POLYTECH LYON

http://polytech.univ-lyon1.fr

ENGLISH COURSES CATALOGUE

(last update: March 2019)

MECHANICAL ENGINEERING

- Introduction to Fluid Mechanics – 3rd year, semester 5 (3 ECTS)
- Advanced Fluid Mechanics 1 – 3rd year, semester 6 (3 ECTS)
- Advanced Fluid Mechanics 2 – 4th year, semester 7 (3 ECTS)

INDUSTRIAL SYSTEMS AND ROBOTICS

- Technology Intelligence"- 3rd year, 1 ECTS

MATHEMATICS AND MODELLING ENGINEERING:

Classes are usually given in French. However, teaching language can be switched to English in case there is a non-French speaking exchange student attending classes.

- Software engineering – 3rd year, semester 6 (4 ECTS)
- Duration modeling – 4th year, semester 8 (1 ECTS)
- Time series– 4th year, semester 8 (3 ECTS)
- Mathematical modeling – 5th year, semester 9 (3 ECTS)
- Discontinuous Galerkin – 5th year, semester 9 (2 ECTS)
- High performance computing – 5th year, semester 9 (4 ECTS)
- Risks – 5th year, semester 9 (2 ECTS)

BIOMEDICAL ENGINEERING

Classes are usually given in French. However, teaching language can be switched to English in case there is a non-French speaking exchange student attending classes.

- Quality and management of software projects in health – 5th year, semester 9 (practicals)
- Optical biomedical – 5th year, semester 9 (4 ECTS)
- Nanotechnologies – 5th year, semester 9 (2 ECTS)
- Embedded systems – 5th year, semester 9 (3 ECTS)
- Project – 5th year, semester 9 (2 ECTS)

There is also the possibility for the students to:

- Follow the language classes in English, Spanish, German or Italian in the different department and semester (2 classes) **(3 ECTS)**
- Follow French as foreign language **(3 ECTS)**

Course details

MATHEMATICS AND MODELLING ENGINEERING

- Software engineering 3rd year, semester 6 (28h CM, 4h TD, 28h TP) **4 ECTS**

Prof. D. Tromeur

Educational purpose:

To have a methodological tool available to implement the object approach (UML2.1.1). To be able to implement the concepts of object-oriented programming using the C++ language: to be able to build a simple application and to contribute to a large and complex one. Introduction of the object concept in scientific computation.

Prerequisite: Tools of scientific computing, Numerical analysis I.

Content:

- Management of a complex application code: object solution using UML 2.1.1 (4HCM, 2HTD, 2HTP) UML methodology concepts (OMG norm (Object Management Group)). Static views of a system: object, class, component, deployment diagrams. Dynamic views of a system: collaboration, sequence, state-transition, activity diagrams

- Object-oriented programming for scientific computing: (16HCM, 16HTP). Basics of POO: object, class, polymorphism, dynamic link, C++ programming: class, operators, friendship concept, generic programming: (template).Simple and multiple Inheritance. STL and scientific libraries implementation (4HCM/6HTP).Structure of advanced data for scientific computing: valarray, map, vector. Introduction to the Template Numerical Toolkit library (lapack++, IML++, SparseLib++, mv++.). Inclusion of new digital features into a complex object-oriented code designed for scientific computing (hydrology, process engineering…).

- Development of human-machine interfaces (2HCM, 2HTD, 2HTP). Use of the Qt library and graphism.

- Code optimization, debugging tolls (2HCM, 2hTP)

Support software: Environment Eclipse Environment, OMONDO/BOUML, STL library, Boost library, GSL 1.9, Template Numerical Toolkit, Java Sun 1 & BEA Logic compilers.

- Time series (20h CM, 14h TD 6h TP) **3 ECTS**

Prof: C.Marteau

Educational purpose:

The course aims at presenting statistical treatment methods related to time series: smoothing, deseasonalization and forecast. By the end of the course students should have developed an awareness of the potential application of time series in industry, in the economy... And be able to analyze them using software outputs.

Prerequisite: Random modeling courses of semesters 5 and 6, Regression models.

