Mechanics Field		Structural Mechanics 1	Total of teaching hours : 92 hrs		
			Course	Supervised work	Lab work
GM I3.5	3 ECTS credits		42 hrs		24 hrs
			4 hrs evaluation + 22 hrs individual work		

Structural Mechanics 1 : Elastic Solids and Theory of Beams

Objectives

- Learn to describe and understand a constraint condition-deformation in a continuous environment. Be able to use deformation measurements by extensometry on the structures.
- Learn how to model a beam type structure and learn how to perform traditional sizing calculations in terms of resistance and deformation (engineer approach).
- Discuss the concepts of elastic energy from deformation of a structure (energy approach of structures). Address the concepts of instability of structures (buckling).

(taxonomic level : application and analysis)

Pre-requisites and links to other modules

Mathematics
- Matrix calculus: own values, own vectors, diagonalisation, change of basis
- Integral calculation : differential equations, integrals:

Resistance of Materials
- Geometric definition of a beam
- Assumptions : on the material, on the efforts applied, on the deformation, on the small displacements, Saint-Venant
- Concept of constraint
- Phenomenon of concentration of constraints
- Description of the traction test
- Properties of the straight sections : centre of gravity, static moments, quadratic moments, main axes
- Torsor of cohesion and layout of diagrams, equation of local balance of a beam
- Simple stresses : traction - compression, pure shear, bending (calculation of the distorted elastic), twisting of beams with circular cross-section
- Compound stresses (overlay principle)
- Order 1 hyperstatism

Linear elasticity Indicative duration : 14 hrs	○ Reminder of mathematics : matrix calculus and operators ○ Deformation study (tensor of deformations, Mohr's circles, flat deformation condition) ○ Study of constraints (vector constraint, tensor, Mohr's circles, flat constraint condition, equation of local balance, Cauchy's reciprocity) ○ Elastic linear behaviour (traction test, Hooke's law, potential elastic energy, generalised elastic area, permissible constraint, equivalent constraint, extensometry by gauges) ○ A special elastic solid : beam
Theory of beams Indicative duration : 28 hrs	○ Basic assumptions of the theory ○ Reminder : geometry of sections (centre of gravity, quadratic moments, etc.) and beam statics (Basic Principle of Static, principle of cutting, diagrams etc.) ○ Tensor of constraints associated with the straight section of a beam ○ Relationship between the constraints and cohesion efforts ○ Study of simple stresses (tensors of constraints, deformations, fields of displacement and potential elastic energy) ○ Compound stresses and criterion/criteria for sizing (concentration of constraints phenomenon, safety coefficients) ○ Energy from structures ○ Study of structures composed of beams (gantries) ○ Resolution of hyperstatic systems ○ Buckling ○ Specific cases of sizing (exercises applied) : • Assemblies (fastenings) • Shocks (taking account of the dynamic effects: for example lift cable) • Thermal expansion (thermo-elastic 1 D)
6 sessions of Lab work (24 hrs)	TP 1 **Characterisation of the mechanical characteristics of a metallic material** : Young's modulus, Poisson ratio, constraint limits, etc. (traction and/or compression test, deformation of a beam by bending) TP 2 **Bending - twisting of a tube** : RdS approach and elasticity (Mohr's circle, extensometry), overlay principle TP 3 **Study of a structure in flat elasticity** : RdS approach and elasticity (in cylindrical coordinates), use of the photoelasticimetry TP 4 **Isostatic beam by bending** : diagrams, measurement of the deformed, study of sections, deflected bending, Maxwell- Betti's theorem of reciprocity TP 5 **Energy of structures approach** : isostatic and hyperstatic gantries and/or trellis structures TP 6 **Curve beams** or **Trellis type structures**

Educational approaches and assessment methods

Lecture : video-projected lesson and paper support with holes to be filled in by the student in the session, available on the school's website.
Lab Work : preparation of Lab works before each session, report to be written on a document to be filled in, supports available on the school's website.
Assessment methods :
- Course mark (60%): two supervised assignments of 2 hrs, just after half-way through the course (coeff. 40%) and another at the end (60%).
- Lab work mark (40%): this mark takes preparing the Lab works assessed in the session, a report and an assessment (oral or written) into account.

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