Numerical methods for solid mechanics

Subject area: Mechanical Engineering

University:	L'X
Level:	MA1, MA2, PhD
Teaching mode:	completely online, at specific time
Instructor(s):	Martin Genet

Short description

This course provides an in-depth introduction to the numerical methods used to solve problems in continuum mechanics. We will present and analyze the fundamental aspects of the methods (for example, the consistency, stability and convergence of the numerical schemes), and will illustrate them on practical examples. We will address structural problems of beams (1D), plates (2D) and solids (3D), static and dynamic, linear and non-linear, in various fields of application.

Full description

(Problem — Method — Exercice)
L1 — Linear algebraic systems — Linear algebraic solvers & Eigensolvers — Spring in series
L2 — Nonlinear algebraic equations/systems — Nonlinear solvers — Rivlin cube
L3 — Ordinary differential equations/systems (Initial value problems) — Integration schemes — Spring-mass system
L4 — Partial differential equations (Thermics/Elastostatics boundary value problem) — The finite element method — Beam in bending
L5 — Partial differential equations (Thermics/Elastostatics boundary value problem) — The finite element method — Sphere under pressure
L6 — Partial differential equations (Thermics/Elastostatics boundary value problem) — The finite element method — Thermal diffusion in a plate
L7 — Partial differential equations (Thermics/Elastostatics boundary value problem) — The finite element method — Perforated plate in tension
L8 — Partial differential equations (Nonlinear elasticity boundary value problem) — The finite element method + Nonlinear solvers — Buckling of an hyperelastic beam
L9 — Partial differential equations (Elastodynamics initial/boundary value problem) — The finite element method + Integration schemes — Vibrations and wave propagation in a thick plate

Learning outcomes

At the end of the course, students should be able to (i) name, describe and analyse the main numerical methods used in mechanics; (ii) use modern numerical methods and tools to solve mechanical

problems in physics and engineering, while understanding and controlling underlying assumptions and approximations; (iii) develop and implement new methods for given problems under given constraints and objectives.

General information

Contact hours per week:	2h of videos + quiz (free schedule), 2h of exercice (fixed schedule), 1-4h of personal work to finish the exercices (free schedule)
Total workload:	54h for videos + exercices, 20h for final project and presentation (in student hours for the whole course)
ECTS credits:	5
Language:	English
Course start date:	19 September 2022
Course end date:	09 December 2022
Add. info about start date:	Week of September 19, 2022
Weekly teaching day/time:	Exercices should be on Monday mornings
Time zone:	CET (Denmark, Germany, France, Netherlands, Switzerland, Czech Republic)
Further information:	
Prerequisites:	(3D) Continuum Mechanics class + Linear algebra class
Activities and methods:	Courses are in the form of short videos followed by short quiz. Exercices are in the form of Jupyter notebooks with theoretical (answer on paper) / code (answer in notebook) / analytical (answer on paper and in notebook) questions. For the exercices, students work in randomly generated groups.
Presence on campus:	no

Final examination

Form:	50% exercices to submit every week, 50% final project and presentation
Date:	
Location/format:	can be online
Re-sit possibility:	
Transcript available:	end of the semester and generally 8 weeks after the exam.
Add. info/requirements:	The exam will take place the week of December 12, 2022

Registration

To register for this course, follow the registration requirements of your **home university** as specified here: www.euroteq.eu/courses-registration.

Administration

Number of places:	18
Minimum participants:	
Internal course code:	MEC552B
Contact:	Martin.genet@polytechnique.edu or exchange-international@polytechnique.edu (for question related to registration & enrollment)

This course is part of the EuroTeQ Engineering University joint course catalogue 2022/2023. This is a collaborative activity of the partner universities DTU, L'X, TU/e, TalTech, CTU, TUM as well as Technion. Students from these universities can participate in the offered courses. It is the responsibility of the student to check if you fulfil the requirements to participate in a specific course. Students are also advised to check with their home institution how to get recognition of the ECTS credits gained in courses of the EuroTeQ course catalogue. For further information about EuroTeQ Engineering University, visit www.euroteq.eu or get in touch with the above-mentioned point of contact.