

SYLLABUS

STUDY YEAR 2024/2025

Master Programme in Space Science and Technology

Enrollment semester Autumn 2024

DATE

2023-10-12

REFERENCE NO.

LTU-4268-2023

DECISION MAKER

Dean of the Faculty of Science and Technology

Programme content and structure

In order to be eligible for the diploma in Master of Science in Space Technology with specializations in Atmospheric and Space Sciences, Space Technology and Instrumentation the student has to obtain 120 ECTS, including courses on the advanced level for at least 90 ECTS and a Master thesis for 30 ECTS. The Program is given in a close collaboration with the leading European universities, space research and industrial organisations. The Programs's structural mobility allows the students to receive knowledge from a number of fundamental academic disciplines within one educational program, i.e. aerospace engineering, atmospheric science, signal processing, space science, space technology and robotics.

Partner universities:

- Luleå University of Technology (LTU), Sweden (coordinator)
- Aalto University, School of Electrical Engineering (Aalto), Finland
- Cranfield University (CU), UK
- Czech Technical University in Prague (CTU), Czech Republic
- Université Toulouse III - Paul Sabatier (UT3), France

The first semester of the Program is common for all students and takes place at LTU, Kiruna Space Campus. During the second semester at LTU the students take courses depending on the specialization. During the second year the students are distributed among the European partner universities, which offer different specializations depending on their respective fields of expertise. The distribution of students is based on their own ranking priorities, merits and place availability.

Specializations at LTU:

- Space Technology and Instrumentation
- Atmospheric and Space Science

Specializations at the partner universities:

- Space Robotics and Automation (Aalto)
- Small Satellites and Space Instrumentation (Aalto)
- Space Automation and Control (CTU)
- Dynamics and Control of Systems and Structures (CU)
- Space Technique and Instrumentation (UT3)
- Astrophysics, Space Science and Planetology (UT3)

Swedish for Beginners 3 ECTS is offered for international students. The course is not included in the degree, and is taken in addition to the compulsory courses.

During the fourth semester the students perform their Master thesis projects in partner universities, space research and industrial organisations around the world.

For admission to the Master thesis at LTU the entry requirements specified in the course syllabus must be completed. An information about the application and admission processes is given and ensured by the responsible department at LTU.

During the summer months, i.e. June-August, the students have a possibility to carry out internships in the research groups at the partner universities, international space research and industrial organisations.

All students that meet the requirements for graduation will receive a diploma of Master of Science with a Major in

Space Technology from LTU. Specializations given at LTU are included in the diploma. Recognition of the Program in each partner university is carried out by the respective institutional entities and authorities according to the university procedures in line with the respective national legislations. Courses and diploma requirements for specializations at the partner universities are available at the respective partner universities, <https://spacemaster.eu/>

Good knowledge in English, equivalent to English 6.

Credits

120 credits

Degree

- Degree of Master of Science (120 credits) - Major; Space Technology

Specialisations

Specialisation

- Atmospheric and Space Science, research oriented (RYSP)
- Space Technology and Instrumentation (RYIN)

Profile

- RYIN, Dynamics & Control of Systems & Structures, Cranfield
- RYIN, Space Automation and Control, Prague
- RYIN, Space Robotics and Automation, Helsinki
- RYIN, Space Technique and Instrumentation, Toulouse
- RYIN, Space Technology and Instrumentation, Kiruna
- RYSP, Astrophysics, Space Science and Planetology, Toulouse
- RYSP, Atmospheric and Space Science, Kiruna

Entry requirements

Academic degree with a minimum of 180 higher education credits in the areas of physics (space, plasma, atmospheric, nuclear, particle, fluid dynamics, aerodynamics), space science, planetology, astronomy, atmospheric science, remote sensing, numerical simulations, mechanical engineering, electrical engineering, space engineering, aerospace engineering, robotics, automation, communication, electronics, mechatronics, control theory or equivalent. A minimum of 22.5 credits in mathematics at the university level is required.

