ME-628

High Strain Rate Mechanics of Materials

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Cursus	Sem.	Type
Mechanics		Opt.

Language of teaching	English
Credits	2
Session	
Exam	Written
Workload	60h
Hours	**45**
Courses	30
Exercises	5
TP	5
Project	5
Number of positions	

Frequency

Only this year

Remark

Next time: Spring 2021. Zoom : https://epfl.zoom.us/j/89961075832?pwd=bUZoQjV5U1Z1eEJ2ZHdQTml0N1FkQT09

Summary

This course offers fundamentals concepts of material behavior under dynamic loads such as impact and shock. It will cover experimental methods and analytical modeling approaches to describe the dynamic deformation behavior of metals, ceramics and polymeric materials.

Content

The course offers a wide range of topics that encompass the behavior of metals, brittle materials and polymers at strain rates ranging from 10^ 4 la to 10^6/s. Fundamentals of wave propagation principles that form the foundation for the course are covered first and the importance of wave propagation in deformation and damage evolution under impact and shock loads are presented from theoretical, experimental and modeling perspectives.
The following contents will be covered.:

1. Motivation and examples of material behavior under high rates of loading
2. Fundamental principles of wave propagation (types of elastic waves, plastic waves, wave equations, 1-D stress wave propagation in solids)
3. Experimental methods (split Hopkinson pressure bar, flyer plate impact and various impact testing methods)
4. Constitutive Behavior of metals at high strain rates-fundamental concepts of thermally activated dislocation motion, effect of temperature and strain rate, and constitutive models (Johnson-cook, Zeriille-Armstrong and MTS models)
5. Drag and relativistic effects of dislocation motion
6. Shear Banding and thermal effects
7. Microstructural deformation mechanisms and deformation substructures in FCC, BCC and HCP metals at high strain rates
8. Fundamentals of shock loading (Rankine-Hugoniot relations, principles of shock wave propagation, equation of state, spall fracture)
9. Dynamic fracture and fragmentation of ceramics (strain rate dependence of fracture strength, analytical and stochastic modeling of strength and fragmentation of ceramics)
10. Dynamic response of soft materials, biological materials and foams
11. Wave propagation and fracture of transparent materials (sapphire, spinels, chemically strengthened glasses)

Keywords

Wave propagation, constitutive modeling, dynamic fracture, Hopkinson pressure bar, Shock wave propagation fragmentation in ceramics and transparent materials

Learning Prerequisites

Required courses

Shength of materials, elasticity, fudnamentals of materials science

Resources

Bibliography

Dynamic Behavior of Materials,by Marc A. Meyers (Wiley publishers), numerous papers from literature

Ressources en bibliothèque

- Dynamic Behavior of Materials,