

Modulhandbuch / module manual

Master-Studiengang / master's degree

Space Engineering

2020

Stand: November 2020

Übersicht

Vorbemerkung / preliminary remarks:

Das Modulhandbuch dient den Studierenden als Orientierungshilfe. Es ist keine Rechtsgrundlage - es gilt die jeweilige Prüfungsordnung in der aktuellen Fassung.

Wir versuchen die Modulbeschreibungen auf dem neuesten Stand zu halten, es kann jedoch immer zu Abweichungen im Hinblick auf Lehrpersonal und Inhalte kommen, die sich im Verlauf des Studienjahres ergeben.

This module manual serves only as an orientation for students. The legal base are always the examination regulations.

Please note that we try to keep the module descriptions up to date, but there can always be minor differences regarding the lecturer or course contents.

Anmerkung zur aktuellen Situation / COVID-19 remarks:

Aufgrund der fortschreitenden Entwicklung der Corona Pandemie ist es leider nicht möglich, alle Modulbeschreibungen auf einem tagesaktuellen Stand zu halten. Dies bedeutet, dass insbesondere die in den Modulbeschreibungen angegebenen Formate der Lehrveranstaltungen sowie Prüfungsformen auch kurzfristig den sich verändernden Gegebenheiten, Vorgaben und Erfordernissen angepasst werden können. Über die jeweilige **Stud.IP-Veranstaltung** werden die Studierenden direkt von den Dozent*innen über den Ablauf von Lehrveranstaltung und Prüfung informiert.

Im Einzelfall kann es auch dazu kommen, dass eine Lehrveranstaltung nicht angeboten werden kann. Sofern es sich um eine Pflichtveranstaltung handelt, wird ein alternatives Angebot bereitgestellt. Wir danken für Ihr Verständnis und wünschen auch unter den gegebenen Umständen ein erfolgreiches und spannendes Studienjahr 2020/21!

Due the ongoing COVID-19 pandemic is not possible to keep every description up to date. Especially the examination type or the format of the course itself could change due to the development of the pandemic.

Please visit the according Stud.IP-courses to receive information provided by the lecturer about changes regarding the course. It is possible that a course cannot be offered due to the pandemic, if this is the case for a mandatory course, an alternative will be offered.

Thank you for your understanding, we wish you a successful and interesting academic year 2020/21!

MSc. SpE					
module	lecture	lecturer	CP	WiSe	SoSe
Foundations					
	Applied Mathematical Methods and Data Analysis	Prof. Dr. Michail Vrekousis	6	x	
	Atmospheric Physics	Prof. Dr. John Philip Burrows	6	x	x
	Communication Technologies (for Space)	Dr.-Ing. Carsten Bockelmann	6	x	x
	Control Theory 1	Prof. Dr. Kai Michels	6	x	x
	Inverse Methods and Data Analysis	Reiner Schlitzer	6	x	
	Science and Exploration Missions	Prof. Dr. Claus Lämmerzahl, Dr. Marco Scharringhausen	3	x	x
	Space Electronics	Prof. Dr. Alberto Garcia-Ortiz	3	x	x
Compulsory Modules					
Space Flight Theory	Mission Design	Martin Drobczyk, Dipl.-Ing. Falk Nohka	1.5		x
	Mission Analysis	Marcus Hallmann	3	x	
	Trajectory Optimization	Prof. Dr. Christof Büskens, Matthias Knauer	4.5	x	
Space Environment and Testing	Design of Space Vehicles	Prof. Dr.-Ing. Andreas Rittweger	3	x	
	Product Assurance and Space Technology	Prof. Dr. Claus Braxmaier, Dr.-Ing. Jens Große	3		x
	Space Environment and S/C Qualification	Hansjörg Dittus	3		x
Satellite Systems	Space Systems Engineering/Concurrent Engineering	Dr. Oliver Romberg	3	x	x
	Structural Design and Analysis	Prof. Dr.-Ing. Andreas Rittweger	3		x
	Thermal Control of Satellites	Hansjörg Dittus	3	x	

