The College of Engineering of

EAFIT University

announces the

final examination of

Raúl A. Valencia

for the degree of

Doctor of Philosophy in Engineering

Monday, October 26, 2015 – 10:00 am

Auditorium,
Fifth floor - Engineering Building,
EAFIT University
Medellin - Colombia

Major Field of Study
Applied Mechanics

Dissertation
Computational Study of Cell Mobility and Transport Phenomena through Textile Vascular Grafts using Multi-Scale Approach

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This examination is open to the public

ABSTRACT

Textile vascular grafts are biomedical devices and play an important role serving as a solution for the partial replacement of damaged arterial vessels. It is believed that the success of a textile vascular graft, in the healing process after implantation, is due to the porous microstructure of the wall. Although the transport of fluids through textiles is of great technical interest in biomedical applications, little is known about predicting the micro-flow pattern and the transport and deposition of individual platelets, related with the graft occlusion. The aim of this work is to investigate how the type of fabric, permeability and porosity affect both the local fluid dynamics at several scales and the fluid-particle interaction between platelets in textile grafts.

Two types of samples were analyzed: woven and electrospun, this last one has been manufactured. This study involves both experimental and computational tests. The experimental tests were performed to characterize the permeability and porosity under static conditions. The computational tests are based on a multi-scale approach where the fluid flow was solved with the Finite Element Method and the discrete particles were solved with the Molecular Dynamic Method. The fluid-particle interaction was accomplished in one-, two-, and four-ways, where the blood was considered as a suspension of platelets in plasma. The textile wall was considered as a porous media with two scales of length: straight tubular structure with porous walls for the macro-domain and representative unit cells of fabric for the micro-domain. Additionally, it presents the implementation of a numerical case that includes one of the main applications of textile vascular grafts to repair Abdominal Aortic Aneurysms (AAA). The results have shown that the type of fabric in textile vascular grafts and the degree of porosity and permeability affect the local fluid dynamics and the level of penetration of platelet particles through the graft wall at several length scales, thus indicating their importance as design parameters.

VITAE

Doctoral student Raúl A. Valencia, M.Sc.
Engineer from UPB University, Mechanical Design Specialist and Master in Mechanical Engineering from EAFIT University. In 2000 he was appointed as assistant professor at the Mechanical Engineering Department at UPB University. He has lectured at Undergrad and Master Programs. As a research assistant, he has participated in several projects on Bioengineering and Mechanical issues with the Applied Mechanics research group (EAFIT), Automatic and Design research group (UPB) and Cardiovascular Dynamics research group (UPB). In 2013 he did his internship at the University of Texas in San Antonio and he was visiting student at Virginia Tech University.

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