

Université de technologie de Compiègne – Thesis proposal

Part 1: Scientific description	
Thesis proposal title	Mechanical and electrical modeling of the uterine contraction (MIMETIC)
PhD grant	50% Haut de France Region, 50% ANSYS company
Research laboratory	Research unit: BMBI UMR CNRS 7338, Biomechanics and Bioengineering Research team: NSE, Neuromécanique et Signaux Electrophysiologiques web site: http://www.utc.fr/bmbi/
Thesis supervisor(s)	Catherine MARQUE, Pr Alain RASSINEUX, Pr, UMR CNRS 7337, ROBERVAL, UTC
Scientific domain(s)	Bioengineering Mechanical modeling
Research work	<p>This thesis aim to propose a tool for the diagnosis of pathological evolution of uterine contractility on a model-aided approach. The multi-scale and multi-physic model to be developed is based on a biophysical model, already developed by our team, that will be improved during this thesis. The proposed work will concern the modeling and model optimization of the mechanical contractile activity of the uterus (in relation with its electrical activity, the electrohysterogram) in order to represent pathological evolutions leading to preterm labor. Indeed, recent work permitted us to evidence that the electrical diffusion alone may not explain the efficiency of uterine labor contraction. During this project, in order to test the new hypothesis, the hydrodynamic-stretch activation mechanism leading to uterine synchronization, that may be a better hypothesis than the electrical propagation alone, we will add to the electrical model, the stretch activation mechanism of uterine cells (mechanotransduction). The implementation of this mechanotransduction will need: 1) the definition of a realistic 3D mesh of the uterus extracted from MRI imaging; 2) a model for the generation of the intra-uterine pressure (IUP), from the forces generated by all the active cells, based on the realistic mesh of the uterus and on finite element modeling (FEM) and fluid-structure interaction; 3) the computation of tissue stretching by the association of an elastic law to the uterine mesh elements; 4) the definition of a law for the mechano/electric coupling permitting to generate the stimulation to other cells, based on their sensitivity to stretching. This will be done by means of stretch sensitive channels added to the electrical model. This work will be done in close collaboration with the R&D Center of ANSYS, society specialized in numerical simulation (http://www.ansys.com/fr-FR), that will fund this work.</p>
Key words	Uterine contraction, biomechanics, numerical simulation
Requirements	Mechanics, biomechanics, numerical simulation
Starting time	October 2017
Location	UMR CNRS 7338, BMBI, UTC

Part 2: Job description	
Duration	36 months
Additional missions available	
Research laboratory	Biomechanics, bioengineering, Modeling
Material resources	Shared office, computer, common simulation platform, ANSYS software licenses
Human resources	<p>The BMBI laboratory is composed of:</p> <ul style="list-style-type: none"> - 40 permanent staff members (27 academic staff, 13 technical and administrative staff) - 31 PhD students - 8 Postdocs - 7 associated researchers - 15 Master students
Financial resources	PhD's grant: Haut de France Region + ANSYS Project: ANSYS
Working conditions	We expect the candidate to have a sense of autonomy and to be able to work with the team. He/she will conduct the research project, present his/her results during regular meetings with the advisors, the team, etc. He/she will also have to present his/her work to the scientific community in international journals and conferences.
Research project	ANSYS, IUF (submitted)
National collaborations	<ul style="list-style-type: none"> - R&D center of ANSYS, specialized in numerical simulation, as co-financer of this thesis (http://www.ansys.com/fr-FR). - UMR CNRS 7337, ROBERVAL, UTC, as co-advisor - CHU Amiens, Obstetrical department, as clinical partner - LTCI (UMR CNRS 5141 Laboratoire Traitement et Communication de l'Information, Telecom ParisTech), as medical images provider
International collaborations	<ul style="list-style-type: none"> - Massimo MISCHI, Technical University of Eindhoven, The Netherlands
International cosupervision	
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Please contact first the thesis supervisor before applying online on <https://webapplis.utc.fr/admissions/doctorants/accueil.jsf>