Subsystems	Orbital Systems	Dr. Peter Rickmers, Dr. Waldemar Bauer	3		x
	Space Propulsion Systems 1	Dr. Peter Rickmers	3		x
	Spacecraft Navigation and Control	Dr.-Ing. Stephan Theil	3	x	
Elective Modules					
	Fatigue and Loads	Prof. Dr. Richard Marian Degenhardt	3	x	
	Cost Estimations for Space Systems	Andy Braukhane	3	x	
	FEM Simulations for the Design of Space Systems	Dr.-Ing. Jens Große	6	x	
	Specification of Embedded Systems	Prof. Dr. Jan Peleska	3		x
	Scientific Payloads	Dr. Sven Herrmann	3		x
	Applied Numerical Fluid Mechanics	PD Dr. Yan Jin	3		x
	On Board Data Handling	Dr. rer. nat. Frank Dannemann	3		x
	Fluid Handling in Spacecrafts	Prof. Dr.-Ing. habil. Michael Dreyer	3		x
	Research and Exploration Missions	Prof. Dr. Claus Lämmerzahl Dr. Marco Scharringhausen	3		x
	Human Space Exploration & Habitation	Daniel Schubert, Paul Zabel	3		x
	Philosophy of Cosmology, Space and Space Travel	Prof. Dr. Claus Lämmerzahl Prof. Dr. Dr. Norman Sieroka	3	x	
Master Project					
	Master Project		12		
Master Thesis					
	Master Thesis				

Foundations

module code /
module title

Applied Mathematical Methods and Data Analysis

 date / version of the module
description

Klicken Sie hier, um Text einzugeben.

1 INFORMATION ON THE MODULE		
1a	module code	Klicken Sie hier, um Text einzugeben.
1b	module title (German title)	Klicken Sie hier, um Text einzugeben.
1c	module title (English title)	Applied Mathematical Methods and Data Analysis
1d	credit points	6
1e	responsible for the module	Prof. Dr. Mihalis Vrekoussis
1f	type of module	choose an option
1g	programs using the module	Klicken Sie hier, um Text einzugeben.
1h	organizational unit offering the module	Klicken Sie hier, um Text einzugeben.
1i	content-related prior knowledge or skills	Klicken Sie hier, um Text einzugeben.
1j	learning contents	<p>The course lectures cover the theoretical basis of the following subject areas:</p> <ul style="list-style-type: none"> • Essential linear algebra (matrices, eigenvalues, linear systems of equations) • Essential calculus (differentiation, integration, Taylor series) • Essential statistics (error analysis, correlation, significance) • Essential optimization (linear and nonlinear regression, parameter estimation, gradient methods) • Essential differential equations (ordinary and partial differential equations, phase diagrams) <p>In the example classes students will learn how to apply this knowledge both analytically and numerically. In order to facilitate the latter, students will learn the basics of the</p>