Content:

Descriptive analysis of time series (seasonal decomposition, exponential smoothing);

Random modeling of a time series: second order process, stationarity, auto covariance function, autocorrelation function, partial autocorrelation function, spectral density;

Unvaried processes: MA, AR, ARMA, ARIMA, SARIMA.

Practice of SARIMA models (Box-Jenkin methodology): identification, estimation, verification, validation, comparison.

Support software: R & SAS

References :

- Brockwell, P. & Davis R., *Introduction to Time Series and Forecasting*, Springer, 1996.
- Bosq D., Lecoutre J-P., *Analyse et prévision des séries chronologiques. Méthodes paramétriques et non paramétriques*, Masson, 1992.
- Aragon, Y., *Séries temporelles avec R : Méthodes et cas*, Springer, 2011.

- Duration modeling 4th year, semester 8 (10h CM, 6hTD, 4hTP) (**1 ECTS)**

Prof. V. Maume-D.

Educational purpose:

By the end of the course, students should be familiar with the vocabulary and the tools used in duration modeling as well as with its main applications to reliability, health care issues... They are expected to be familiar with the models and the associated underlying assumptions as well as with the commonly encountered problems. They should also be able to calculate standard estimators and interpret standard tests, using the R and SAS software

Prerequisite: Random modeling courses of semesters 5 and 6

Content:

- Duration models
- Parametric and non-parametric modeling
- Regression models, Bayesian approach.

Support software: R or SAS

References:

- Droesbeke, J.J. & Fichet, B. & Tassi, P., Analyse Statistique des durées de vie. Modélisation des données censurées
- Klein, J.P.&Moeschberger,M.L., Survival Analysis : Techniques for Censored and Truncated Data, Springer, 2003.

- Mathematical modeling 5th year Semester 9 (CM 30, TP 30) (3 ECTS)

Prof. D. Le Roux

Educational purpose:

To acquire a command of all the problems involved from the modeling of a physical problem to its numerical solution and of the underlying mathematical tools. Students are also expected to be able to combine and implement the discretization methods they have been taught during the first two years of their curriculum.

Prerequisite: Courses in Numerical methods

Content: In this course, the modeling process is tackled all the way from its physical formulation to its numerical solution. The program consists of several independent modules:

- Modeling in biology: reaction-diffusion equations describing animal coat pattern formation. Analysis of solutions.

Solving nonlinear models using Newton and Gear's methods.

- Modeling of the valuation of financial products (options, futures).The Black and Scholes equations are derived from Brownian motion and discretized using finite difference and finite element methods.

- Modeling in fluid mechanics: the main equations (momentum and continuity) are derived from conservation laws. Lagrangian vs. Eulerian description. The turbulence problem.

Application to various problems in geophysics.

- Modeling of dynamical systems, bifurcations, nonlinear analysis.

Support software: FreeFem++

References:

They will be provided during the course in the form of articles in journals, book chapters, etc...

- Discontinuous Galerkin methods 5th year Semester 9 (CM 15, TP 15) (**2 ECTS**)

Prof. D. Le Roux

Educational purpose:

By the end of the course, students should be able to discretize PDE systems using the discontinuous Galerkin method and should be conversant with its properties, in particular from a numerical point of view.

Prerequisite: Mathematical methods for engineers, Finite elements I

Content: Definition of the method's specific functional framework. Discontinuous variational formulations, broken Sobolev spaces, non-compliant error analysis. Reminders on orthogonal polynomials (for approximation spaces). DG methods for scalar and non-linear conservation laws: weak formulation, well-posed problem, stability, convergence, error computation, inf sup condition. RKD methods. How to introduce diffusion operators in the DG methods (symmetric interior penalty methods…). DG methods will be shown to be mixed methods that are stabilized for diffusion problems. Numerical fluxes approximation: centered and upwind schemes, examples and applications. Use of non-conforming meshes. Unsteady problems. Application to Stokes, Naiver-Stokes and Saint-Venant equations.

References:

D.A. Di Pietro, A. Ern, Mathematical aspects of discontinuous Galerkin methods, Springer, 2012.

