

## Abstract

The goal of the WIT Curriculum is to train doctoral students for careers in teaching and research positions in the academic world, as well as for positions in industry and government. Therefore, this curriculum is very balanced. It is based on education in the area of interest and surrounding areas, on training in doing research and in presenting and communicating research ideas, on cooperating with other research groups, on assessing other research results and approaches, and on actually doing research and teaching in a scientific environment.

The WIT Curriculum is structured as followed: In section 1 some motivation is given. Section 2 describes the reports that have the aim to communicate ideas. The formal course requirements of the Vienna University of Technology's curriculum for Doctorate Studies are described in section 3. Section 4 presents ways to actively involve doctoral students in the international research community. Publication requirements and the assessment of other publications are illustrated in section 5. Teaching requirements are outlined in section 6. Section 7 describes the role of transferable skills. In Section 8 instruments of career development are mentioned. In section 9 the most important requirement for the doctoral degree is described, namely the doctoral dissertation. The WIT Curriculum is concluded in Section 10 with a matrix that provides an overview of the curriculum, a description of the requirements, a timeline, and the status (optional or compulsory).

## 1 Motivation

A curriculum for doctoral studies of this kind is atypical for Austrian Universities. In Austria, doctoral students have a high degree of academic freedom. The WIT curriculum fosters a goal oriented realisation of the research work within 3 – 4 years. Regardless of a Curriculum for doctoral studies, the student's personal responsibility and commitment to pursuing research is an important prerequisite for a successful doctoral thesis.

The objective of the WIT Curriculum is to provide an environment that encourages students to contribute to the advancement of technology through independent creative research. The WIT programme has many aspects: education in the area of interest and the surrounding areas, training in research, pursuing research, training in doing a comprehensive project, cooperating with other research groups, assessing relevant research results and approaches, teaching, and training in presenting and communicating ideas. An aim of doing a doctoral degree is to become an independent researcher, capable of generating, pursuing and communicating novel research ideas. Therefore, WIT doctoral students are encouraged to become involved in research activities as soon as they enter the programme.

The entry requirement for admission at WIT is a MSc in the respective research area. The doctoral programme at WIT has a broad focus and requires work consisting of advanced studies in preparation for research, the preparation, completion and publication of original research, the approved examinations on courses, teaching assignments, acquiring of transferable skills, and the production of a doctoral dissertation. These requirements are described in detail in the following sections.

---

<sup>1</sup> This curriculum is based on the „WIT PhD Curriculum“, which was developed by the Women's Postgraduate College for Internet Technologies (WIT) in 2004. See [http://wit.tuwien.ac.at/research/phd\\_curriculum/WIT\\_PhD\\_Curriculum.pdf](http://wit.tuwien.ac.at/research/phd_curriculum/WIT_PhD_Curriculum.pdf).

## 2 Reports

The aim of these reports is to guide the student towards the doctoral programme. Basically, writing internal reports is a good practice for communicating ideas and preparation for writing the dissertation.

### 2.1 3 Month Report

#### 2.1.1 Aim

The aim of the 3 month report is an initial survey of the research area and its principal literature. This analysis helps the doctoral student to familiarise herself with the field of research by doing general reading in the area of interest. The report is organised in a way to be reused in subsequent publications (e.g. the proposal for the doctoral thesis, scientific workshops, scientific papers, dissertation etc.).

#### 2.1.2 Content

- What research areas have been addressed?
- What are the technical and conceptual foundations? A presentation of the theoretical basis or framework the research area is based on.
- What is the major area of application? (if not basic research)
- The main part of the report is to give an overview of the principal literature relevant to the research topic, accompanied by references of relevant sources.
- What are the future directions of the student's work, including a timetable? What directions of the research areas are of less importance to this work and why?

#### 2.1.3 Format

The format of the report must include (besides the points addressing the main content):

- Student's name
- Student's affiliation
- Abstract
- Keywords
- Introduction
- Conclusion and future work
- References

The report should be about 1,000 words.

