

EACH Programme Description

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| 1 | NAME OF CURRICULUM | Excellence in Analytical Chemistry |
| 2 | ACRONYM | EACH |
| 3 | EDUCATIONAL INSTITUTION(S) | <i>University of Tartu Uppsala University, Sweden University Claude Bernard Lyon 1, France; Åbo Akademi University, Finland.</i> |
| 4 | CURRICULUM TYPE | Joint Master Programme |
| 5 | LEVEL OF STUDY | Master's studies |
| 6 | CURRICULUM GROUP | Physical sciences |
| 7 | LANGUAGE(S) OF INSTRUCTION | English |
| 8 | OTHER LANGUAGES REQUIRED FOR ATTAINMENT OF THE LEARNING OUTCOMES | <i>Swedish, French or Estonian</i> |
| 9 | FORM OF STUDIES | Regular studies |
| 10 | NOMINAL PERIOD OF STUDY | 2 years |
| 11 | AMOUNT OF CREDITS (ECTS) | 120 ECTS |
| 12 | QUALIFICATIONS GRANTED | <ul style="list-style-type: none"> - Master of Science (Excellence in Analytical Chemistry) (UT) - Master of Science (EACH - Excellence in Analytical Chemistry) (UU) - Master of Physical and Analytical Chemistry (Industrial Analysis) (UCBL) - Master of Science (Technology) (Masters Programme in Excellence in Analytical Chemistry) (AAU) |
| 13 | DOCUMENTS ISSUED UPON GRADUATION | Diploma with Diploma Supplement |
| 14 | HIGHER EDUCATION INSTITUTION(S) ISSUING GRADUATION DOCUMENTS | Tartu University; Uppsala University; University Claude Bernard Lyon; Åbo Akademi University. |
| 15 | APPROVAL | 1. Approved in the Faculty of Science and Technology 18.06.2015 2. Approved in the University Senate, 25.09.2015 |
| 16 | SPECIALISATION(S) | Analytical chemistry |
| 17 | VERSION OF CURRICULUM | 2016/2017 |
| 18 | PROGRAMME MANAGER | Ivo Leito |
| 19 | TERMS OF ADMISSION | BA degree or equivalent qualification. Prerequisites: at least 60 ECTS in chemistry or in industrial chemistry and 20 ECTS in mathematics or physics. Admissions requirements to be set in the University |

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| | | Admissions Regulations. |
| 20 | GOALS OF CURRICULUM | The goal of the curriculum is to provide students with in-depth knowledge and practical skills in analytical chemistry to be qualified for research and development. |
| 21 | BRIEF DESCRIPTION OF CURRICULUM STRUCTURE | <p>I study year at the University of Tartu</p> <ol style="list-style-type: none"> 1. General Analytical Chemistry Module (21 ECTS); 2. Metrology and Quality Management Module (9 ECTS); 3. Socio-economical Module (12 ECTS), 4. Internship (6 ECTS); 5. Elective courses (9 ECTS) 6. Optional courses (3 ECTS) <p>II study year – to be spent in one of the partner universities:</p> <ol style="list-style-type: none"> 7. Specialisation module (25 ECTS) ja language module (5 ECTS) <ol style="list-style-type: none"> 7.1. Uppsala <ol style="list-style-type: none"> 7.1.1. Module of organic-bioorganic analysis and multimodal separation techniques (25 ECTS); 7.1.2. Swedish language (5 ECTS) 7.2. Lyon <ol style="list-style-type: none"> 7.2.1. Industrial analytical chemistry module (25 ECTS); 7.2.2. French language (5 ECTS) 7.3. Åbo <ol style="list-style-type: none"> 7.3.1. Electroanalysis Module (25 ECTS); 7.3.2. Swedish language (5 ECTS) 8. Master thesis (30 ECTS) |
| 22 | REQUIREMENTS FOR COMPLETION OF CURRICULUM | Completion of the coursework as foreseen in the curriculum. |

