Saint-Venant's solution for bending
- Discuss the de Saint-Venant's solution for traction
- Discuss the de Saint-Venant's solution for shear
- Discuss the shear center and the principal axis characterizing a beam cross section
- Discuss the generalized stress and strain of the Timoshenko beam model
- Discuss the generalized stress and strain of the Euler-Bernoulli beam model
- Discuss the generalized stress and strain of the Mindlin plate model
- Discuss the generalized stress and strain of the Kirchhoff plate model
- Describe how to use the principle of virtual work in order to solve the elastic problem of a planar structure made with hinged rods
- Derive and discuss the shear flux equation and its applications

- Discuss how to compute the force and moment resultant of a thin panel within the semi monocoque model
- Discuss how to compute the shear center of an open cross section semi monocoque model
- Discuss how to compute the torsional stiffness of a multi-cells semi monocoque cross section
- Describe the role of ribs, and how to estimate the loads they are subjected to
- Discuss the differential bending of an open cross section
- Discuss the rate of convergence of the finite element method
- Discuss the finite element shape functions properties and what requirement they need to satisfy
- Discuss Hermite shape functions
- Explain how to use the Ritz method in order to find an approximated elastic solution
- Derive the principle of virtual work for a pre-compressed beam
- Discuss the vibration frequency of a beam as a function of its tension
- Discuss the buckling load of panels
- Explain how to estimate the shear stiffness of a semi monocoque cross section model
- Explain the isoparametric finite elements
- Describe and discuss the different failure modes of rivets