Good knowledge in English, equivalent to English 6

Selection

The selection procedure is based on academic qualifications, quality and quantity aspects

Selection group

Academic: 100%

Compulsory courses

Compulsory courses 60 credits

| Course code | Course | Cr | Level | Comment |
|-------------|-----------------------|-----|----------------|---------|
| F7008R | The Solar System | 7.5 | Master's level | |
| P7004R | Master Degree Project | 30 | Master's level | |
| R7017R | Space Physics | 7.5 | Master's level | |
| R7021R | Space Communication | 7.5 | Master's level | |
| R7028R | Spacecraft Systems | 7.5 | Master's level | |

Course is offered for non-Swedish speakers, not included in the degree 3 credits

Selective space is 3 credits. It is mandatory to select elective courses up to the given number of credits. The given number of credits of elective courses listed must be met for degree.

| Course code | Course | Cr | Level | Comment |
|-------------|--------------------------------------|----|------------------|------------|
| S0046P | Swedish for International Students 1 | 3 | Bachelor's level | Selectable |

Profile: RYIN, Dynamics & Control of Systems & Structures, Cranfield

Compulsory courses, 50 Credits within Master thesis 45 credits and other course 5 credits

| Course code | Course | Cr | Level | Comment |
|-------------|----------------------------|----|-------|---------|
| | Space Populsion, 5 Credits | | | |
| | Master thesis, 45 Credits | | | |

Elective courses, within selective courses 10 credits of 35 credits

| Course code | Course | Cr | Level | Comment |
|-------------|--|----|-------|---------|
| | Advanced Composite Analysis and Impact 5 Credits | 5 | | |
| | Spacecraft Attitude Dynamics and Control 5 Credits | 5 | | |
| | Finite Element Methods 5 Credits | 5 | | |
| | Space Communications 5 Credits | 5 | | |

| Course code | Course | Cr | Level | Comment |
|-------------|---|----|-------|---------|
| | Aerospace Navigation and Sensors 5 Credits | 5 | | |
| | Guidance Navigation and Control of Space Systems 5 Credits | 5 | | |
| | Mathematics and Programming for Astrodynamics and Trajectory Design 5 Credits | 5 | | |

Profile: RYIN, Space Automation and Control, Prague

Compulsory courses, 60 Credits, within Diploma thesis 30 credits and other courses 30 credits

| Course code | Course | Cr | Level | Comment |
|-------------|---|----|-------|---------|
| | Space Systems, Modeling and Identification 7 Credits | 7 | | |
| | Optimal and Robust Control Design 8 Credits | 8 | | |
| | Diploma thesis, 30 Credits | | | |
| | Individual Design Project 8 Credits | 8 | | |
| | Control Systems for Aircraft and Spacecraft 7 Credits | 7 | | |

Profile: RYIN, Space Robotics and Automation, Helsinki

Compulsory courses, 47 Credits within Master thesis 30 credits and other courses 17 credits

| Course code | Course | Cr | Level | Comment |
|-------------|---|----|-------|---------|
| | Embedded Real-Time Systems 5 Credits | 5 | | |
| | Robotics 5 Credits | 5 | | |
| | Master thesis, 30 Credits | | | |
| | Modelling, Estimation and Dynamic Systems 5 Credits | 5 | | |
| | Master's Thesis Process 2 Credits | 2 | | |

Elective courses, 55 Credits, of which optional space 10 credits

| Course code | Course | Cr | Level | Comment |
|-------------|-------------------------------------|----|-------|---------|
| | Micro and Nano Robotics, 5 Credits | | | |
| | Mechatronics Basics, 5 Credits | | | |
| | Basics of Sensor Fusion, 5 Credits | | | |
| | Space Instrumentation 5 Credits | | | |
| | Reinforcement Learning, 5 Credits | | | |
| | Computer Vision, 5 Credits | 5 | | |
| | Robotic manipulation, 5 Credits | 5 | | |
| | Satellite Systems, 5 Credits | | | |
| | Autonomous Mobile Robots, 5 Credits | | | |
| | Introduction to Space 5 Credits | | | |
| | Space Physics 5 Credits | | | |

Finnish studies, choose among following courses 3 credits

| Course code | Course | Cr | Level | Comment |
|-------------|-------------------------------|----|-------|---------|
| | Get to Know Finland, 1 Credit | | | |
| | Finnish 1, 3 Credits | 3 | | |
| | Survival Finnish 2, 1 Credit | | | |
| | Survival Finnish 1, 1 Credit | | | |