## 2.2 6 Month Report

### 2.2.1 Aim

The aim of this report is a comprehensive and critical survey of the research area and literature, in order to identify limitations and what is missing in current literature. This analysis supports the doctoral student in eliciting ideas for further work and finally, to guide her towards the research question. More detailed reading in a fairly narrow, more technical area of the problem is required. The report is an extension of the 3 month report, and is organised in a way to be reused in subsequent publications (e.g. the proposal for the dissertation, scientific papers, scientific workshops, dissertation etc.).

### 2.2.2 Content

- What research areas have been addressed?
- What are the technical and conceptual foundations? A presentation of the theoretical basis or framework the research area is based on.
- What is the major area of application? (if not basic research)
- Who originally 'invented' the area of research?
- Who and what institutions have had a major impact on the topic?
- What keywords describe the area of research?
- Give an overview of the literature relevant to the research topic, accompanied by a full bibliography of relevant sources.
- What are current trends in the area of research?
- What are the significant problems in the field of research? Outline the current knowledge of the problem domain, as well as the state of existing solutions.
- What research methods have been mainly used?
- What are the leading conferences and journals in the research area?
- What are the most important and very interesting projects?
- What are the future directions of this work including a timetable?

### 2.2.3 Format

The format of the report must include (besides the points addressing the main content):

- Student's name
- Student's affiliation
- Abstract
- Introduction
- Keywords
- Conclusion and future work
- References

The report should be about 2,000 words.

## 2.3 Doctoral Proposal

### 2.3.1 Aim

A doctoral Proposal is different from other research papers, this paper addresses specifically a student's thesis that is the thesis, the whole thesis and nothing but the thesis. The aim of this proposal is an introductory presentation of the topic of the dissertation. The doctoral proposal covers a substantial discussion of the idea, the research question, the goal, the applied methodology and the evaluation approach of the doctoral thesis. As the doctoral proposal represents mainly the doctoral student's perspective, there is a need for feedback from a wide range of experienced researchers. Two external experts should review the doctoral proposal, if this is explicitly required by the doctoral student. The proposal is a means of communication to peers and other experts, in order to foster discussion, feedback and new ideas. The doctoral proposal integrates parts of the 6 month report and is organised in a way to be reused in subsequent publications (e.g. scientific papers, dissertation etc.).

### 2.3.2 Content

#### Motivation and Research Question

- What is the motivation / problem statement of the thesis? What is the problem? Why is it a problem?
- What is the research question? For example: What is a better way to do / create / modify / evolve X? Is it possible to accomplish X at all? What is a good or better formal / conceptual / empirical model for X?
- What is the contribution of the thesis? What limitations, lacks or failings of current understanding, knowledge, methods, or technologies does this research result resolve? Why does it matter?

#### Critical Literature Review

- What are the significant problems in the field of research? Outline the current knowledge of the problem domain, as well as the state of existing solutions.

#### Research Design

- What is your research field? If there is more than one, how do they relate to each other?
- What is the research result you are proposing? Present preliminary ideas, the proposed approach.
- How does your proposed research result relate to existing work? What previous work do you build on? How is your research work different, new or better to existing approaches (with reference to the related literature and commercial / non- commercial products if available)?
- What is the target audience or user group?

#### Research Method

- What is the research method you are using?
- What type of research result (e.g. experiments, prototypes, models, studies etc.) will solve the research question?

#### Evaluation of Results

- How do you prove that the research result is valid?
- How do you evaluate your results?

#### Preliminary Results

- What are the results achieved so far?

### **Progress to Date / Research Plan**

- What is the state of your thesis?
- What are your future plans including a timetable of activities milestones and publication plan?
- What corrective actions, risks to completion have you identified?

### **2.3.3 Format**

The publication format of the report is the general format of research papers and must include the following points (besides the points addressing the main content):

- Student's name
- Student's affiliation
- Abstract
- Keywords
- Introduction
- Timetable
- Related Work
- Conclusion and future work
- References

The paper should be about 4,000 words.

