

**EU objectives****At the end of this course, students will be able to :**

Simulate the dimensions of complex mechanical systems (solid, fluid, thermal) to reduce the weight and energy consumption of the systems involved, and so reduce their environmental impact.

- Master the modelling of 2D and 3D lattice structures;
- Master the modelling of 2D and 3D beam and grid structures;
- Master the modelling of 2D and 3D solids;
- Master the modelling of plate and shell structures;
- Mastering how to take account of thermal effects in the behaviour of solids.
- Know the different numerical schemes in fluid mechanics;
- Master the modelling of fluid flows coupled with heat transfer in Finite Volumes;
- Master finite difference discretization and interpolation schemes;
- Master the techniques for solving algebraic transport equations;
- Build a digital model (2D/3D) from a real problem;
- Analyse simulation results and validate them with experimental results.

**Description of the ECUEs****FINITE ELEMENT METHOD**

- Description of the finite element method, for the linear calculation of solids in static and vibratory regimes;
- Strong and weak formulations associated with systems of equilibrium differential equations ;
- Finite element formulation of 1D, 2D and 3D bars ;
- Finite element formulation of 2D and 3D beams ;
- Finite element formulation of T3 and Q4 plane elasticity in plane stresses or strains;
- 3D solid finite element formulation TH4 and H8 ;
- Finite element formulation of flat facet plates and shells;
- Quality of finite element models for industrial problems ;
- Learning ANSYS industrial finite element software.

TD and TP: Solving exercises and practising the theoretical concepts covered in class using software.

## CFD

- Numerical approaches to fluid mechanics ;
- Formulation of the Finite Difference method ;
- The conservative form of the transport equations ;
- Discretisation and interpolation schemes ;
- Solving algebraic transport equations ;
- Pressure/speed coupling ;
- Learning the Star-CCM+ finite volume software package.

TD and TP: Solving exercises and practising the concepts covered in class using software

### **Prerequisites**

Continuum Mechanics, Elasticity, Fluid Mechanics, Heat Transfer, Basic Numerical Analysis.

### **Bibliography**

- D.L. Logan, "A First Course in the Finite Element Method", Thomson Edition, ISBN 978-1305635111, 992 pages, 2016.
- G. Dhatt, G. Touzot, E. Lefrançois, "Méthode des éléments finis", Edition Hermès - Lavoisier, 601 pages, ISBN 9782746246669, 2015.
- C. Hirsch, "Numerical Computation of Internal and External flows", Vol 1 & 2, Edition Wiley, ISBN-13: 978-0471924524, 1990.
- J.L. Batoz, G. Dhatt, "Modélisation des structures par éléments finis", V1, 2, Editions Hermès, ISBN 978-2866012434, 1990.
- D. Anderson, J.C. Tannehill, R.H. Pletcher, "Computational Fluid Mechanics and Heat Transfer", Edition CRC Press, ISBN 978-1591690375, 774 pages, 2011.