Profile: RYIN, Space Technique and Instrumentation,Toulouse

Compulsory courses, 60 Credits, within Master Thesis 30 credits and other courses 30 credits

| Course code | Course | Cr | Level | Comment |
|-------------|---|----|-------|---------|
| | Scientific English 3 Credits | 3 | | |
| | Space systems and technology 9 Credits | 9 | | |
| | Practical assignments, Master Thesis, 9 Credits | | | |
| | Space sciences 6 Credits | 6 | | |
| | Data analysis and programming 9 Credits | 9 | | |

| Course code | Course | Cr | Level | Comment |
|-------------|--|----|-------|---------|
| | Space industry and engineering 3 Credits | 3 | | |
| | Practical assignments, Master Thesis, 21 Credits | | | |

Profile: RYIN, Space Technology and Instrumentation, Kiruna

Elective courses 30 credits

Selective space is 30 credits. It is mandatory to select elective courses up to the given number of credits. The given number of credits of elective courses listed must be met for degree.

| Course code | Course | Cr | Level | Comment |
|-------------|---|-----|----------------|------------|
| P7005R | Space Engineering Project 1 | 7.5 | Master's level | Selectable |
| P7006R | Space Engineering Project 2 | 7.5 | Master's level | Selectable |
| R7007E | Special Studies in Space Engineering | 7.5 | Master's level | Selectable |
| R7011R | Image Processing with Space Applications | 7.5 | Master's level | Selectable |
| R7012R | Remote Sensing | 7.5 | Master's level | Selectable |
| R7018R | Spacecraft on board datahandling | 7.5 | Master's level | Selectable |
| R7025R | Orbit and Attitude Dynamics | 7.5 | Master's level | Selectable |
| R7026R | Spacecraft Control | 7.5 | Master's level | Selectable |
| R7030R | Spacecraft Guidance, Navigation and Control | 7.5 | Master's level | Selectable |

Profile: RYSP, Astrophysics, Space Science and Planetology, Toulouse

Compulsory course, Master thesis 27 credits

| Course code | Course | Cr | Level | Comment |
|-------------|--------------------------------------|----|-------|---------|
| | Internship, Master thesis 27 Credits | 27 | | |

Elective courses - choose of 3 courses

*) Astrophysics, 18 Credits - Choose 3 option from below:

- Interactions of planets with their environment.
- The interstellar medium and stellar formation.
- Stellar and planetary seismology.
- Compact objects and accretion.

- Cosmology and galaxy physics.

| Course code | Course | Cr | Level | Comment |
|-------------|--|----|-------|---------|
| | Astrophysics - 3 modules to choose, each 6 Credits | | | |
| | Transversal courses 9 Credits | | | |
| | Numerical simulation and data processing 3 Credits | | | |
| | Physics and astrophysics, 15 Credits | | | |

Profile: RYSP, Atmospheric and Space Science, Kiruna

Elective courses 30 credits

Selective space is 30 credits. It is mandatory to select elective courses up to the given number of credits. The given number of credits of elective courses listed must be met for degree.

| Course code | Course | Cr | Level | Comment |
|-------------|--|-----|----------------|------------|
| F7011R | Climate Physics | 7.5 | Master's level | Selectable |
| F7012R | Special Studies in Space and Atmospheric Science | 7.5 | Master's level | Selectable |
| F7019R | Advanced Radiative Transfer | 7.5 | Master's level | Selectable |
| P7005R | Space Engineering Project 1 | 7.5 | Master's level | Selectable |
| P7006R | Space Engineering Project 2 | 7.5 | Master's level | Selectable |
| R7011R | Image Processing with Space Applications | 7.5 | Master's level | Selectable |
| R7012R | Remote Sensing | 7.5 | Master's level | Selectable |
| R7018R | Spacecraft on board datahandling | 7.5 | Master's level | Selectable |

Specialisation: Atmospheric and Space Science, research oriented (RYSP)