		Python programming language and how to use Python to solve real-world problems from the course's topic areas.																																																																		
1k	learning outcomes/ competencies/ targeted competencies	Basic knowledge in mathematical methods for data analysis and their application using the Python programming language.																																																																		
1l	calculation of student workload (part a: calculation of presence time and working hours)	<p>The total amount of the presence time and working hours of the module has to be calculated additionally in the detailed calculation a) to c).</p> <p>a) detailed calculation: SWS / presence time/working hours in each course of the module</p> <table border="1"> <tr> <td><input checked="" type="checkbox"/> 2</td> <td>lecture(s) with</td> <td>2</td> <td>SWS/ contact hours</td> <td>28</td> <td>hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td>seminar(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>hours of presence time</td> </tr> <tr> <td><input checked="" type="checkbox"/> 2</td> <td>exercise(s) with</td> <td>2</td> <td>SWS/ contact hours</td> <td>28</td> <td>hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td>internship(s) with</td> <td></td> <td>sum of working hours</td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/></td> <td>seminar(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>total hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td>laboratory/laboratories with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>total hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td>tutorial(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/></td> <td>excursion(s) with</td> <td></td> <td>SWS contact hours in total</td> <td></td> <td>working hours</td> </tr> <tr> <td><input type="checkbox"/></td> <td colspan="5">other form of course (e.g. block seminar), namely this: Klicken Sie hier, um Text einzugeben.</td> </tr> <tr> <td></td> <td>with</td> <td>SWS / with totaly</td> <td>contact hours</td> <td><input type="checkbox"/> presence time</td> <td><input type="checkbox"/> working hours</td> </tr> <tr> <td></td> <td colspan="5">= sum of presence time and working hours: 56</td> </tr> </table>	<input checked="" type="checkbox"/> 2	lecture(s) with	2	SWS/ contact hours	28	hours of presence time	<input type="checkbox"/>	seminar(s) with		SWS/ contact hours		hours of presence time	<input checked="" type="checkbox"/> 2	exercise(s) with	2	SWS/ contact hours	28	hours of presence time	<input type="checkbox"/>	internship(s) with		sum of working hours			<input type="checkbox"/>	seminar(s) with		SWS/ contact hours		total hours of presence time	<input type="checkbox"/>	laboratory/laboratories with		SWS/ contact hours		total hours of presence time	<input type="checkbox"/>	tutorial(s) with		SWS/ contact hours			<input type="checkbox"/>	excursion(s) with		SWS contact hours in total		working hours	<input type="checkbox"/>	other form of course (e.g. block seminar), namely this: Klicken Sie hier, um Text einzugeben.						with	SWS / with totaly	contact hours	<input type="checkbox"/> presence time	<input type="checkbox"/> working hours		= sum of presence time and working hours: 56				
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	calculation of student workload (part b: preparation time and follow-up work/self-study)	<p>b) working hours for preparation/follow-up work of the course(s) and/or self-study</p> <p>= sum of working hours: 56</p>																																																																		

	calculation of student workload (part c: exam preparation etc.)	c) exam preparation (incl. examination) = sum of working hours: 68
	calculation of student workload (total amount of hours including a) - c))	Total amount of the presence time and working hours a) to c): 180
1m	description of possible optional courses in the module	<u>Can a student choose between different courses within the module?</u> NO <u>Short description of selection option</u> Klicken Sie hier, um Text einzugeben.
1n	language(s) of instruction	<input type="checkbox"/> German <input checked="" type="checkbox"/> English <input type="checkbox"/> Spanish <input type="checkbox"/> French <input type="checkbox"/> Other, namely this: Klicken Sie hier, um Text einzugeben.
1o	frequency	(regular cycle module is offered) e.g.: winter semester, yearly or summer semester, yearly or each semester winter semester yearly Klicken Sie hier, um Text einzugeben.
1p	duration	one semester module Klicken Sie hier, um Text einzugeben.
1q	Literature (optional)	Klicken Sie hier, um Text einzugeben.
1r	more information on the module (optional)	Klicken Sie hier, um Text einzugeben.
2	INFORMATION ON THE MODULE EXAMINATION (see also AT Art. 5 section 8)	
2a	type of examination	<input checked="" type="checkbox"/> module exam; i.e. exam with only one component (MP) <input type="checkbox"/> combination exam, i.e. exam with several components (administered by instructors) (KP) <input type="checkbox"/> partial exam; i.e. exam with several components (administered by registrar) (TP)
2b	exam components or prerequisites (type, number)	<i>PL = graded component of the examination</i> <i>SL = ungraded component of the examination, coursework</i> <i>PVL = prerequisite of the examination (see AT Art. 5 Section 10)</i> <input checked="" type="checkbox"/> PL number <input type="checkbox"/> SL number <input type="checkbox"/> PVL justification If necessary, further explanations: Klicken Sie hier, um Text einzugeben.