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| 23 | LEARNING OUTCOMES OF CURRICULUM (to be attained/developed /professional knowledge and skills, general competencies, etc.) | <p>Upon completion of the curriculum, the student:</p> <ol style="list-style-type: none"> 1) Has systematic understanding of the physical, chemical and metrological foundations of analytical chemistry; factors affecting analytical results; methods for calculating and presenting of results and evaluating their quality for the widespread chemical analysis methods. 2) Has systematic understanding of laboratory quality systems (ISO 17025 and GLP), economic and legal aspects of chemical analysis and basic understanding of managing an analytical laboratory, including maintaining a quality management system. 3) Has the basic skills to work with the widespread analysis and sample preparation techniques and to tune them according to specific analysis tasks; to optimize analysis procedures; to make data evaluation and sampling. 4) Is able to define the problem, choose the methods, test them and determine their characteristics, assess their suitability for the task and apply corrective actions in one of the subfields of analytical chemistry: <ul style="list-style-type: none"> - Separation science and organic analysis, including multimodal separation techniques and complex samples of biological importance; - Industrial analytical chemistry and process control; - Electroanalysis and electrochemical sensors, including their design, miniaturization and uses for different analytical tasks. 5) Has the knowledge and skills to evaluate the adequacy of chemical analysis results obtained either by him/herself or by others. 6) Is able to apply his/her knowledge and skills for solving novel analytical chemistry problems, including in multidisciplinary context, having limited information and time. 7) Is able to work in a team (including as team leader), manage streams of information, time and resources, present results both for experts and non-experts. 8) Is able to speak Swedish; French or Estonian at least at A1 level. |
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| 24. | MODULES | First year modules will be passed in Tartu |
| | MODULE: | General Analytical Chemistry Module |
| | GOALS OF MODULE: | To provide the basic knowledge and skills in analytical chemistry. |
| | LEARNING OUTCOMES OF MODULE (to be attained/developed/professional knowledge and skills, general | <p>Upon completion of the module, the student:</p> <ol style="list-style-type: none"> 1) Has systematic understanding of analytical chemistry, its main concepts, methods of analysis and their characteristics 2) Knows the physical and chemical background of the common chemical analysis techniques and is able to apply them in practice; |

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| competencies, etc.) | <p>3) Knows and is able to apply mathematical methods for treatment of measurement data and is able to present measurement results correctly;</p> <p>4) Knows the specialisation related terminology and will be capable of explaining and defending the results of his/her research in an academic discussion;</p> <p>5) Will be able to solve the problems of analytical chemistry in teamwork.</p> |
| MODULE COURSES AND PRINCIPLES OF CHOOSING THEM BY STUDENTS | <p>LOKT.06.032 Practical chemical analysis (6 ECTS)</p> <p>LOKT.06.050 Master seminar in measurement science I (6 ECTS)</p> <p>LOFY.01.039 Measurement data processing (3 ECTS)</p> <p>LOKT.06.033 Practical works in chemical analysis and metrology (6 ECTS)</p> <p>Obligatory for all students studying in the programme.</p> |
| MODULE: | Metrology and Quality Management Module (9 ECTS) |
| GOALS OF MODULE: | The goal of the module is to provide knowledge and skills on metrology and its application in analytical chemistry and on the quality assurance of measurements and analysis. |
| LEARNING OUTCOMES OF MODULE (to be attained/developed/professional knowledge and skills, general competencies, etc.) | <p>Upon completion of the module, the student:</p> <p>1) Has the knowledge of the main metrological concepts (traceability, measurement uncertainty) and approaches (validation of analysis procedures, reference materials, interlaboratory comparisons) relevant to chemical analysis;</p> <p>2) Has the knowledge and skills for ensuring and assessing the reliability of analysis results and expressing them correctly;</p> <p>3) Knows the main principles of quality management and the main quality management systems in laboratories (ISO 17025 and GLP) and is capable of following these requirements.</p> |
| MODULE COURSES AND PRINCIPLES OF CHOOSING THEM BY STUDENTS | <p>LOKT.06.030 Metrology in chemistry (6 ECTS)</p> <p>LOFY.01.082 Quality management (3 ECTS)</p> <p>Obligatory for all students studying in the programme.</p> |
| MODULE: | Socio-economical Module (12 ECTS) |
| GOALS OF MODULE: | To provide socio-economical knowledge of analytical chemistry and language skills at level A1 in one of the following: Swedish; French or Finnish. |
| LEARNING OUTCOMES OF MODULE (to be attained/developed/professional knowledge and skills, general competencies, etc.) | <p>Upon completion of the module, the student:</p> <p>1) Understands the socio-economic impact of analytical chemistry, both at micro- and macro-economy level; understands the economics of functioning of an analytical laboratory;</p> <p>2) Is able to communicate results of chemical analysis to a non-specialist audience;</p> <p>3) Is able to communicate, at the level A1, in one of the three languages spoken in partner universities (Swedish, French</p> |