Compulsory courses 22.5 credits

| Course code | Course | Cr | Level | Comment |
|-------------|---------------------|-----|----------------|---------|
| F7004R | Atmospheric Physics | 7.5 | Master's level | |
| F7014R | Polar Atmosphere | 7.5 | Master's level | |
| R7013R | Space Instruments | 7.5 | Master's level | |

Optional courses 37.5 credits

Selective space is 37.5 credits. It is mandatory to select elective courses up to the given number of credits. The given number of credits of elective courses listed must be met for degree.

| Course code | Course | Cr | Level | Comment |
|-------------|---|-----|----------------|------------|
| E7003R | Electronics in Space | 7.5 | Master's level | Selectable |
| F7002E | Atmospheric dynamics and climate | 7.5 | Master's level | Selectable |
| F7011R | Climate Physics | 7.5 | Master's level | Selectable |
| F7012R | Special Studies in Space and Atmospheric Science | 7.5 | Master's level | Selectable |
| F7018R | Introduction to Spectroscopy and Radiative transfer | 7.5 | Master's level | Selectable |
| P7005R | Space Engineering Project 1 | 7.5 | Master's level | Selectable |
| P7006R | Space Engineering Project 2 | 7.5 | Master's level | Selectable |
| R7011R | Image Processing with Space Applications | 7.5 | Master's level | Selectable |
| R7012R | Remote Sensing | 7.5 | Master's level | Selectable |
| R7018R | Spacecraft on board datahandling | 7.5 | Master's level | Selectable |

Specialisation: Space Technology and Instrumentation (RYIN)

Compulsory courses 15 credits

| Course code | Course | Cr | Level | Comment |
|-------------|----------------------|-----|----------------|---------|
| E7003R | Electronics in Space | 7.5 | Master's level | |
| R7013R | Space Instruments | 7.5 | Master's level | |

Optional courses 37.5 credits

Selective space is 37.5 credits. It is mandatory to select elective courses up to the given number of credits. The given number of credits of elective courses listed must be met for degree.

| Course code | Course | Cr | Level | Comment |
|-------------|---|-----|----------------|------------|
| F7004R | Atmospheric Physics | 7.5 | Master's level | Selectable |
| F7014R | Polar Atmosphere | 7.5 | Master's level | Selectable |
| F7018R | Introduction to Spectroscopy and Radiative transfer | 7.5 | Master's level | Selectable |

| Course code | Course | Cr | Level | Comment |
|-------------|--|-----|------------------|------------|
| P7005R | Space Engineering Project 1 | 7.5 | Master's level | Selectable |
| P7006R | Space Engineering Project 2 | 7.5 | Master's level | Selectable |
| R0010R | Onboard computers and onboard software | 7.5 | Bachelor's level | Selectable |
| R7004R | Spacecraft Environment Interactions | 7.5 | Master's level | Selectable |
| R7007E | Special Studies in Space Engineering | 7.5 | Master's level | Selectable |
| R7011R | Image Processing with Space Applications | 7.5 | Master's level | Selectable |
| R7012R | Remote Sensing | 7.5 | Master's level | Selectable |
| R7018R | Spacecraft on board datahandling | 7.5 | Master's level | Selectable |
| R7023R | Propulsion with space applications | 7.5 | Master's level | Selectable |
| R7025R | Orbit and Attitude Dynamics | 7.5 | Master's level | Selectable |
| R7026R | Spacecraft Control | 7.5 | Master's level | Selectable |

Study schedule

Year of study 1 Enrollment semester Autumn 2024, Is offered in 2024/2025

| Study-period | Course code | Course | Cr | Comment |
|--------------|-------------|--------------------------------------|-----|------------|
| 1 | F7008R | The Solar System | 7.5 | |
| 1 | R7028R | Spacecraft Systems | 7.5 | |
| 1 | S0046P | Swedish for International Students 1 | 3 | Selectable |
| 2 | R7017R | Space Physics | 7.5 | |
| 2 | R7021R | Space Communication | 7.5 | |

Year of study 2 Enrollment semester Autumn 2024, Is offered in 2025/2026, planned study schedule

| Study-period | Course code | Course | Cr | Comment |
|--------------|-------------|-----------------------|----|--------------------|
| 3-4 | P7004R | Master Degree Project | 30 | Entry requirements |

