

## **MS in Technomathematics Curriculum 2011-2012**

The Master's Degree Programme in Technomathematics and Technical Physics takes two years, corresponds to 120 ECTS credits and leads to the degree of Master of Science in Technology. The language of tuition in the programme is English. The programme has two alternative major subjects: Technomathematics and Technical Physics.

### **Technomathematics**

*Programme Coordinator in Technomathematics is professor, Ph.D. Matti Heiliö*

Technomathematics is the art and science of applying mathematics and computational models into real life problems in industrial research and applied science, such as

- measurements, experiments and intelligent data-analysis
- modelling and simulation of systems and processes
- production management and process monitoring/control
- financial models, risk analysis and decision support systems.

The professional scope is wide-ranging and growing rapidly, and therefore the aim is to develop the student's mathematical and computational skills for industry and other research and development tasks. The graduate is able to combine modeling, computational skills, advanced theory and data analysis in innovative ways and to provide solutions to questions of industrial R&D. The programme also provides the graduate with capabilities for scientific doctoral studies and independent research.

Education in applied mathematics at LUT is international. A specific goal is to develop university pedagogy in applied mathematics education. The most important fields of education and research are inverse problems, computational material science and statistical/soft modeling. Some examples of applications and research areas: inverse problems, stochastic methods, Bayesian methods with MCMC, fuzzy logic and systems, fuzzy methods in knowledge engineering, data assimilation techniques, computational fluid dynamics, wavelets and image/signal analysis, data intensive methods in weather models, forest inventory and environmental monitoring.

### **ECMI Masters in Industrial Mathematics (ECMIMIM) Project**

The Laboratory of Mathematics is a partner in the ECMIMIM (the ECMI Masters in Industrial Mathematics) Erasmus curriculum development project. This European network of Master's programmes in mathematics is oriented towards applications in real world, industry, society and environment. The network has agreed on the European Model Curriculum, which will facilitate mobility at the European scale. The LUT students of Technomathematics have a possibility of studying as exchange students in another ECMIMIM partner university abroad.

### **LUT-Milano Collaboration**

An integrated educational programme in mathematics has been designed between Lappeenranta University of Technology (LUT) and Università degli Studi di Milano (UNIMI), leading to two recognized Master's degrees, one from the student's home institution and one from the host institution. The Double Degree Programme is a two-year programme (120 ECTS) at Master's level leading to two degrees. The students study at both institutions according to an integrated curriculum and mobility plan. The language of instruction of the programme is

English. The contents, the curriculum of the Programme and mobility plan are specified in a separate document.

Students who have been accepted into the MS in Technomathematics programme at LUT may apply to LUT-Milano double degree programme. Selection will be made by a separate application procedure between LUT and University of Milano after the student has been admitted to MS in Technomathematics programme at LUT.

For more information: [www.lut.fi/mathspysics/ecmimim](http://www.lut.fi/mathspysics/ecmimim)

<b>Degree Structure</b>		
General Studies	9	ECTS cr
Major Subject	76	ECTS cr
Minor Subject	20	ECTS cr
Elective Studies	15	ECTS cr
<i>Total</i>	<i>120 (min.)</i>	<i>ECTS cr</i>

### **General Studies 9 ECTS cr**

<i>Obligatory Studies (9 ECTS cr)</i>	<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BK10A0300 Introduction to M.Sc. Studies	M.Sc. (Tech.) 1	1	1
FV11A8900 Academic Writing in English	B.Sc. (Tech.) 3 M.Sc. (Tech.) 1-2	1-2, 4 3,	
	B.Sc. (Econ. & Bus. Adm.) 3 M.Sc. (Econ. & Bus. Adm.) 1-5	3-4, 2	
BM20A5000 Principles of Technical Computing and Scientific Publishing	B.Sc. (Tech.) 2 M.Sc. (Tech.) 1	1-2	4

### **Major Subject, obligatory studies 44 + 32 ECTS cr**

<i>Obligatory Studies (44 ECTS cr)</i>	<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BM20A2102 Differential Equations	M.Sc. (Tech.) 1-2	3	6
BM20A2500 Linear Algebra and Normed Spaces	M.Sc. (Tech.) 1-2	1	3
BM20A4000 Case Study Seminar	M.Sc. (Tech.) 1	1-4	5
BM10A0000 Master's Thesis and Seminar	M.Sc. (Tech.) 2	1-4	30

### **Major Subject, elective modules 32 ECTS cr**

The student chooses a minimum of 32 ECTS cr of courses from the modules a-d. The extent of one of the modules should be at least 15 ECTS cr, the rest of the courses can freely be selected from the other modules.