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| | or Estonian). |
| MODULE COURSES AND PRINCIPLES OF CHOOSING THEM BY STUDENTS | <p>LOKT.06.034 Measurements and the law (3 ECTS) MJRI.10.037 Economic aspects of measurements (3 ECTS) LOKT.04.072 Environment and measurements (3 ECTS) FLKE.02.295 French for Beginners I on the Basis of English, Level 0 > A1.1 (6 ECTS) FLKE.01.271 Swedish for Beginners I, on the Basis of English, Level 0 > A1 (6 ECTS) FLLC.09.001 Estonian for Beginners I, on the Basis of English, Level 0 > A1.1 (6 ECTS)</p> <p>The student has to choose at least two out of the three courses – LOKT.04.072, LOKT.06.034 and MJRI.10.037 – and one a foreign language course.</p> |
| MODULE: | Internship (6 ECTS) |
| GOALS OF MODULE: | Student acquires understanding of the analytical chemistry issues in a professional environment at industry, research institution or a professional laboratory as well as the knowledge and skills for performing certain tasks in that professional environment. |
| LEARNING OUTCOMES OF MODULE (to be attained/developed/professional knowledge and skills, general competencies, etc.) | <p>Upon completion of the module, the student:</p> <ol style="list-style-type: none"> 1) Has understanding of the analytical chemistry issues in a professional environment at industry, research institution or a professional laboratory; 2) Has the knowledge and skills for performing certain tasks in professional environment and use the lab equipment; 3) Understand the quality norms and standards practiced in a particular field; 4) Has experienced working in teams and in professional non-educational setting. |
| MODULE COURSES AND PRINCIPLES OF CHOOSING THEM BY STUDENTS | LOKT.00.017 Practical speciality training Obligatory for all students studying in the programme. |
| MODULE: | Elective courses (9 ECTS) |
| GOALS OF MODULE: | The objective of the module is to enhance students' knowledge in analytical chemistry according their liking and interests. |
| LEARNING OUTCOMES OF MODULE (to be attained/developed/professional knowledge and skills, general competencies, etc.) | Upon completion of the module, the student has acquired further knowledge and skills in analytical chemistry. |
| MODULE COURSES AND PRINCIPLES OF CHOOSING THEM BY STUDENTS | LOKT.06.047 Atomic spectroscopy (3 ECTS) LOFY.05.051 Master's course of biological physics (3 ECTS) LOKT.02.035 Electrochemical methods of measurement and |