2c	Give this information for combination examinations only: Weights (in percentage) of component grades	<p>PL 1: Klicken Sie hier, um Text einzugeben.</p> <p>PL 2: Klicken Sie hier, um Text einzugeben.</p> <p>PL 3: Klicken Sie hier, um Text einzugeben.</p> <p>PL 4: Klicken Sie hier, um Text einzugeben.</p> <p>If necessary, further comments: Klicken Sie hier, um Text einzugeben.</p>
2d	form of examination (see AT BPO/AT MPO Art. 8, 9 and 10)	<p> <input type="checkbox"/> Assignment <input type="checkbox"/> Oral examination (single) <input type="checkbox"/> Presentation, oral <input checked="" type="checkbox"/> Written examination <input type="checkbox"/> Group examination, oral <input type="checkbox"/> Presentation and written assignment <input type="checkbox"/> Portfolio <input type="checkbox"/> Project report <input type="checkbox"/> Bachelor Thesis <input type="checkbox"/> Internship report <input type="checkbox"/> Colloquium <input type="checkbox"/> Master Thesis <input type="checkbox"/> Other (concrete definition is given in the examination regulations): Klicken Sie hier, um Text einzugeben. </p>
2e	language(s) of instruction	<p> <input type="checkbox"/> German <input checked="" type="checkbox"/> English <input type="checkbox"/> Spanish <input type="checkbox"/> French <input type="checkbox"/> Other, namely this: Klicken Sie hier, um Text einzugeben. </p>

module code /
 module title

Atmospheric Physics

 date / version of the module
 description

2020

1 INFORMATION ON THE MODULE		
1a	module code	01-01-03-AtPhy
1b	module title (German title)	Atmospheric Physics
1c	module title (English title)	Atmospheric Physics
1d	credit points	6
1e	responsible for the module	Prof. Dr. John P. Burrows
1f	type of module	compulsory module
1g	programs using the module	Klicken Sie hier, um Text einzugeben.
1h	organizational unit offering the module	Klicken Sie hier, um Text einzugeben.
1i	content-related prior knowledge or skills	Klicken Sie hier, um Text einzugeben.
1j	learning contents	The origin of the solar system and the earth's atmosphere; the evolving atmospheric composition; the physical parameters determining conditions in the atmosphere (e.g. temperature, pressure, and vorticity); the laws describing electromagnetic radiation; the interaction between electromagnetic radiation and matter (absorption emission and scattering); atmospheric radiative transport; radiation balance, climate change; atmospheric thermodynamics and hydrological cycle; aerosols and cloud physics; an introduction into atmospheric dynamics (kinematics, circulation etc.).
1k	learning outcomes/ competencies/ targeted competencies	An adequate understanding of the fundamentals of atmospheric physics. This addresses a) gaining an understanding the laws of physics, which determine the behaviour of the earth system comprising the sun the atmosphere and earth surface, b) learning the ability to apply the laws of physics to calculate parameters and forecast conditions in the atmosphere. This knowledge is required for subsequent advanced

courses in the M.Sc. programmes. In later life, these learning outcomes are essential for undertaking a) research in atmospheric, environmental and climate science Earth observation and remote sensing from ground based ship, aircraft and space based instrumentation, b) being employment in earth observation, earth science, meteorology, industry, or governmental and space agencies.

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calculation of student workload (part a: calculation of presence time and working hours)

The total amount of the presence time and working hours of the module has to be calculated additionally in the detailed calculation a) to c).

a) detailed calculation:

SWS / presence time/working hours in each course of the module

2 lecture(s) with 2 SWS/ contact hours 28 hours of presence time

seminar(s) with SWS/ contact hours hours of presence time

2 exercise(s) with 2 SWS/ contact hours 28 hours of presence time

internship(s) with sum of working hours

seminar(s) with SWS/ contact hours total hours of presence time

laboratory/laboratories with SWS/ contact hours total hours of presence time

tutorial(s) with SWS/ contact hours

excursion(s) with SWS contact hours in total working hours

other form of course (e.g. block seminar), namely this:

Klicken Sie hier, um Text einzugeben.

with SWS / with total contact hours presence time working hours

= sum of presence time and working hours:

56

calculation of student workload (part b: preparation time and follow-up work/self-study)

b) working hours for preparation/follow-up work of the course(s) and/or self-study

= sum of working hours:

56

	calculation of student workload (part c: exam preparation etc.)	c) exam preparation (incl. examination) = sum of working hours: 68
	calculation of student workload (total amount of hours including a) - c))	Total amount of the presence time and working hours a) to c): 180
1m	description of possible optional courses in the module	<u>Can a student choose between different courses within the module?</u> NO <u>Short description of selection option</u> Klicken Sie hier, um Text einzugeben.
1n	language(s) of instruction	<input type="checkbox"/> German <input checked="" type="checkbox"/> English <input type="checkbox"/> Spanish <input type="checkbox"/> French <input type="checkbox"/> Other, namely this: Klicken Sie hier, um Text einzugeben.
1o	frequency	(regular cycle module is offered) e.g.: winter semester, yearly or summer semester, yearly or each semester winter semester yearly Klicken Sie hier, um Text einzugeben.
1p	duration	one semester module Klicken Sie hier, um Text einzugeben.
1q	Literature (optional)	• Houghton, J.T., The physics of atmospheres, Cambridge University Press, 1977, ISBN 0 521 29656 0 • Wallace, John M. and Peter V. Hobbs, Atmospheric Science, An Introductory Survey, Academic Press, 2nd Edition 2005, ISBN 0-12-732951-x
1r	more information on the module (optional)	Klicken Sie hier, um Text einzugeben.
2	INFORMATION ON THE MODULE EXAMINATION (see also AT Art. 5 section 8)	
2a	type of examination	<input checked="" type="checkbox"/> module exam; i.e. exam with only one component (MP) <input type="checkbox"/> combination exam, i.e. exam with several components (administered by instructors) (KP) <input type="checkbox"/> partial exam; i.e. exam with several components (administered by registrar) (TP)
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2c	Give this information for combination examinations only: Weights (in percentage) of component grades	<p>PL 1: Klicken Sie hier, um Text einzugeben.</p> <p>PL 2: Klicken Sie hier, um Text einzugeben.</p> <p>PL 3: Klicken Sie hier, um Text einzugeben.</p> <p>PL 4: Klicken Sie hier, um Text einzugeben.</p> <p>If necessary, further comments: Klicken Sie hier, um Text einzugeben.</p>
2d	form of examination (see AT BPO/AT MPO Art. 8, 9 and 10)	<p> <input type="checkbox"/> Assignment <input type="checkbox"/> Oral examination (single) <input type="checkbox"/> Presentation, oral <input checked="" type="checkbox"/> Written examination <input type="checkbox"/> Group examination, oral <input type="checkbox"/> Presentation and written assignment <input type="checkbox"/> Portfolio <input type="checkbox"/> Project report <input type="checkbox"/> Bachelor Thesis <input type="checkbox"/> Internship report <input type="checkbox"/> Colloquium <input type="checkbox"/> Master Thesis <input type="checkbox"/> Other (concrete definition is given in the examination regulations): Klicken Sie hier, um Text einzugeben. </p>
2e	language(s) of instruction	<p> <input type="checkbox"/> German <input checked="" type="checkbox"/> English <input type="checkbox"/> Spanish <input type="checkbox"/> French <input type="checkbox"/> Other, namely this: Klicken Sie hier, um Text einzugeben. </p>

module code /
 module title

Communication Technologies for Space

 date / version of the module
 description

Klicken Sie hier, um Text einzugeben.

1 INFORMATION ON THE MODULE		
1a	module code	01-M-ComT
1b	module title (German title)	Klicken Sie hier, um Text einzugeben.
1c	module title (English title)	Communication Technologies for Space
1d	credit points	6
1e	responsible for the module	Dr.-Ing. Carsten Bockelmann
1f	type of module	compulsory module
1g	programs using the module	Klicken Sie hier, um Text einzugeben.
1h	organizational unit offering the module	Klicken Sie hier, um Text einzugeben.
1i	content-related prior knowledge or skills	Klicken Sie hier, um Text einzugeben.
1j	learning contents	<ul style="list-style-type: none"> • Introduction to communications: history of wireless communication and space communication • Basic concepts and terminology in communications • Recap of Fourier transformation • Introduction to system theory (signals, linear time invariant systems, convolution, statistic process, etc.) • Passband-Baseband transformation and receiver concepts • Wireless channel basics (linear and non-linear distortions, noise, Nyquist, etc.) • Analog modulation • Basics in sampling theory and discrete systems and signals • Digital modulation

