INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Computational Hemodynamics			Field of study	Biomechanics		
Master in	Biomedical Technology - Biomechanics and Rehabilitation			School	School of Technology and Management		
Academic Year	2019/2020	Year of study	1	Level	2-1	ECTS credits	6.0
Type	Semestral	Semester	2	Code	5025-421-1202-00-19		

Workload (hours)	162	Contact hours	T -	TP 15	PL 45	TC -	S -	E -	OT -	O -

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tuturial; O - Other

Name(s) of lecturer(s): Ricardo Frederico Pereira Dias

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Identify different constitutive equations.
2. Distinguish a stationary flow from a non stationary flow.
3. For a given flow, identify and simplify the different governing equations - the conservation equations for mass, linear momentum and energy.
4. Know how to implement bi and three-dimensional complex geometries using numerical tools.
5. Distinguish different types of domain discretization and recognize the importance of using adaptive meshes.
6. Know how to establish the boundary conditions for a given flow using numerical tools.
7. Know how to use the numerical tools to visualize numerical results with clinical relevance such as: shear stress in the wall of blood vessels, velocity profiles and pressure.

Prerequisites

Before the course unit the learner is expected to be able to:
1. Characterize the anatomy of the cardiovascular system.
2. Identify physiological and pathological aspects of the cardiovascular system.

Course contents

Rheological models of blood; Numerical models in fluid-structure interaction; Blood flow

Course contents (extended version)

1. Rheological models of blood
   - Generalized Newtonian models
   - Viscoelastic models: integral and differential models
2. Numerical models in fluid-structure interaction
   - Eulerian-Lagrangian formulation for arbitrary flow in moving domains
3. Blood flow
   - Flow of blood in the pulmonary and vascular systems
   - Governative equations: the conservation equations for mass, momentum and energy
   - Finite element method applied to blood flow
   - Use of numerical tools for analysis of problems with clinical interest

Recommended reading

1. Fung, Y. C. , Biomechanics Circulation, Springer, 2nd. edition, New York, USA, 1996.
2. Thiriet, M. , Biology and Mechanics of Blood Flows: Part II: Mechanics and Medical Aspects, Springer, New York, USA, 2007.
3. Li S. , Liu W. K. , Meshfree Particle Methods, Springer-Verlag, Berlin, Germany, 2004.
4. Patankar, S. V. , Numerical heat Transfer and Fluid Flow, Taylor & Francis, USA, 1980.
5. Versteeg H. K. , Malalasekera W. , An introduction to computational fluid dynamics, Pearson Prentice Hall, Harlow, 1995.

Teaching and learning methods

The exposition of the fundamental notions from each of the topics outlined in the programme, relating the theory with some practical examples, will be carried out in the theoretical-practical classes. The numerical works will be performed in the laboratory classes, the reports of the referred works being then written.

Assessment methods

- Single Method - (Regular, Student Worker) (Final, Supplementary, Special)
  - Practical Work - 80%
  - Final Written Exam - 20%

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Ricardo Frederico Pereira Dias	Hélder Teixeira Gomes	Fernando Jorge Coutinho Monteiro	Paulo Alexandre Vara Alves
09-03-2020	16-03-2020	19-03-2020	20-03-2020

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