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| | <p>analysis (3 ECTS)</p> <p>LOFY.01.040 Practical works on physical measurements and calibrations (3 ECTS)</p> <p>LOKT.06.043 Bridging course in chemistry (3 ECTS)</p> <p>LOKT.08.005 Chemometrics (6 ECTS)</p> <p>LOKT.09.028 Quality systems (3 ECTS)</p> <p>LOKT.06.039 Measurement science in chemistry summer school (12 ECTS)</p> <p>LOKT.10.017 Measurements in biochemistry (3 ECTS)</p> <p>LOFY.01.037 Modern Metrology (3 ECTS)</p> <p>LOFY.01.036 Measuring and instrumentation (3 ECTS)</p> <p>LOFY.01.096 Nanometrology (3 ECTS)</p> <p>LOFY.01.098 Project and quality management (3 ECTS)</p> <p>LOFY.01.020 Signal processing (3 ECTS)</p> <p>LOKT.09.022 Structural analysis I (3 ECTS)</p> <p>LOKT.06.016 Liquid chromatography and mass spectrometry (6 ECTS)</p> |
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| MODULE COURSES AND PRINCIPLES OF CHOOSING THEM BY STUDENTS | The student compiles the elective module independently keeping in mind the II year specialisation and the recommendations of the Programme Director. |
| MODULE: | Optional courses (3ECTS) |
| GOALS OF MODULE: | The goal of the module is to learn in accordance with interests and further studies or career. |
| LEARNING OUTCOMES OF MODULE (to be attained/developed/professional knowledge and skills, general competencies, etc.) | Upon completion of the module, the student has acquired knowledge in the areas studied. |
| MODULE COURSES AND PRINCIPLES OF CHOOSING THEM BY STUDENTS | Any courses taught at the University of Tartu or other HEIs. |
| MODULE: | 7.1. Specialisation module in Uppsala 7.1.1 Organic and bioorganic analysis and multimodal separation techniques (25 ECTS) |
| GOALS OF MODULE: | Student acquires in-depth knowledge and practical skills in organic and bioorganic analysis and multimodal separation techniques |
| LEARNING OUTCOMES OF MODULE (to be attained/developed/professional knowledge and skills, general | Upon completion of the module, the student: 1) Is able to describe theoretical models for separation, optimization and detection for chromatographic (liquid - and gas chromatography) and capillary electrophoretic methods and predict how changes in experimental conditions influence a separation with these methods; |

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| competencies, etc.) | <p>2) Is able to describe the principle and the design of the components that are included in separation and mass spectrometric instrumentation;</p> <p>3) Knows which type of information that can be received from a chromatogram, electropherogram and mass spectrum (as well as from the hyphenated techniques) and have the ability to carry out general evaluation of spectra;</p> <p>4) Can choose appropriate technique regarding both separation and detection and be able to choose and justify the choice of instrumentation based on performance and requirements that the applications demand;</p> <p>5) Can plan and carry out validation of the performance of analytical methods;</p> <p>6) Can plan and carry out both qualitative and quantitative analysis of for example bioanalytical nature</p> |
| MODULE COURSES AND PRINCIPLES OF CHOOSING THEM BY STUDENTS | <p>LOKT.06.056 (1KB153) - Separation and Mass Spectrometry (10 ECTS)</p> <p>LOKT.06.057 (1KB154) - Applied Analysis of Complex Samples (15 ECTS)</p> <p>Obligatory for the students who have chosen this specialisation.</p> |
| MODULE: | 7.1.2. Swedish language (5 ECTS) |
| GOALS OF MODULE: | Development of the language skills, depending on students' prior knowledge, at least to the level A1. |
| LEARNING OUTCOMES OF MODULE (to be attained/developed/professional knowledge and skills, general competencies, etc.) | <p>Upon completion of the module, the student can in Swedish:</p> <ol style="list-style-type: none"> 1) Communicate in everyday situations; 2) Briefly express their views and arguments; 3) Understand simpler conversations with basic vocabulary. |
| MODULE COURSES AND PRINCIPLES OF CHOOSING THEM BY STUDENTS | <p>XXXX – Swedish language (5 ECTS)</p> <p>Obligatory for the students who have chosen this specialisation.</p> |
| MODULE: | 7.2. Specialisation module no 2 at Lyon 7.2.1. Industrial analytical chemistry module (25 ECTS) |
| GOALS OF MODULE: | Provision of knowledge and skills of all the critical parts of the industrial analysis which are linked to the usage of analysis instrumentation in industry. |
| LEARNING OUTCOMES OF MODULE (to be attained/developed/professional knowledge and skills, general competencies, etc.) | <p>Upon completion of the module, the student:</p> <ol style="list-style-type: none"> 1) Knows the principles and limitations of sampling in process environment; 2) Knows the fundamentals and has skills in usage of the main analytical techniques (spectroscopic, mass-spectrometric, chromatographic), including in an industrial production environment; |

