LULEÅ UNIVERSITY OF TECHNOLOGY

UNIVERSITÉ DE LORRAINE

EUSMAT

European School of Materials

DocMASE

Doctorate in Materials Science and Engineering

Report

Study plan

Doctoral Candidate: Luca DI STASIO

Thesis Supervisors: Prof. Zoubir AYADI
Université de Lorraine
Nancy, France

Prof. Janis VARNA
Luleå University of Technology
Luleå, Sweden

December 15, 2015

Education and Culture

Erasmus Mundus

DocMASE

Contents

Tables

Acronyms

DocMASE Doctorate in Materials Science and Engineering

ECTS European Credits Transfer System

EMMA École Doctorale Energie Mécanique et MAteriaux

FEM Finite Element Method

VBA Visual Basic for Applications

Abstract

The different requirements imposed by the regulations of EMMA doctoral school, Luleå University of Technology Graduate School and the DocMASE framework are reviewed. Based on such constraints, a tentative study plan for first year is proposed. The purpose is to satisfy the bulk training requirements at the beginning of the project, in order to devote the remaining years to research activities, such as coding, publishing and conference attendance.

1 Review of educational requirements

1.1 Requirements of DocMASE framework

Table 1: Requirements of the Doctorate in Materials Science and Engineering (DocMASE) framework.

Type	**ECTS credits**	**Attendance**	**Description/Notes**
Scientific courses	15		
Intercultural skills	10		
Complementary skills	5		
Yearly summer schools		At least 2	
Annual workshops			Presentation of research work.
Seminars & Conferences			Attend conferences and present individual research work.
Scientific publications			Peer-reviewed publications.

1.2 Requirements of EMMA doctoral school

Table 2: Requirements of the doctoral school École Doctorale Energie Mécanique et MAteriaux (EMMA).

Type	**ECTS credits**	**Hours**	**Attendance**	**Description/Notes**
Scientific courses	4	20		Reduced requirement for co-supervised project with foreign university.
Transverse courses	4	20		Reduced requirement for co-supervised project with foreign university.
Doctoriales			At least once	1-time for 5-days, preferably during the 2^{nd} year. Held by Collge Lorrain Ecole Doctorale.
Seminars & Conferences			15 seminars	
Yearly doctoral school seminar			At least once	Oral or poster presentation.
First quarter review				Written report.
Mid-term review				Oral presentation.
On-line portfolio of competences				To be regularly updated.
Scientific publications				At least one peer-reviewed publication.

1.3 Requirements of Luleå University of Technology

Table 3: Requirements of Luleå University of Technology.

Type	**ECTS credits**	**Hours**	**Description/Notes**
Scientific & transverse courses	60		Minimum 60, maximum 120 ECTS credits.

2 Proposed study plan

Table 4: Proposed first-year study plan.

Title	Code	ECTS credits	Hours
Aerospace Materials	T7005T	7.5	
Institution	Luleå University of Technology.		
Organization	The course will take place from April 4, 2016 (week 14) to June 19, 2016 (week 24).		
Objective	After the end of this course the student is supposed to - have deep knowledge about structure and behaviour of high performance materials used in aerospace industry - be able to evaluate properties of composites, ceramic materials and alloys to perform optimal material selection for use in harsh environments and service conditions - will know and understand the most important degradation mechanisms that initiate and evolve due to thermal and mechanical loads and lead to material fatigue and reduced durability - be able to do produce long fiber composites, to measure their mechanical properties, to observe and to quantify damage modes and to analyse their effect on properties - be able to apply composite material degradation models, to perform fracture mechanics analysis in alloys and to predict time dependent material behaviour - be able to perform numerical simulations of structures using commercial software to design optimized structures - have good skills in analysing research papers and writing research reports.		
Syllabus	The material classes analyzed in this course are high performance materials like light weight alloys, superalloys, ceramics and different types of composites including materials modified on nanoscale. Methodology will be given to determine properties of these multiscale materials on all considered length scales. The properties most important for design in the aerospace applications are performance at high mechanical loads, extreme temperatures and material aging and fatigue due to extreme environmental effects. Processing methods will be considered in relation to desired material performance. Durability and damage tolerance will be accessed by analyzing degradation, creep and damage mechanisms. Methodology for structural analysis will be given and training performed.		
Requirements	It satisfies the DocMASE for scientific training, EMMA requirements for scientific courses and Luleå University of Technology requirements.		

Needs	The focus of the course is strongly related to the project theme, as it reviews the methods for performance assessment and damage prediction for materials used in aerospace applications.
Status	Agreed upon with supervisors.

Français langue étrangére (French as second language) FI4 131 B ≈ 8/9 44

Institution	Université de Lorraine.
Organisation	The course will take place between 18:00 and 20:00 for two days a week (Monday and Tuesday), between January 4, 2016 and March 25, 2016.
Requirements	It satisfies the DocMASE for intercultural skills training and EMMA requirements for transverse courses. It could probably be transferred for credits to satisfy Luleå requirements.
Needs	As I have never studied French, the course will provide me with the basic tools to live and work in France as well with the foundations on which to build an independent learning path.
Status	Enrolled.