### **2.3.4 Future Work**

Projects should be defined in order to support the research result of the dissertation at any stage. It is recommended that these projects are combined with the doctoral student's teaching activities. Master's and bachelor's theses are an opportunity for the doctoral student as well as for the MSc / BSc student to tackle demanding projects. It is a win-win situation for both: the MSc / BSc student undertake cutting-edge research projects and doctoral students exercise their project management skills. Seminars should be given on work done or on publications and projects analysed and assessed. A couple of Doctoral Consortia ought to be selected and targeted for submission in the near future. A Summer School and Conferences in the area of research should be targeted.

## **2.4 Research Poster**

The purpose of a research poster is to present information on current research that often is not totally complete, or to present information on methods or observations that are the result of ongoing research. By presenting information on research during its infancy, problem areas can be discussed with peers and methods can be adjusted to give optimum results. Research posters are intended to reach a large number of people and present the research topic graphically on one page. Research posters have a long tradition at science conferences. It is an opportunity for doctoral students to present their peer-reviewed research work the first time in their career to a wider academic audience. Research posters are also an ideal means to communicate the state of the doctoral student's research to peers, within the department and outside.

### 3 Courses

The “Curriculum for Doctorate Studies” at Vienna University of Technology<sup>2</sup> requires approved examinations on courses equivalent to 18 ECTS (European Credit Transfer System) points for the „Dr. rer. soc. oec.“, “Dr. rer. nat.” and the „Dr. techn.“. Doctoral students should select specific courses in consultation with their supervisor. Their choice of courses must be approved by the respective dean of student affairs.

## 4 International Research Community

For developing a successful research career as well as a remarkable research record, it is of major importance that doctoral students become involved in the international academic community at an early stage of their doctoral thesis. The creation of a doctoral student's own research network is vital and can be achieved through systematic initiatives. The WIT curriculum is based on the following: participation in international conferences and workshops, summer schools, Doctoral Consortia (if available) and spending time as a visiting researcher or engineering intern at an internationally recognised institution.

### 4.1 Conferences and Workshops

Conferences and publications are main venues for reporting research findings, exchanging ideas, and developing new plans for research. Particularly, conferences are major venues for research communities. These communities often have a very powerful impact on career paths of researchers. Beside research topics, employment opportunities, visiting scientist positions, program committees, grants, or projects are topics raised in informal meetings at conferences. Conferences are a vital part of a research culture and career planning. Usually, doctoral students become involved in the international research community at conferences with the acceptance of their first paper. As the first publications of a doctoral student are generally accepted at conferences or workshops after one or two years of research, it is recommended that doctoral students first visit conferences without having a paper. This 'passive participation' at an early stage of the doctoral programme fosters the integration of doctoral students in the research community, support the elicitation of new research ideas, provide an overview of latest research issues, and give the opportunity of getting to know general conference customs. WIT supports up to 3 'passive participations' in conferences or workshops.

Beside the unique opportunity of this WIT curriculum to support the 'passive participation' in conferences, it is emphasised that doctoral students should actively participate in conferences with publications and presentations as early as possible. With an 'active participation' in conferences and workshops, doctoral students learn to structure, communicate and present their research work as well as focus on a sound research methodology.

### 4.2 Education and Research Experiences

#### 4.2.1 Summer School

International summer schools are addressed to young researchers at the doctoral student level. Summer schools offer the excellent opportunity of an intensive studying week (or two) to doctoral students and research fellows with excellent academic backgrounds. The attendance to summer schools is limited. The goal of summer schools is to have hot topics from fundamental as well as advanced areas presented by top researchers in the field, bringing participants to the frontiers of current research. A summer school is a forum for meeting new people and really getting acquainted with them. It is also a place to create collaboration networks between scholars working on similar issues. Activities in most summer schools are based on

---

<sup>2</sup> <http://www.tuwien.ac.at/fileadmin/t/rechtsabt/downloads/Curriculum-Doctorates-TUWien-2007-06.pdf>

collaborative projects. Projects are done in heterogeneous groups in order to foster multi-disciplinary approaches and fruitful discussions. Lectures give inspiration and novel ideas to the students' work.

Summer schools support the continuous development of the research work of doctoral students. Therefore, it is recommended that doctoral students attend one or two summer schools at different stages of their doctoral program. The first one is dedicated to the elicitation of concrete ideas for the research question, and the second one to further develop and consolidate the research work. The student should participate in the first summer school within the first year of the doctoral program. Summer schools should be in the student's area of research or in a related field.