1k	learning outcomes/ competencies/ targeted competencies	<p>As outcome, the students should be able to:</p> <ul style="list-style-type: none"> • explain basic communications concepts and theoretical foundations; • apply mathematical tools and concepts relevant in communications; • explain and apply analog and digital modulation. 																																																																														
1l	calculation of student workload (part a: calculation of presence time and working hours)	<p>The total amount of the presence time and working hours of the module has to be calculated additionally in the detailed calculation a) to c).</p> <p>a) detailed calculation: SWS / presence time/working hours in each course of the module</p> <table border="1"> <tr> <td><input checked="" type="checkbox"/> 2</td> <td>lecture(s) with</td> <td>2</td> <td>SWS/ contact hours</td> <td>28</td> <td>hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td>seminar(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>hours of presence time</td> </tr> <tr> <td><input checked="" type="checkbox"/> 2</td> <td>exercise(s) with</td> <td>2</td> <td>SWS/ contact hours</td> <td>28</td> <td>hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td>internship(s) with</td> <td></td> <td>sum of working hours</td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/></td> <td>seminar(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>total hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td>laboratory/laboratories with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>total hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td>tutorial(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/></td> <td>excursion(s) with</td> <td></td> <td>SWS contact hours in total</td> <td></td> <td>working hours</td> </tr> <tr> <td><input type="checkbox"/></td> <td colspan="5">other form of course (e.g. block seminar), namely this:</td> </tr> <tr> <td></td> <td colspan="5">Klicken Sie hier, um Text einzugeben.</td> </tr> <tr> <td></td> <td>with</td> <td>SWS / with totaly</td> <td>contact hours</td> <td><input type="checkbox"/> presence time</td> <td><input type="checkbox"/> working hours</td> </tr> <tr> <td></td> <td colspan="5">= sum of presence time and working hours:</td> </tr> <tr> <td></td> <td colspan="5">56</td> </tr> </table>	<input checked="" type="checkbox"/> 2	lecture(s) with	2	SWS/ contact hours	28	hours of presence time	<input type="checkbox"/>	seminar(s) with		SWS/ contact hours		hours of presence time	<input checked="" type="checkbox"/> 2	exercise(s) with	2	SWS/ contact hours	28	hours of presence time	<input type="checkbox"/>	internship(s) with		sum of working hours			<input type="checkbox"/>	seminar(s) with		SWS/ contact hours		total hours of presence time	<input type="checkbox"/>	laboratory/laboratories with		SWS/ contact hours		total hours of presence time	<input type="checkbox"/>	tutorial(s) with		SWS/ contact hours			<input type="checkbox"/>	excursion(s) with		SWS contact hours in total		working hours	<input type="checkbox"/>	other form of course (e.g. block seminar), namely this:						Klicken Sie hier, um Text einzugeben.						with	SWS / with totaly	contact hours	<input type="checkbox"/> presence time	<input type="checkbox"/> working hours		= sum of presence time and working hours:						56				
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	calculation of student workload (part b: preparation time and follow-up work/self-study)	<p>b) working hours for preparation/follow-up work of the course(s) and/or self-study</p> <p>= sum of working hours:</p> <p>56</p>																																																																														

	calculation of student workload (part c: exam preparation etc.)	c) exam preparation (incl. examination) = sum of working hours: 68
	calculation of student workload (total amount of hours including a) - c)	Total amount of the presence time and working hours a) to c): 180
1m	description of possible optional courses in the module	<u>Can a student choose between different courses within the module?</u> NO <u>Short description of selection option</u> Klicken Sie hier, um Text einzugeben.
1n	language(s) of instruction	<input type="checkbox"/> German <input checked="" type="checkbox"/> English <input type="checkbox"/> Spanish <input type="checkbox"/> French <input type="checkbox"/> Other, namely this: Klicken Sie hier, um Text einzugeben.
1o	frequency	(regular cycle module is offered) e.g.: winter semester, yearly or summer semester, yearly or each semester winter semester yearly Klicken Sie hier, um Text einzugeben.
1p	duration	one semester module Klicken Sie hier, um Text einzugeben.
1q	Literature (optional)	<ul style="list-style-type: none"> • J. Proakis: Digital Transmission • Kammeyer: Nachrichtenübertragung
1r	more information on the module (optional)	Klicken Sie hier, um Text einzugeben.
2	INFORMATION ON THE MODULE EXAMINATION (see also AT Art. 5 section 8)	
2a	type of examination	<input checked="" type="checkbox"/> module exam; i.e. exam with only one component (MP) <input type="checkbox"/> combination exam, i.e. exam with several components (administered by instructors) (KP) <input type="checkbox"/> partial exam; i.e. exam with several components (administered by registrar) (TP)
2b	exam components or prerequisites (type, number)	<i>PL = graded component of the examination</i> <i>SL = ungraded component of the examination, coursework</i> <i>PVL = prerequisite of the examination (see AT Art. 5 Section 10)</i> <input type="checkbox"/> PL number <input checked="" type="checkbox"/> SL number <input type="checkbox"/> PVL justification If necessary, further explanations: Klicken Sie hier, um Text einzugeben.

