Assessment plan for the curriculum of the Master's degree programme in Systems and Control, 2023-2024

Introduction
This assessment plan is a systematic description of the testing and assessment modes for all study components in the curriculum of the Master's degree programme in Systems and Control, 2023-2024. The plan is based on the assessment policy of the Faculty of Science and Engineering, as set out in the 2016-2017 version of the FMNS Quality Assurance Manual (Chapter 6: Assessment) and the protocol setting out the duties and powers of the Faculty's Board of Examiners (December 2013).

The assessment plan for the curriculum consists of the following parts:

1. objective(s) of the degree programme
2. the learning outcomes of the degree programme
3. descriptions of the study components, as set out in the appendices to the Teaching and Examination Regulations 2023-2024 of the degree programme
4. descriptions of the content of each study component in Ocasys, the online course catalog. The following elements are relevant in this context:
    - objectives
    - description of content
    - lecturers
    - assessment mode(s) and calculation of final mark
    - mode(s) of instruction.
5. An overview of the examiners and a detailed assessment mode for each study component. This overview is based on the curriculum approved by the Programme Committee, as set out in the appendices to the Teaching and Examination Regulations 2023-2024 for the degree programme.
6. A matrix showing the relationship between the study components and the detailed learning outcomes for each competence area.

Parts 3 and 4 are not included in this document. For the descriptions of the study components, see the Appendix to the Teaching and Examination Regulations 2023-2024 for the degree programme in Systems and Control. Descriptions of the content of each study component can be found in Ocasys, the online course catalog (http://www.rug.nl/ocasys/).

1. Objectives of the degree programme

With a master's degree in Systems and Control, students are trained to use interdisciplinary strategies to control complex systems and processes. The techniques used include modelling, dynamic data analysis, dynamic systems theory, control theory, optimization and network analysis. This master's programme has a focus in 'Complex Systems and Networks'. The most challenging problems in today's engineering systems have to do with systems that consist of many components that influence each other and whose structure and dynamics are very complex and difficult to control. Examples are our electricity network with many energy producing and summing units; billions of people on social media; or billions of neurons in the human brain. In these complex systems, each individual component interacts (physically or via digital information) with a portion of all other components with the pattern of connections defining the network. The students in this master programme will learn the underlying theory to analyze and control complex systems, in a way that provides provable guarantees for the regulated behavior of the system. They learn to use this theory in a critical way in a series of applications, whereby the understanding of the methods used is paramount.

2. Learning outcomes of the degree programme

The above objective has been translated into a set of learning outcomes for the programme.

Knowledge and Understanding
The master graduate in Systems and Control:

1.1 Has profound knowledge of the generic concepts of Systems and Control, including the necessary mathematics and engineering concepts, its relevance in technology, and computational aspects, at a level which permits admission to a higher level post-graduate programme

1.2 Has understanding of the disciplines that are relevant to the field of Systems and Control (such as electrical and mechanical engineering, robotics, physics) at a level which permits admission to a higher level post-graduate programme

1.3. Has operational knowledge and design/development skills in the field of Systems and Control

Application of Knowledge and Understanding
In addition, the master graduate in Systems and Control:

2.1 Has critical awareness and is capable of performing analysis, design, modeling and simulations within the context of complex engineering problems and networks, using methods from the field of systems and control

2.2 Is capable of applying his/her in-depth knowledge and practical skills to solve complex problems with respect to technological dynamical systems taking into consideration their external interaction with the environment as well as the internal interactions between their subsystems

2.3 Is capable of carrying out research at academic level, aimed at identifying, formulating and solving complex problems within the field of systems and control
2.4 Is capable of developing and designing new methods, algorithms and control strategies using specific knowledge from the field of systems and control while optimizing processes and resources
2.5 Is capable of analyzing data relevant to control systems and networks and retrieve information from the literature and other sources of information
2.6 Is capable to write scientific reports
2.7 Has developed an attitude aimed at seeking new innovative applications
2.8 Has experience in the application of systems and control in an industrial environment or in a research environment abroad
2.9 Is capable of collaborating in a (multi-disciplinary) research and design team

Judgement
In addition, the master graduate in Systems and Control:
3.1 Is capable of judging his/her and others' actions within a scientific context, taking economic, societal and ethical aspects into account
3.2 Is able to act in a responsible manner in regards to sustainability, economy and social welfare
3.3 Is able to draw conclusions on the basis of limited or incomplete information, and is able to realize and formulate the limitations of such conclusions
3.4 Is capable of working independently as well as part of a team to solve technological problems
3.5 Is able to explain scientific information and defend scientific outcomes within his/her research field

Communication Skills
In addition, the master graduate in Systems and Control:
4.1 Is capable of communicating in the English language, clearly and effectively, verbally and in writing, on his/her subject and relevant applications, at a level which is understandable to experts and non-experts
4.2 Is able to communicate scientifically with experts from different disciplines
4.3 Is capable of using modern communication tools

Learning Skills
In addition, the master graduate in Systems and Control:
5.1 Is capable of addressing issues inside as well as outside his/her main subject area, and thereby gaining new knowledge and skills
5.2 Is able to recognize potential systems and control applications in recent advances in science and technology
5.3 Has the ability to learn independently and engage in life-long learning

3. Descriptions of the study components

For the descriptions of the study components, see the Appendix to the Teaching and Examination Regulations 2023-2024 for the degree programme in Mathematics.

4. Descriptions of the content of each study component

Descriptions of the content of each study component can be found in Ocasys, the online course catalogue (http://www.rug.nl/ocasys/).