#### **4.2.2 Doctoral Consortium**

A Doctoral Consortium (also called Doctoral Symposium or Ph.D Workshop) is a workshop for doctoral students at any stage in their thesis. Doctoral Consortia are mostly held in conjunction with large international conferences and benefit from the surrounding setting. A Doctoral Consortium is intended to bring doctoral students within the area of research together, and to give them the opportunity of presenting and discussing their on-going thesis research in the context of an international conference, outside of their usual university atmosphere. The workshops last usually between two and five days, prior to the main conference. About 10 - 15 doctoral students have the possibility to participate. A Doctoral Consortium will be accompanied by four to six prominent professors, who will actively participate and contribute to the discussions. A Doctoral Consortium is a great forum for doctoral students to receive useful and constructive feedback from a knowledgeable audience, to exchange ideas, to compare approaches and meet fellow researchers in the field. Due to the mentoring nature of the event, mentors foster discussions related to future career perspectives, and give advice for possible future direction of the research work as well as general advice on doing research, e.g. publication strategy, research methodology etc.

As a Doctoral Consortium provides a unique environment, it is recommended that doctoral students attend one or two Doctoral Consortia at different stages of their doctoral thesis. The first Doctoral Consortium should be targeted after a summer school and after the first year of the student's doctoral program. A Doctoral Consortium should be in the area of research or in a related field.

#### **4.2.3 Visiting Researcher / Engineering Internship**

In order to advance the thesis research and the professional background, the doctoral students should visit an internationally recognised research or development institution. In addition to the advantage of improving and maturing their research results, doctoral students have the opportunity to experience a new research culture or a professional development environment. The research or development institution must have a good reputation for the particular research or development area. It can either be a university, a commercial research and development center (e.g. IBM Research, Microsoft Research, HP Research, etc.), a non-commercial national research center (e.g. INRIA - Institut National de Recherche en Informatique et en Automatique), or a non-commercial international research center (e.g. CERN - the European Organization for Nuclear Research). The maximum duration of the stay is 3 months per year.

## **5 Peer-Reviewed Publications**

Publications are the most important tool for communicating a good idea and for demonstrating that the broader research community considers an idea to be important and well developed. The feedback obtained from referee reports or a conference presentation can be extremely helpful to appreciate the research result and to further develop research. Therefore, students are strongly encouraged to look for opportunities to publish their ideas and work. In Europe, it is common that doctoral candidates have a number of published papers. At least five peer-reviewed publications, either conference papers or workshop papers addressing the thesis research is the requirement for a doctoral student at WIT.

The doctoral candidates are also required to take part in the review process of international conferences. The role of a referee teaches doctoral students to focus on publications from a different perspective. Doctoral students learn how to review a paper and, as the expectations of programme committees become more transparent, they learn important criteria for getting a paper accepted.

## 6 Teaching

All doctoral candidates are required to assist with lectures, labs, practicals, seminars, and diploma/master theses as agreed in their regular employment contracts.

## 7 Transferable Skills

Studying for a science degree provides benefits which last a lifetime and knowledge and skills which are valued by employers generally. Skills that are useful in more than one context are called transferable skills. Transferable skills, defined as “skills developed in one situation which can be transferred to another situation” [3], are known by a variety of other terms - key skills, core skills, soft skills, generic skills, generic competences etc. They can be equally useful in all areas of our lives - academic, work, social and personal - and form an important part of (post)graduate training, as they are rated by employers as of almost equal importance to specialist scientific and technical skills. Transferable skills programmes have become a common standard throughout UK universities for undergraduate, graduate and postgraduate students. Leading computer science departments at universities in the UK (e.g. The University of Edinburgh, The University of Manchester, Imperial College London, etc.) provide a comprehensive transferable skills programme to their doctoral students.