Modeling of crystal behavior and textures EMMA 05 5 24

Institution	Université de Lorraine.
Organisation	Distance learning format.
Objective	Nowadays, the basic problems of crystal plasticity are well solved and their applications in the various fields of research of mechanics and physics of materials became standard. The goal of this course is to familiarize with crystal plasticity in order to understand and set up various modeling in the broad field of mechanics of materials. The course is supplemented by simulations to carry out on PC.

Syllabus	Introduction (geometrical considerations, mechanisms of plastic deformation of crystals). Equations of deformation (small and large strain formulation). Crystal plasticity criteria (Schmid, Bishop and Hill, viscoplastic slip). Work hardening of crystals (matrix of work hardening, techniques of simulations). The mechanical problem of crystal plasticity (relation between strain and stress). Polycrystal deformation (static, Sachs, Taylor, relaxed constraints, self consistent models, finite elements). Discrete modelings (molecular, atomic). Application of polycrystalline models to materials (prediction of crystallographic texture, parameters of anisotropy, work hardening and formability for cubic, hexagonal, multiphase, intermetallic, superplastic materials and nano materials). Computer modeling in crystal plasticity. Effects of temperature on crystal plasticity (continuous or discontinuous recrystallization, possibilities of modeling). Heterogeneities of the deformation (instability and localization of deformation in single and polycrystals).
Requirements	It satisfies the DocMASE for scientific training and EMMA requirements for scientific courses. It could probably be transferred for credits to satisfy Luleå requirements.
Needs	The course is not directly related to the topic of the research project. It is nonetheless related to the doctoral school theme, i.e. materials science. Being formed in aerospace and mechanical engineering, given that the thesis' topic refers directly to aerospace applications and envisioning a career related to such fields, I think a higher-level course on crystal behaviour fits well and could help me acquire a more complete background in the field.
Status	Under discussion.

Physique quantique à l'usage exclusif des non physiciens EMMA 11 3 15

(Quantum physics for non-physicists)

Institution	Université de Lorraine.
Organisation	The course will take place from 14:00 to 17:00 on February 24, March 02, 09, 16, 23, 2016 (a total of 5 lectures).
Objective	The course presents the basics of quantum mechanics for non-specialists with mathematical background.
Syllabus	Axioms and formulations of quantum mechancis. Interpretations of quantum physics. From classical to quantum mechanics. From quantum to classical mechanics. Quantum information and informatics.
Requirements	It satisfies the DocMASE for scientific training and EMMA requirements for scientific courses. It could probably be transferred for credits to satisfy Luleå requirements.

Needs	The course is not directly related to the topic of the research project. It is nonetheless related to the doctoral school theme, i.e. materials science. It will provide the basics to understand advanced topics in materials science research related to molecular, atomic and sub-atomic scales.
Status	Under discussion.

Utilisation avancée de Microsoft-Excel et realisation de macro-commandes en langage visual basic pour la résolution de problémes scientifiques et le traitement de données
(Advanced use of Microsoft-Excel and realisation of macros in visual basic for the solution of scientific problems and data analysis)

RP2E MS 21 | ≈ 4 | 20

Institution	Université de Lorraine.
Organization	The course will take place from 09:00 to 17:00 (with a hour and a half lunch-break) on March 07, 08 and 10, 2016 (a total of 6 lectures).
Objective	The student will be capable of apply in practical cases all the concepts acquired in the course.
Syllabus	Advanced Microsoft-Excel functions for the solution of non-linear equations, matrix equation, non-linear systems of equations, ... Application of Microsoft-Excel to the analysis of complex sets of data (requiring algorithmic programming). Create an application with Visual Basic for Applications (VBA).
Requirements	It satisfies the DocMASE for scientific training and EMMA requirements for scientific courses. It could probably be transferred for credits to satisfy Luleå requirements.
Needs	The course could greatly help the research work conducted in the doctoral project. As many simulations will be run and thus a large amount will be generated, an advanced knowledge of Microsoft-Excel could help automate the data analysis procedure and thus increase productivity.
Status	Under discussion.

Modelisation des milieux heterogenes (Heterogeneous materials modeling)

RP2E MS 23 | ≈ 4 | 20

Institution	Université de Lorraine.
Organization	The course will take place on March 21, 22, 23, 24 and 25, 2016 (a total of 6 lectures).

Objective	Provide the scientific foundations for the numerical modeling of heterogeneous materials at multiple scales.
Syllabus	Homogenisation techniques: introduction to the micro-mechanics of materials; homogenisation methods; estimation of effective material properties. Variational and Finite Element Method (FEM): principles of variational methods in heterogeneous media elasticity; homogenisation and its application to FEM in linear thermo-elasticity.
Requirements	It satisfies the DocMASE for scientific training and EMMA requirements for scientific courses. It could probably be transferred for credits to satisfy Luleå requirements.
Needs	The subject of the course is related to the project theme, as it reviews the methods for the micro-mechanical and multi-scale analysis of heterogeneous materials, such as fiber reinforced polymer composites. It could potentially provide valid tools that can be put to fruitful use in the research work.
Status	Under discussion.