Profile: RYIN, Space Technology and Instrumentation, Kiruna

Year of study 2 Enrollment semester Autumn 2024, Is offered in 2025/2026, planned study schedule

| Study-period | Course code | Course | Cr | Comment |
|--------------|-------------|---|-----|------------|
| 1 | P7005R | Space Engineering Project 1 | 7.5 | Selectable |
| 1 | P7006R | Space Engineering Project 2 | 7.5 | Selectable |
| 1 | R7007E | Special Studies in Space Engineering | 7.5 | Selectable |
| 1 | R7018R | Spacecraft on board datahandling | 7.5 | Selectable |
| 1 | R7025R | Orbit and Attitude Dynamics | 7.5 | Selectable |
| 2 | P7005R | Space Engineering Project 1 | 7.5 | Selectable |
| 2 | P7006R | Space Engineering Project 2 | 7.5 | Selectable |
| 2 | R7007E | Special Studies in Space Engineering | 7.5 | Selectable |
| 2 | R7011R | Image Processing with Space Applications | 7.5 | Selectable |
| 2 | R7012R | Remote Sensing | 7.5 | Selectable |
| 2 | R7026R | Spacecraft Control | 7.5 | Selectable |
| 2 | R7030R | Spacecraft Guidance, Navigation and Control | 7.5 | Selectable |

Profile: RYSP, Atmospheric and Space Science, Kiruna

Year of study 2 Enrollment semester Autumn 2024, Is offered in 2025/2026, planned study schedule

| Study-period | Course code | Course | Cr | Comment |
|--------------|-------------|--|-----|------------|
| 1 | F7012R | Special Studies in Space and Atmospheric Science | 7.5 | Selectable |
| 1 | F7019R | Advanced Radiative Transfer | 7.5 | Selectable |
| 1 | P7005R | Space Engineering Project 1 | 7.5 | Selectable |
| 1 | P7006R | Space Engineering Project 2 | 7.5 | Selectable |
| 1 | R7018R | Spacecraft on board datahandling | 7.5 | Selectable |
| 2 | F7011R | Climate Physics | 7.5 | Selectable |
| 2 | F7012R | Special Studies in Space and Atmospheric Science | 7.5 | Selectable |
| 2 | P7005R | Space Engineering Project 1 | 7.5 | Selectable |
| 2 | P7006R | Space Engineering Project 2 | 7.5 | Selectable |
| 2 | R7011R | Image Processing with Space Applications | 7.5 | Selectable |
| 2 | R7012R | Remote Sensing | 7.5 | Selectable |

Specialisation: Atmospheric and Space Science, research oriented (RYSP)

Year of study 1 Enrollment semester Autumn 2024, Is offered in 2024/2025

| Study-period | Course code | Course | Cr | Comment |
|--------------|-------------|---|-----|------------|
| 3 | F7004R | Atmospheric Physics | 7.5 | |
| 3 | R7013R | Space Instruments | 7.5 | |
| 4 | E7003R | Electronics in Space | 7.5 | Selectable |
| 4 | F7014R | Polar Atmosphere | 7.5 | |
| 4 | F7018R | Introduction to Spectroscopy and Radiative transfer | 7.5 | Selectable |
| 4 | P7005R | Space Engineering Project 1 | 7.5 | Selectable |

(RYIN)**Year of study 1 Enrollment semester Autumn 2024, Is offered in
2024/2025**

| Study-period | Course code | Course | Cr | Comment |
|--------------|-------------|---|-----|------------|
| 3 | F7004R | Atmospheric Physics | 7.5 | Selectable |
| 3 | R7004R | Spacecraft Environment Interactions | 7.5 | Selectable |
| 3 | R7013R | Space Instruments | 7.5 | |
| 3 | R7023R | Propulsion with space applications | 7.5 | Selectable |
| 4 | E7003R | Electronics in Space | 7.5 | |
| 4 | F7014R | Polar Atmosphere | 7.5 | Selectable |
| 4 | F7018R | Introduction to Spectroscopy and Radiative transfer | 7.5 | Selectable |
| 4 | P7005R | Space Engineering Project 1 | 7.5 | Selectable |
| 4 | R0010R | Onboard computers and onboard software | 7.5 | Selectable |