lmeca2195 — Gasdynamics and reacting flows

2024

5.00 credits	30.0 h + 30.0 h	Q2

Teacher(s)	Papalexandris Miltiadis ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	It is expected that the students have mastered the basics of thermodynamics, as covered in the courses LMECA1855 or LPHYS1343, as well as the basics of fluid mechanics, as covered in the courses LMECA1321 or LPHY1213.
Main themes	• Governing equations of compressible flows • Steady and unsteady compressible flows in one dimension • Steady compressible flows in two and three dimensions • Supersonic combustion, detonations • Subsonic combustion - deflagrations, explosions • Introduction of multiphase compressible flows.
Learning outcomes	**At the end of this learning unit, the student is able to :** With respect to the reference AA of the programme of studies "Masters degree in Mechanical Engineering", this course contributes to the development and acquisition of the following skills • AA1.1, AA1.2, AA1.3 • AA2.2, AA2.4, AA2.5 • AA3.2, AA3.3 • AA4.1, AA4.2, AA4.3, AA4.4 • AA5.1, AA5.4, AA5.6 • AA6.1, AA6.4 1 More precisely, by the end of the course, the student will be capable i) to use the main concepts of gas dynamics to the analysis of propulsion systems ii) to apply the main concepts of compressible flows to the analysis of the aerodynamics of aircraft and rockets iii) to perform thermo-mechanical calculations involving nonlinear waves of gas dynamics (shock waves, rarefaction waves and contact surfaces) iv) to understand and use elements of supersonic combustion and detonation dynamics to the study of explosions and of systems for hypersonic propulsion.
Evaluation methods	• i) Exam. The exam consists of exercises. It is written, with open books and notes, • ii) 3 homework assignments. • The grade on the exam counts for 70% of the overall grade on the course. The grade on each assignment counts for 10% of the overall grade on the course. Overall = 0.7 exam + 0.1 HW1 + 0.1 HW2 + 0.1 HW3 • The grades on the homework assignments count for the August session too. • We maintain the right to ask a student for an oral exam in case of technical problems or suspicion of fraude. • Failure to comply with the methodological guidelines defined on moodle, particularly with regard to the use of online resources or collaboration between students, will result in an overall mark of 0 for all homework assignment. • The use of artificial intelligence tools for the homework assignments or the exam is prohibited.
Teaching methods	• Course lectures • Session of exercices • Lectures in the classroom with physical presence.
Content	1. Steady and unsteady compressible flows in one spatial dimension. Variable-area flows, nozzle operation, rocket equation. 2. Compressible potential flow; subsonic and supersonic regime. Applications to flow around airfoils. 3. Normal shock waves. Rankine-Hugoniot relations. Oblique shocks. Weak shocks and rarefaction. Prandtl-Meyer equation. 4. Steady supersonic flow in many dimensions. Method of characteristics. 5. Unsteady one dimensional flows. Shock formation. Piston-induced flow. Wave interactions. Shock tubes and Riemann problem. 6. Detonations. Chapman-Jouguet theory. ZND theory. Multi-dimensional structure. Applications.

	7. Introduction to numerical methods.
Inline resources	https://moodle.uclouvain.be/course/view.php?id=821
Bibliography	• M.V. Papalexandris, *Gas Dynamics, 2022,* Presses Universitaires de Louvain, **Mandatory**. • P.A. Thompson, *Compressible Fluid Dynamics*, 1988. **Recommended**. • H.W. Lipmann and A. Roshko, *Elements of Gasdynamics*, 2001, Dover. **Recommended**
Faculty or entity in charge	MECA

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Mechanical Engineering	MECA2M	5		
Master [120] in Electro-mechanical Engineering	ELME2M	5		
Master [120] in Energy Engineering	NRGY2M	5		