# Biofluid Dynamics (6 cfu)

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***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The aim of the course is to investigate some theoretical and technical aspects of Fluid Dynamics, paying a special attention to biomedical applications. At the end of the course, the students are supposed to know the main models (Newtonian and Non-Newtonian fluids) and some important exact solutions. Moreover, they will be able to deal with the principal rheological models and other biological applications. A basic knowledge of the boundary value theory and turbulence will be also achieved.

***COURSE CONTENT***

Physiology and rheology of blood flow.

Elements of Continuum Mechanics. Continuity equation. Momentum balances. Flow equation.

Newtonian fluids. Cauchy-Poisson constitutive law. Navier-Stokes equations. Nondimensional equations and Reynolds’ number. Viscometric flows in cylindrical coordinates. Stokes’ equation. Perfect fluids. Boundary layer. Prandtl’s boundary layer equations. Blasius solution. Darcy law.

Stokesian fluids. Generalized Newtonian fluids. Shear-thickening and shear-thinning fluids. Some hemodynamical models: power law, Carreau, Casson, Bingham, Herschel-Bulkley. Micropolar fluids. Rivlin-Ericksen fluids.

Turbulence. Reynolds averaged equations. Reynolds stress tensor. Boussinesq hypothesis and eddy viscosity. Turbulent kinetic energy equation. Turbulent boundary layer.

***READING LIST***

Y.C. Fung*, Biomechanics. Circulation*, Springer-Verlag, 1997

G.P. Galdi et al., *Hemodynamical Flows*, Birkhäuser, 2008

In addition, lecture notes will be provided by the teachers.

***TEACHING METHOD***

Classroom lectures, with the help of some numerical simulations.

***ASSESSMENT METHOD AND CRITERIA***

There will be an oral examination about theoretical topics and analysis of some models, aimed to evaluate the knowledge and the expertise of the student.

The relevance of the answers, the appropriate use of the specific terminology and the reasoned and coherent structuring of the discourse will contribute to the evaluation.

The exam will last about 40-50 minutes.

***NOTES AND PREREQUISITES***

In order to address the course, some knowledge of vector calculus, differential equations and classical mechanics are required. Nevertheless, the useful concepts will be recalled during the lessons.

Further information can be found on the lecturer's webpage at http://docenti.unicatt.it/web/searchByName.do?language=ENG or on the Faculty notice board.