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LECTURE NOTES 6

Blood Flow Modelling and Diagnostics

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edited by

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Centre of Excellence for Applied Biomedical Modelling and Diagnostics

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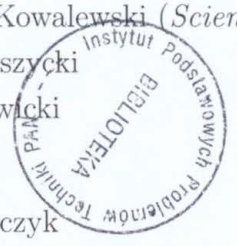
ABIOMED LECTURE NOTES



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Preface

The rapid growth and development of the experimental methods in fluid mechanics, ultrasound systems for medicine and computational tools for flow modelling brought about the need for a closer exchange of knowledge used by people working in these areas. This aim encouraged us to organize in Warsaw a four days meeting on *Blood Flow—Modelling and Diagnostics* (BF 2005). It was prepared in the framework of the Center of Excellence ABIOMED (T. Kowalewski, A. Nowicki), conjoined with ERCOFTAC SIG-37: Bio-Fluid Mechanics and Heat Transfer Interest Group (A. van Steenhoven).

The main interest of today's research in haemodynamics is more and more dedicated to accurate modelling of blood flow characteristics. It became evident that blood is a complex fluid, with properties depending on many factors, not limited to shear rate and hematocrit. The cardiovascular tubing system is characterized by large variety of scales, shapes and wall properties. The fluid mechanics strongly varies inside different vascular regions, altering pressure drops and blood redistribution in a flexible way. Moreover, the heat and mass transfer within the system plays an important role. The pulsating flow characteristics and laminar to turbulent transitions introduce additional complications that are very difficult to deal with analytical and numerical tools. On the other hand, development of new diagnostic tools allows for more and more detailed verification and validation of the modelling attempts. The BF 2005 program made an effort to give a good overview of these problems. Generally, it consisted of three main parts: modelling of blood as a flow media, numerical modelling of the cardiovascular flow and experimental diagnostics by optical and acoustic means.

The present volume contains set of invited articles concerning the most recent advances in the above topics and selected research papers presented during the workshop as contributed papers. The lecture notes are ordered in the way facilitating understanding complexity of the cardio-vascular circulatory system. The book starts with a general description of blood properties, followed with an overview of peculiarities of the circulatory system and de-

scription of experimental methods used by fluid mechanicians to analyse the blood flow. Another view on the cardiovascular diagnostic is brought by the ultrasound technique (USD). Highlights of its recent advances offering high precision measurements are described in the book. The last two review papers demonstrate growing potential of the Computational Fluid Dynamics (CFD) in resolving extremely complex flow configurations of the cardiovascular systems. Seven contributed papers complete the book offering up to date research examples in the modelling and diagnostics of cardiovascular systems.

We hope that the book enables a wide range of researchers, with a different background (mechanical engineering, mathematics, electronics, acoustics and medicine) to find different experience and tools used in the area of cardiovascular fluid mechanics. It is especially interesting to find similarities and differences in optical and acoustic methods of the blood flow measurement, as well as to compare numerical modelling of cardiac surgery with practical experience of medical doctors. Experimental facts, computational results, and extensive bibliography following each article offer unique collection of information facilitating necessary efforts for merging these different fields of expertise.

Tomasz A. Kowalewski Warsaw, November 2005