#### **a) Theory of Applied Analysis**

<i>List of selectable courses</i>	<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BM20A1300 Complex Analysis	M.Sc. (Tech.) 1-2	1	3
BM20A2600 Integral Transforms	B.Sc. (Tech.) 3	4	3
BM20A3301 Stochastic Theory and Models	M.Sc. (Tech.) 1	4	3-5
BM20A3801 Advanced Mathematical Methods	M.Sc. (Tech.) 1	1-4	3-6
BM20A4201 Applied Functional Analysis	M.Sc. (Tech.) 1-2	2-3	4-6
	2		

**b) Data Driven Modelling**

<i>List of selectable courses</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BM20A1900	Statistics II	M.Sc. (Tech.)	1- 2	3
			2	
BM20A2000	Simulation	M.Sc. (Tech.)	1 1	4
BM20A3001	Statistical Analysis in Modelling	M.Sc. (Tech.)	1 2	5
BM20A3401	Design of Experiments	M.Sc. (Tech.)	1- 4	4
			2	
BM20A3801	Advanced Mathematical Methods	M.Sc. (Tech.)	1 1-4	3-6
BM20A3900	Modelling Methodology in Process Engineering	M.Sc. (Tech.)	1 1-2	6

**c) Numerical Methods, Optimization and Scientific Computing**

<i>List of selectable courses</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BM20A2701	Numerical Methods II	M.Sc. (Tech.)	1 3	3
BM20A2800	Nonlinear Optimization	M.Sc. (Tech.)	1- 3	4
			2	
BM20A2901	Discrete Optimization	M.Sc. (Tech.)	1- 4	5
			2	
BM20A3801	Advanced Mathematical Methods	M.Sc. (Tech.)	1 1-4	3-6
BM20A4701	Modelling with Partial Differential Equations	M.Sc. (Tech.)	2 2	4
BM20A5100	Scientific Computing and Numerics for PDEs	M.Sc. (Tech.)	2 4	6

**d) Fuzzy Methods and Soft Computing**

<i>List of selectable courses</i>		<i>year</i>	<i>per.</i>	<i>ECTS cr</i>
BM20A2201	Logic and Discrete Methods	M.Sc. (Tech.)	1 1-4	4
BM20A3101	Fuzzy Sets and Fuzzy Logic	M.Sc. (Tech.)	1- 1-2	6
			2	
BM20A3202	Fuzzy Engineering	M.Sc. (Tech.)	1- 3-4	6
			2	
BM20A3602	Fuzzy Data Analysis	M.Sc. (Tech.)	1- 3-4	6
			2	
BM20A3801	Advanced Mathematical Methods	M.Sc. (Tech.)	1 1-4	3-6
BM20A4500	Evolutionary Computation	M.Sc. (Tech.)	1- 2-3	5
			2	

**Minor Subject 20 ECTS cr**

The student can choose any minor subject taught at LUT if the required prerequisites are completed. The choice of the minor subject should, however, be discussed with the Programme Coordinator in Technomathematics.

**Elective Studies 15 ECTS cr**

Elective studies can include any courses offered by LUT if the required prerequisites are completed. Studies in other universities may be included upon application. Elective studies may include a maximum of 6 ECTS credits of traineeship improving expertise. The student should discuss the choice of elective courses with the Programme Coordinator.

**Master's Thesis and Seminar 30 ECTS cr**

Thesis topics arise from various application areas, research projects and contacts with industry. Typically, the thesis contains a theoretical study, as well as the use of up-to-date mathematical and computational methods for solving an application practical problem.

### **Minor in Technomathematics 20 ECTS cr**

Minor in Technomathematics can be studied by students of other Master's degree programmes. However, suitable background knowledge is needed. This means basic knowledge about matrix calculation, optimization, statistics, numerical analysis and especially mathematical programming with some procedural language (preferably Matlab/Octave).