WIT acknowledges its responsibility in the provision of opportunities to develop transferable skills, and therefore features a transferable skills programme, but the responsibility of taking advantage of the opportunities provided rests with the students. Adaptability, self-direction, self-discipline, and resilience, together with the ability to think laterally and creatively, and to plan and manage projects are all needed for the completion of doctoral thesis. Writing, time management, and presentation skills are also crucial.

This programme concentrates on the professional development of postgraduates, providing courses directly linked to postgraduate study (e.g. thesis workshop, paper production) and future careers (e.g. career planning, team development), grouped into four categories: communication skills, research methodology, project planning and management skills, and special research topics and new technologies are described in the following.

### 7.1 Communication Skills

These courses cover the knowledge and skills doctoral students need to prepare and deliver structured and successful presentations, to moderate discussions, to lead a team or chair a committee, or to defend a research idea. Examples for courses: rhetoric, strategic communication, effective presentations, moderation seminars, group development, etc.

### 7.2 Research Methodology

Publishing a paper at a conference, workshop or in a journal is the most important way of communicating the results of research to the scientific community. These courses offer advice and guidance on how to write a paper and get it published, on research methodologies, and on skills for conducting research. Some examples for courses: scientific writing, “How to do a Ph.D.”, thesis writing, philosophy of science, research methods, etc.

### 7.3 Project Planning and Management Skills

Time management is a core skill of effective management - it affects the way one uses (or wastes) other people's valuable time as well as one's own. It has also a huge impact on career planning and on a balanced work life relationship. These courses offer advice on how to manage a career as well as professional projects

like dissertations. Some examples for courses: time management, developing a successful career, work-life balance, fiscal law, intellectual property rights, etc.

## **7.4 Special Research Topics and New Technologies**

Professional development in terms of latest research trends and new technologies are crucial for doctoral candidates. These courses keep doctoral students technically and research-wise up to date. These courses may be covered for example through tutorials at international conferences, courses at the university or talks at the WIT colloquium series.

# **8 Career Development**

## **8.1 Mentoring**

Mentoring relationships are needed for advice and guidance in career matters. Today more than ever, information about organisational culture is vital for pursuing a successful research career. Therefore, WIT provides mentors to all of its doctoral students. Two types of mentoring are offered: One is targeting a research career, while the other is focusing on an industry career. The mentors involve university professors, senior researchers, managers, or senior engineers acting as close, trusted, and experienced colleagues and guides in order to explain the working dynamics of both formal and informal systems within the institution.

## **8.2 Career Coaching**

To accelerate the professional development at the actual workplace professional coaching is used more and more as a new approach. A coach and a willing individual enter into a powerful collaborative relationship aimed at creating a positive change. The individual creates results through a process of discovery, goal setting, and strategic actions. The coach acts as a thinking partner and provides support, encouragement and challenge. Coaching can focus on many different aspects of life including executive, leadership, management, business development, career planning, time management, life balance, etc. WIT provides personal and group coaching opportunities in order to support its PhD students during their PhD and prepare them for professional careers.

# **9 Doctoral Dissertation**

The most important requirement for the “Dr.” degree is the dissertation. The dissertation is on a subject chosen by the candidate and related to an area of study supported by WIT. It must demonstrate the student’s ability to carry out independent research and study. The dissertation must be accepted by the student’s supervisors.

## 10 Overview

Responsibilities	Description	Timeline	Status
<b>Reports</b>			
3 Month Report	Initial survey of the research area and principal literature.	End of month 3	Compulsory
6 Month Report	Comprehensive and critical survey of the research area and literature.	End of month 6	Compulsory
Doctoral Proposal	Introductory presentation of the topic of the dissertation: <ul style="list-style-type: none"> <li>• Research Question</li> <li>• Critical Literature Review</li> <li>• Research Results</li> <li>• Research Method</li> <li>• Evaluation of Results</li> <li>• Progress to Date / Research Plan</li> </ul>	End of month 9 - 12	Compulsory
Research Poster	Poster to graphically present the topic of the dissertation inside and outside the department and foster discussions	End of month 9 - 12	Compulsory
<b>Courses</b>	Exams according to the “Curriculum for Doctorate Studies at Vienna University of Technology”	From the beginning	Compulsory
<b>International Research Community</b>			
Conferences and Workshops	‘Active’: Participation in conferences and presentation of accepted publications	Beginning of year 2	Compulsory
	‘Passive’: Participation in conferences without accepted publications	From the beginning	Optional
Education and Research Experience	Summer School	From the beginning	Optional
	Doctoral Consortium	Beginning of year 2	Optional
	Visiting researcher /Engineering Internship at an internationally recognised research and development institution: <ul style="list-style-type: none"> <li>• University</li> <li>• Commercial research center (e.g. IBM Research, Microsoft Research, etc.)</li> <li>• Non-commercial national (e.g. INRIA)</li> <li>• Non-commercial international research center (e.g. CERN)</li> </ul>	Beginning of year 2	Optional