5. Overview of examiners and testing and assessment modes for study components

In this section an overview of the examiners and a detailed assessment mode for each study component is given. This overview is based on the curriculum approved by the Programme Committee, as set out in the appendices to the Teaching and Examination Regulations 2023-2024 for the degree programme.

The abbreviations for the relevant modes of assessment:

- Written exam with open questions (WE)
- Oral exam (OR)
- Assignment (AST)
- Practical Work (PR)
- Presentation (P)
- Report (R)
- Interim test (IT)

The Systems and Control modules offered locally at the University of Groningen are:

Module	**Course code**	**Offered**	**ECTS**	**First examiner**	**Second examiner (if necessary)**	**Practical**	**Assessment type**
Advanced Systems and Control	WMSC001-05	annual	5	prof.dr. S. Trenn	prof.dr.ir. J.M.A. Scherpen		WE, P, AST
Robust Control	WMMA021-05	annual	5	dr. H. van Waarde	dr.ir. B. Besselink		AST, WE
Robotics for IEM	WMIE005-05	annual	5	See MSc IEM	See MSc IEM	X	WE, R
Fitting Dynamical Models to Data	WMIE007-05	annual	5	See MSc IEM	See MSc IEM	X	WE
Calculus of Variations and Optimal Control	WMMA056-05	biennial, 23-24	5	dr.ir. B. Besselink	prof. dr. M.K. Camlibel		AST, WE
Data-Based Analysis and Control	WMMA058-05	biennial, 23-24	5	dr. H. van Waarde	prof. dr. M.K. Camlibel		AST, WE
Game Theory with Engineering Applications	WMIE009-05	annual	5	See MSc IEM	See MSc IEM		WE, R, P
Modeling and Identification	WMMA007-05	biennial, 24-25	5	tbd in 24/25	tbd in 24/25		AST, WE
Modeling and Control of Complex Nonlinear Engineering Systems	WMMA020-05	annual	5	dr.ir. B. Besselink	prof.dr.ir. J.M.A. Scherpen		AST, WE
Analysis and Control of Smart Systems	WMIE015-05	annual	5	See MSc IEM	See MSc IEM		WE
Optimization in Engineering Systems	WMIE026-05	annual	5	See MSc IEM	See MSc IEM		AST, WE
Integration Project	WMSC002-05	annual	5	dr. S. Ahmed	prof.dr. S. Trenn	X	R, P, PR
Data-Driven Optimization	WMME011-05	annual	5	See Msc ME	See Msc ME		AST, WE
Introduction to Stochastic Programming	WMIE019-05	annual	5	See MSc IEM	See MSc IEM		AST, WE

Mathematical Modelling	WMIE033-05	annual	5	See MSc IEM	See MSc IEM		AST
Opto-Mechatronics	WMME015-05	annual	5	See MSc ME	See MSc ME	X	WE
Internship/Design project	WMSC901-20	annual	20	See list below	See list below	X	PR, P, R
Research Project Systems and Control	WMSC902-40	annual	40	See list below	See list below		PR, P, R

Examiners for Internship/Design Project (20 EC) and Research Project Systems and Control

dr. S. Ahmed
prof. dr. D. Bauso
prof. dr.ir. B. Besselink
prof. dr. M.K. Camlibel
prof. dr. M. Cao
dr. A.K. Cherukuri
prof. dr. C. de Persis
prof. dr. B. Jayawardhana
prof. dr. N. Monshizadeh
prof. dr. J.G. Peypouquet
prof. dr.ir. J.M.A. Scherpen
prof. dr. S. Trenn
dr. H. van Waarde

Examiners of the research project of the master's degree programme in Applied Mathematics, Industrial Engineering Management (IEM), and Mechanical Engineering (ME) may act as a second examiner for the research project of the master's degree programme in Systems and Control as well.

On an individual basis the Board of Examiners can allow examiners of other degree programmes to act as examiner for the research project of the master's degree programme in Systems and Control as well.

6. Relationship between course units and details of the learning outcomes

In this section the relation between the course units and the learning outcomes is shown. Here the following notation is used:

1 : the course makes a limited contribution to the specified learning outcome

2: the course makes a substantial contribution to the specified learning outcome

	1.1	1.2	1.3	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	5.1	5.2	5.3
WMSC001-05	2									2							2	2			2	2	
WMMA021-05	2												1		2			1					
WMIE005-05	1	2	2	2	2		2			2					2			1	2				
WMIE007-05	2	2	2					2							2			1					
WMMA056-05	2			2			2											1					
WMMA058-05	2		2	2	1		1	2										1					
WMIE009-05	2	2	2	2	2		2			2					2			1	2			2	
WMMA007-05	2		2	2		2	2	2				2					2	1	2			2	
WMMA020-05	2	2	2	2	2	2	2			2		2					2	2				2	
WMIE015-05	2	2	2	2	2		2			2			2	2				1	2			2	

	1.1	1.2	1.3	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	5.1	5.2	5.3
WMIE026-05	2	2		2	2		2						2	2				1	2				
WMSC002-05			2		2		2	2	2			2			2	2	2	1			2		
WMME011-05	2			2			2						2		2			1					
WMIE019-05	2		2	2			2											1					
WMIE033-05	2	2		2														1	2				
WMME015-05	2	2	2	2	2		2			2								2	2			2	
WMSC901-20			1		1		1	1	1		2	1			1	1	1	1		1	1		
WMSC902-40	2	2	2			2		2	2	2		2	2				2	2		2	2	2	2