A minimum of 20 ECTS credits should be selected from the courses below:

<i>Minor Studies min. 20 ECTS cr</i>		<i>per.</i>	<i>ECTS cr</i>
BM20A1300	Complex Analysis	1	3
BM20A1900	Statistics II	2	3
BM20A2000	Simulation	1	4
BM20A2102	Differential Equations	3	6
BM20A2201	Logic and Discrete Methods	1-4	4
BM20A2500	Linear Algebra and Normed Spaces	1	3
BM20A2600	Integral Transforms	4	3
BM20A2701	Numerical Methods II	3	3
BM20A2800	Nonlinear Optimization	3	4
BM20A2901	Discrete Optimization	4	5
BM20A3001	Statistical Analysis in Modelling	2	5
BM20A3101	Fuzzy Sets and Fuzzy Logic	1-2	6
BM20A3202	Fuzzy Engineering	3-4	6
BM20A3301	Stochastic Theory and Models	4	3-5
BM20A3401	Design of Experiments	4	4
BM20A3602	Fuzzy Data Analysis	3-4	6
BM20A3801	Advanced Mathematical Methods	1-4	3-6
BM20A3900	Modelling Methodology in Process Engineering	1-2	6
BM20A4201	Applied Functional Analysis	2-3	4-6
BM20A4500	Evolutionary Computation	2-3	5
BM20A5000	Principles of Technical Computing and Scientific Publishing	1-2	4

### **Additional Information**

#### **Personal Study Plan**

The personal study plan (PSP) is the student's own plan how s/he is going to complete the Master's degree. The degree structure of the Master's programme determines the frame of the studies. At the Master's level, the student makes the PSP by the end of 1<sup>st</sup> period, and submits it to International Study Coordinator for comments. The electronic personal study plan (ePSP, in Finnish eHOPS) is a tool for drawing the plan up. The students of the Faculty of Technology are recommended to compile the PSP in an electronic form by using the ePSP tool at WebOodi.

#### **Credit Transfer**

ECTS credits can be transferred from the student's previous university level studies or higher university degrees from Finnish or foreign universities. More information on credit transfer is available from International Study Coordinator.

## Complementary Studies

The student with a Finnish degree from the University of Applied Sciences or equivalent may have to study complementary studies. The extent of these studies depends on the content of the previous degree. More information is available from International Study Coordinator.

## Traineeship

A traineeship in the Master's degree can be worth 6 ECTS credits. A two-week full traineeship is worth one ECTS credit. Employment prior to the studies at LUT can be accepted, if it has not been included in any previous degrees. Acceptable practical work may include computational tasks, measurements and instrumentation, work with experiments, data analysis or tasks which improve the student's understanding of science based methods and technology. The traineeship is approved by traineeship coordinators.

Mathematics: Professor Matti Heiliö

Physics: Lecturer Jari Soininen

## Maturity Test

The student must take a maturity test to show how well s/he knows the topic of the Master's thesis. The test evaluates the student's familiarity with the theories and problems of the thesis. The student is asked to contact the supervising professor to agree how the maturity test is taken, that is, as a seminar presentation or as a written test. The maturity test is evaluated on a scale of passed/failed by the supervising professor of the thesis.

## The Courses Offered in English

	<i>ECTS cr</i>
BM10A0000 Master's Thesis and Seminar	30
BM20A1300 Complex Analysis	3
BM20A1900 Statistics II	3
BM20A2000 Simulation	4
BM20A2102 Differential Equations	6
BM20A2201 Logic and Discrete Methods	4
BM20A2500 Linear Algebra and Normed Spaces	3
BM20A2600 Integral Transforms	3
BM20A2701 Numerical Methods II	3
BM20A2800 Nonlinear Optimization	4
BM20A2901 Discrete Optimization	5
BM20A3001 Statistical Analysis in Modelling	5
BM20A3101 Fuzzy Sets and Fuzzy Logic	6
BM20A3202 Fuzzy Engineering	6
BM20A3301 Stochastic Theory and Models	3 - 5
BM20A3401 Design of Experiments	4
BM20A3602 Fuzzy Data Analysis	6
BM20A3801 Advanced Mathematical Methods	3 - 6
BM20A3900 Modelling Methodology in Process Engineering	6
BM20A4000 Case Study Seminar	5
BM20A4201 Applied Functional Analysis	4 - 6
BM20A4500 Evolutionary Computation	5
BM20A4800 Project Work in Applied Mathematics	10 - 30
BM20A5000 Principles of Technical Computing and Scientific Publishing	4
BM20A5100 Scientific Computing and Numerics for PDEs	6
BM30A0500 Applied Optics	6
BM30A0601 Optoelectronics	6
BM30A1500 Advanced Topics in Material Science	6
BM30A1600 Microelectronics	6
BM30A1700 Physics of Semiconductor Devices	3 - 6
BM30A2100 Microelectronics Processing Technology	2

BM30A2200	Semiconductor and Superconductor Physics	6
BM30A2300	Project Work in Technical Physics	10 - 30

**Technical Physics (See Separate Chapter in Study Guide)**

*Programme Coordinator in Technical Physics is professor, Ph.D. Erkki Lähderanta*

**Further Information**

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