<b>Publications</b>			
Peer-Reviewed Publications	Minimum five publications, either conference papers or workshop papers addressing the thesis research	Beginning of year 2	Compulsory
<b>Teaching</b>			
Teaching	Supervise: Theses, labs, practicals or seminars Assist with: Lectures	Beginning of year 2	Compulsory
<b>Transferable Skills</b>			
Communication Skills	Example courses: rhetoric, strategic communication, effective presentations, moderation seminars, group development, etc.	From the beginning	Compulsory
Research Methods	Example courses: scientific writing, 'How to do a Ph.D.', thesis writing, philosophy of science, research methods, etc.		
Project Planning and Management Skills	Example courses: time management, developing a successful career, work-life balance, fiscal law, intellectual property rights, etc.		
Special Research Topics and New Technologies	Example courses: new software development methodologies, UML 2, etc.		
<b>Carreer Development</b>			
Mentoring	Mentoring relationships for advice and guidance in career matters	Beginning of year 2	Optional
Carreer Coaching	Coaching for professional development	Beginning of year 2	Optional
<b>Doctoral Dissertation</b>			
Doctoral Dissertation	Written research work to communicate results	End of year 3 - 4	Compulsory

## References

- [1] Carnegie Mellon University, School of Computer Science, Ph.D. program in Language and Information Technologies [http://www.lti.cs.cmu.edu/Ph.D./](http://www.lti.cs.cmu.edu/Ph.D/) (September 13, 2004)
- [2] Cornell University, Computer Science Ph.D. Program <http://www.cs.cornell.edu/degreeprogs/grad/Ph.D./> (September 13, 2004)
- [3] Imperial College London, Department of Computing, Ph.D. Programme <http://www.doc.ic.ac.uk/research/Ph.D./> (September 13, 2004)
- [4] King's College, Department of Computer Science, <http://www.dcs.kcl.ac.uk/programmes/pg/> (September 13, 2004)
- [5] Massachusetts Institute of Technology, The Doctoral Program in Electrical Engineering and Computer Science <http://www.eecs.mit.edu/grad/> (September 13, 2004)
- [6] Princeton University, Ph.D. Program in Computer Science <http://www.cs.princeton.edu/gradpgm/> (September 13, 2004)
- [7] Stanford University, Ph.D. Degree Program <http://cs.stanford.edu/Degrees/Ph.D..php> (September 13, 2004)
- [8] The University of Edinburgh, School of Informatics, Ph.D. Programme <http://www.inf.ed.ac.uk/postgraduate/Ph.D..html> (September 13, 2004)
- [9] The University of Manchester Department of Computer Science, Ph.D. Programme [http://www.cs.man.ac.uk/Study\\_subweb/Ph.D.Web/](http://www.cs.man.ac.uk/Study_subweb/Ph.D.Web/) (September 13, 2004)
- [10] University College London, Department of Computer Science, Ph.D. Programme <http://www.cs.ucl.ac.uk/research/students/programme.html> (September 13, 2004)
- [11] University of Bristol, Department of Computer Science, Ph.D. Programme <http://www.cs.bris.ac.uk/Tools/Local/Handbook/research.html> (September 13, 2004)
- [12] University of California-Berkeley, Ph.D. degree program in Electrical Engineering and Computer Science <http://www.eecs.berkeley.edu/Gradnotes/grad.notes.html> (September 13, 2004)