B. Rivière, Discontinuous Galerkin methods for solving elliptic and parabolic equations: Theory and implementation. SIAM, 2008

- High performance computing, 5th year, semester 9 (35HCM, 35HTP) (**4 ECTS)**

Prof. D. Tromeur-Dervout

Educational purpose:

To acquire the reflex of conceptualizing distributed programming, of writing a new module compliant with the standards of a given code, and of validating and verifying a code.

Prerequisite: Numerical analysis I and II, Tools of scientific computing and Software engineering.

Content:

Introduction to message exchange libraries (MPI), compiler directives programming (Open MP) and to computation using GPGPU (OpenCL). Modeling of distributed architectures, code performance assessment for a given architecture.

High performance computing methods suited to the programming models: pipeline, under structuring, domain decomposition (Schur, Feti, Schwarz), decomposition of operators, decomposition in function spaces, distributed DFT, parallel Krylov methods. Code and/or PDE coupling methods.

Code validation and verification procedure.

Software support: MPI, open MP, OpenCL, Fortran90, Petsc, Scala pack.

- Risks, 5th year, semester 9 (12h CM, 8h TD) (**2 ECTS)**

Prof. A.-L. Fougères

Educational purpose:

How to evaluate the probability of sparse events? How to determine the height of a dyke for the probability of any overflow to be smaller than some regulatory value? How to set the rate of a reinsurance premium? The course is intended to provide the probabilistic and statistical tools needed to answer the above questions. Attention will also be paid to the numerical implementation of the methods proposed in R.

Prerequisite: Random modeling of semesters S5 & S6.

Content:

Introduction to extreme value theory. Examples.

Maximum and threshold overrun modeling.

Evaluation of small probabilities and extreme quantiles.

References:

Resnick, S. I., Heavy-tail phenomena. Probabilistic and statistical modeling, Springer Series in Operations Research and Financial Engineering. Springer, 2007.

De Haan, L. & Ferreira, A., Extreme value theory. An introduction. Springer New York, 2006

Beirlant, J. & Goegebeur, Y. & Segers, J. & Teugels, J., Statistics of Extremes, Theory and applications. Wiley, 2004.

MECHANICAL ENGINEERING

- Introduction to Fluid Mechanics – 3rd year, semester 5 **(3 ECTS)**

Prof: Arie Biesheuvel

Objectives:

Introduction to the application of the principles of mass, momentum, and energy to fluid flows.

Program Description:

Unidirectional incompressible flows: Bernoulli equation, actuator disk theory, rotating flow machinery;

Dimensional analysis: dimensionless parameters, head losses in pipe systems, drag coefficients;

Unidirectional compressible flows: isentropic flow in pipes of varying area, de Laval nozzles, normal shocks, Fanno flow.

- Advanced Fluid Mechanics 1 – 3rd year, semester 6 **(3 ECTS)**

Prof: Arie Biesheuvel

Objectives:

In-depth study of the principles of fluid mechanics, with emphasis on the effects of viscosity.

Program Description:

Kinematics of the velocity field: Eulerian and Lagrangian description of fluid motion, Poisson–Stokes decomposition, transport theorem, mass-conservation equation, stream function;

Equations governing the motion of fluids: Cauchy's stress principle and principle of local equilibrium, Cauchy equation, Poisson–Stokes constitutive relation for a Newtonian fluid, Navier–Stokes equation, energy equation, entropy equation, equation of heat transfer, Euler equations for an ideal fluid, Bernoulli's theorem, Crocco's equation;

Elementary solutions: steady unidirectional flow (Poiseuille flow, Couette flow), unsteady unidirectional flow (Stokes's problems, starting flow in a pipe), flow with circular streamlines (Couette device);

Introduction to vorticity dynamics: vorticity equation, vorticity generation at rigid surfaces, spreading line vortex, Burgers vortex, flow toward a stagnation point at a rigid boundary;

Flows in which inertia forces are negligible: flow due to a moving sphere at small Reynolds, Oseen equation;

Flows at large Reynolds number: Prandtl's boundary layer equations, the boundary layer on a flat plate, Falkner–Skan equation, von K´arm´an integral equation, Pohlhausen method, jets and wakes.

