INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

4th YEAR MA OPTIONAL COURSES_SEMESTER 8

Practical info

Location(s)

Toulouse

Finite Element Methods & Model Reductions

ECTS
4 crédits

Hourly volume

Introducing

Objectives

At the end of this course, the student will have understood and will be able to :

- Write the weak (variational) form of the classical PDE models (with the corresponding energy minimization in symmetric cases).
- Write and code a FE scheme (for linear and non-linear scalar models)

- Develop offline-online strategies to perform reduced basis models in real time (POD and Machine Learning based).

- Employ Finite Element libraries in Python, FEniCS (and FreeFEM++),

Necessary prerequisites

Fundamentals of PDE models and math. analysis, Numerical analysis.

Location(s)

Toulouse

Practical info

Modeling and scientific computing in fluid and structural mechanics

ECTS
4 crédits

Hourly volume
55h

Introducing

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

The fundamentals of Mechanics for fluid and deformable solids, from a physical, mathematical and numerical point of view.

The student will be able to:
- Understand the physical meaning of the various terms used in fluid mechanics and elasticity models.
- Calculate exact solutions of simple problems and interpret them physically
- Evaluate orders of magnitude and know the physical meaning of the main dimensionless numbers
- Formulate and apply a finite volume method for numerically solving simple problems of fluid mechanics
- Formulate and solve the problem of elasticity by means of the finite element method.
- Use an industrial software to model and compute the elasticity problem in static as well as in dynamic.
- Write and implement a mixed formulation to couple different elastic domains and different numerical codes used as black-boxes.

Necessary prerequisites

Fundamentals in:
Continuum mechanics
Numerical analysis
Partial derivative equations

Practical info

Location(s)

Toulouse

Data analysis

ECTS
4 crédits

Hourly volume
58h

Introducing

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):
- Data base organisation of R and Python data frames. Syntaxes R and Python languages. R and Python functions design, program and test.
- Statistical analyses of multidimensional data: dimension reduction and clustering with R and Python.
- Statistical interpretation of various graphical displays including the different kinds of factor analyses and clustering.

The student will be able to:
- Manage big data sets with R and Python.
- Lead exploratory data analyses of real big data. It includes univariate, bivariate and multivariate data analyses featuring PCA, MCA, FDA, NMF kmeans, mixture models, DBSCAN¿ depending on data structures and analysis purposes;
- Detect relevant structures within complex data sets and compile insightful interpretations.

Practical info

Location(s)

Toulouse

Stochastic Processes: Time Series and Gaussian Processes

ECTS
4 crédits

Hourly volume
58h

Introducing

Objectives

At the end of this lecture, the student should have acquired the following skills, as well theoretically than practically with the R statistical Software and / or Python.

1) Time series
-Estimate or eliminate the trend and/or the seasonality of a time series
-Study the stationnarity of a time series
-Calculate and estimate the autocorrelogram and the autocorrelograms (total and partial) of a stationary process
-Study and/or adjust an ARMA (or ARIMA) model on a stationary time series
-Carry an optimal linear forecast of an ARMA process

2) Gaussian processes
-Know the fundamental properties of Gaussian processes
-Be able to characterize a Gaussian process through its covariance function
-Be able to use Gaussian Processes for modeling real life situations.

Necessary prerequisites

1) Time series
Probability and Statistics (MIC2) I2MIMT31
Statistics (MIC3) I3MIMT05
Probability and Inferential Statistics (I4MMMT21)

2) Gaussian processes
Advanced probabilities: martingales, stochastic algorithms and Montecarlo methods.
Markov chains.
Integration and probabilities.

Practical info

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Toulouse