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| | <p>3) Knows the principles of experiment planning and data analysis, as well as industrial IT and automatization and has the ability to apply them;</p> <p>4) Knows the analysis strategies used in process environment and is able to apply them in practice;</p> <p>5) Is able to select and set up an analysis and data treatment system for industrial process control taking into account all limitations of the process environment.</p> |
| MODULE COURSES AND PRINCIPLES OF CHOOSING THEM BY STUDENTS | LOKT.06.058 Industrial Analysis (25 ECTS) Obligatory for the students who have chosen this specialisation. |
| MODULE: | 7.2.2. French language |
| GOALS OF MODULE: | Development of the language skills, depending on students' prior knowledge, at least to the level A1. |
| LEARNING OUTCOMES OF MODULE (to be attained/developed/professional knowledge and skills, general competencies, etc.) | Upon completion of the module, the student can in French: 1) Communicate in everyday situations; 2) Briefly express their views and arguments; 3) Understand simpler conversations with basic vocabulary. |
| MODULE COURSES AND PRINCIPLES OF CHOOSING THEM BY STUDENTS | XXXX – French language (5 ECTS) Obligatory for the students who have chosen this specialisation. |
| MODULE: | 7.3. Specialisation module at Abo 7.3.1. Electroanalysis module (25 ECTS) |
| GOALS OF MODULE: | <i>Student acquires theoretical background and practical skills in electrochemistry and chemical sensors.</i> |
| LEARNING OUTCOMES OF MODULE (to be attained/developed/professional knowledge and skills, general competencies, etc.) | Upon completion of the module, the student: 1) Understands the fundamental principles of electrochemistry, their options and limits and can apply them for solving a particular task; 2) Can define a problem of analysis and choose the appropriate methods for solving; 3) Knows the design principles of and materials used in electrochemical sensors, is able to test and characterise sensors and knows the principles of sensor miniaturization; 4) Knows the sensor-based measurement strategies and the corresponding data analysis possibilities and is able to apply them in practice. |
| MODULE COURSES AND PRINCIPLES OF CHOOSING THEM BY STUDENTS | LOKT.06.055 (410523.0) – Special Project in Analytical Chemistry (10 ECTS) LOKT.06.052 (410304.0) - Applied electrochemistry (5 ECTS) LOKT.06.054 (410517.0) – Seminars in Analytical Chemistry (5 ECTS) LOKT.06.053 (410522.0) - Chemical sensors (5 ECTS) |

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| | Obligatory for the students who have chosen this specialisation. |
| MODULE: | 7.3.2. Swedish language (5 ECTS) |
| GOALS OF MODULE: | Development of the language skills, depending on students' prior knowledge, at least to the level A1. |
| LEARNING OUTCOMES OF MODULE (to be attained/developed/professional knowledge and skills, general competencies, etc.) | Upon completion of the module, the student can in Swedish: 4) Communicate in everyday situations; 5) Briefly express their views and arguments; 6) Understand simpler conversations with basic vocabulary. |
| MODULE COURSES AND PRINCIPLES OF CHOOSING THEM BY STUDENTS | XXXX – Swedish language (5 ECTS) Obligatory for the students who have chosen this specialisation. |
| MODULE: | 8. Masters' thesis (30 ECTS) |
| GOALS OF MODULE: | Student develops practical skills in planning, executing and reporting of scientific research in the field of analytical chemistry. |
| LEARNING OUTCOMES OF MODULE (TO BE ATTAINED/DEVELOPED/PROFESSIONAL KNOWLEDGE AND SKILLS, GENERAL COMPETENCIES, ETC.) | Upon completion of the module, the student: 1) Is intimately familiar with one specific field of analytical chemistry and can formulate the arguments/statements to be presented at defence. 2) Is able to pose and critically analyse the arguments presented in field-specific sources and to argue and justify his/her positions; 3) Knows the general principle of research ethics and can evaluate the scientific level of the research and its degree of application linked to particular area of research; 4) Can structure and deliver a public presentation and participate in academic discussions; 5) Knows the principles and requirements for scientific work and can formulate their work results accordingly. |
| MODULE COURSES AND PRINCIPLES OF CHOOSING THEM BY STUDENTS | Obligatory for all students. |

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| 26 | ADDITIONAL INFORMATION | http://www.analyticalchemistry.eu/ |
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