- Advanced Fluid Mechanics 2 – 4th year, semester 7 **(3 ECTS)**

Prof: Arie Biesheuvel

Objectives:

In-depth study of the principles of fluid mechanics, with emphasis on effectively inviscid flows.

Program Description:

Irrotational flow theory and its applications: general properties of irrotational flow, spherical expanding bubble, irrotational flow due to a moving sphere, two-dimensional flow due to a moving cylinder, Zhukovsky's theorem, hydrodynamic impulse, force and moment on a body, elementary singular solutions (source, sink, source doublet), Green's theorems, Rankine bodies, use of the complex potential for two-dimensional flow, conformal transformation of the plane of flow, circle theorem, Blasius–Chaplygin theorems;

Flow of effectively inviscid fluid with vorticity: vorticity equation, Helmholtz's laws and Kelvin's circulation theorem for an inviscid fluid, the expression for the velocity distribution with a specified vorticity, line vortices, sheet vortices, vortex momentum and hydrodynamic impulse, two-dimensional flow in unbounded fluid, motion of a group of point vortices, von K´arm´an Vortex Street, Kelvin–Helmholtz instability.

BIOMEDICAL ENGINEERING

- Quality and management of software projects in health – 5th year, semester 9 (12h TP)

Program Description:

Practicals only in English (lectures in French) : collaborative projects to put into practice what has been seen during lectures (1st project will allow to work on methodology, 2n project will focus on a scientific subject)

Pedagogical support:
- Management system of pedagogical quality : STBL, DAL, DCD
- IDE (Linux or Windows based)

- Optical biomedical – 5th year, semester 9 (48h CM, 12h TD) (4 ECTS)

Program Description:

This class is about optical biomedical, from physical bases to biomedical and medical applications.
- Physical bases :
  - geometrical optics
  - physical optics
  - Lasers

- Interaction of light and biological environment :
  - human vision
  - optical properties of biological environment
  - light propagation in biological environments
  - photothermal effects in biological environments

- Optoelectronics :
  - sources
  - detectors

- Optical medical and biomedical applications :
  - optical analysis of biological samples
  - optical analysis in vivo (superficial tissues)
  - optical analysis in vivo (solid organs)
  - optical therapies

- Security of patients and operators of optical medical devices

- Practicals (TP) :
  - o TP1 spectroscopy
  - o TP2 interferences 1
  - o TP3 interferences 2

Pedagogical support:
- Slides and numerical sources
- Practicals notebook

- Nanotechnologies – 5th year, semester 9 (24h CM, 6h TD) (2 ECTS)

This class is an introduction to micro- and nano-technologies applied to health.

- Development of new biomedical markers and therapeutic vectorization agents through the use of nano-objects :
o general introduction
o medical imaging
o therapy and et vectorization

- Miniaturisation of medical devices for in-vitro diagnostic:
o general introduction
o micro-nanofabrication methods
o microfluidic components (valves, pumps, separators, ...)
o diagnosis dedicated systems

Pedagogical support:
- Slides and numerical sources
- Practicals notebook

- Embedded systems – 5th year, semester 9 (30h CM, 24h TD) (3 ECTS)

Program Description:

This class presents embedded hardware and software systems, with a focus on health-related applications
- General presentation of embedded hardware and software systems
- Reconfiguratble hardware systems or logical systems :
- Micro-programmed systems
- connected embedded systems

Pedagogical support:
- Slides and numerical sources

- ‘Petit Biomed @ Polytech’ platform, with design and development tools from Xilinx, Digilent et Texas Instrument

- Project – 5th year, semester 9 (30h TD) (2 ECTS)

Program Description:

This class allows students to apply biomedical engineering skills to a project that they define.
- students work in guided autonomy (with a referent teacher)
- Strong technical focus : design and development of software, electronic cards, embedded systems… with health related applications
- Deliverables : specification (with schedule, methods, deliverables) ; technical brief, oral presentation and demonstration

Pedagogical support:
Computer tools and ‘Petit Biomed @ Polytech’ platform