



2EL1850 – Simulation of multiphysic couplings with FEM

Instructors: Guillaume Puel

Department: DÉPARTEMENT MÉCANIQUE ENERGÉTIQUE PROCÉDÉS

Language of instruction: ANGLAIS

Campus: CAMPUS DE PARIS - SACLAY

Workload (HEE): 60

On-site hours (HPE): 35,00

Elective Category : Engineering Sciences

Advanced level : Yes

Description

The aim of this class is to give theoretical and applied insights on multiphysic couplings simulations such as : thermomechanical, piezoelectric, vibroacoustic, magnetomechanic.

Quarter number

SG8

Prerequisites (in terms of CS courses)

Partial Differential Equations

1EL1010 - Radiation and propagation or 1EL1500 - Physics of waves or

1EL4000 - Materials or 1EL5000 - Continuum mechanics or 1EL7000 -

Transport phenomena

Syllabus

- S1-S2 Variational formulation and 1D FEM / Application: thermoelastic beam (weak thermo-mechanical coupling)
- S3-S4 2D FEM / Application: heated room with an open window (weak coupling: heat transfer and fluid mechanics)
- S5 Multiphysic coupling techniques / Application: thermal micro-actuator
- S6-S7 Model error estimation / Application: heated room with an open window (error estimation)
- S8-S9 Time- and frequency-dependent problems / Application: time-transient heating of a room and acoustics
- S10-S11 Hands-on session: MEMS design and performance analysis (stent, accelerometer, energy harvester...)
- S12 Final exam

**Class components (lecture, labs, etc.)**

S1 to S9: lecture 1h30 + numerical tutorial on Comsol 1h30

S10 to S11: hands-on sessions: MEMS design in groups of 4

Grading

2-hr written exam (1h theory + 1h practical on simulation tool): 65% of the final mark

Project evaluation: 35% of the final mark

Course support, bibliography

Textbook

Resources

Instructor: Guillaume PUEL

Tutorial classes: 35 students

Software: Comsol Multiphysics (Structural mechanics, MEMS)

Learning outcomes covered on the course

- Solve and model a multiphysic problem including solid mechanics, heat transfer, fluid mechanics, electricity, and magnetism
- Design sensors and actuators thanks to the use of different coupled physics and technologies
- Model and solve a multiphysic problem using a commercial finite element code with specific attention to solution accuracy.

Description of the skills acquired at the end of the course

The validation of the milestones 2 of the skills **C1** and **C6** is related to the project made during the two hands-on sessions S10 and S11.

The validation of the milestone 2 of the skill **C2** is related to the final mark for this course.