2c	Give this information for combination examinations only: Weights (in percentage) of component grades	<p>PL 1: Klicken Sie hier, um Text einzugeben.</p> <p>PL 2: Klicken Sie hier, um Text einzugeben.</p> <p>PL 3: Klicken Sie hier, um Text einzugeben.</p> <p>PL 4: Klicken Sie hier, um Text einzugeben.</p> <p>If necessary, further comments: Klicken Sie hier, um Text einzugeben.</p>
2d	form of examination (see AT BPO/AT MPO Art. 8, 9 and 10)	<p> <input type="checkbox"/> Assignment <input type="checkbox"/> Oral examination (single) <input type="checkbox"/> Presentation, oral <input checked="" type="checkbox"/> Written examination <input type="checkbox"/> Group examination, oral <input type="checkbox"/> Presentation and written assignment <input type="checkbox"/> Portfolio <input type="checkbox"/> Project report <input type="checkbox"/> Bachelor Thesis <input type="checkbox"/> Internship report <input type="checkbox"/> Colloquium <input type="checkbox"/> Master Thesis <input type="checkbox"/> Other (concrete definition is given in the examination regulations): Klicken Sie hier, um Text einzugeben. </p>
2e	language(s) of instruction	<p> <input type="checkbox"/> German <input checked="" type="checkbox"/> English <input type="checkbox"/> Spanish <input type="checkbox"/> French <input type="checkbox"/> Other, namely this: Klicken Sie hier, um Text einzugeben. </p>

module code /
 module title

Contol Theory 1

 date / version of the module
 description

Klicken Sie hier, um Text einzugeben.

1 INFORMATION ON THE MODULE		
1a	module code	01-15-03-CTh1-V Control Theory 1
1b	module title (German title)	Regelungstheorie 1
1c	module title (English title)	Contol Theory 1
1d	credit points	6
1e	responsible for the module	Michels, Kai, Prof. Dr.-Ing.
1f	type of module	choose an option
1g	programs using the module	Klicken Sie hier, um Text einzugeben.
1h	organizational unit offering the module	Klicken Sie hier, um Text einzugeben.
1i	content-related prior knowledge or skills	Klicken Sie hier, um Text einzugeben.
1j	learning contents	<ul style="list-style-type: none"> • Definition and features of state variables • State space description of linear systems • Normal forms • Coordinate transformation • General solution of a linear state space equation • Lyapunov stability • Controllability and observability • Concept of state space control • Steady-state accuracy of state space controllers • Observer • Controller design by pole placement • Riccati controller design

		<ul style="list-style-type: none"> Falb-Wolovitch controller design 																																																																														
1k	learning outcomes/ competencies/ targeted competencies	<ul style="list-style-type: none"> Understanding and handling of state space methodology Design of state space controllers with different methods Observer design 																																																																														
1l	calculation of student workload (part a: calculation of presence time and working hours)	<p>The total amount of the presence time and working hours of the module has to be calculated additionally in the detailed calculation a) to c).</p> <p>a) detailed calculation: SWS / presence time/working hours in each course of the module</p> <table border="1"> <tr> <td><input checked="" type="checkbox"/> 2</td> <td>lecture(s) with</td> <td>2</td> <td>SWS/ contact hours</td> <td>28</td> <td>hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td>seminar(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>hours of presence time</td> </tr> <tr> <td><input checked="" type="checkbox"/> 2</td> <td>exercise(s) with</td> <td>2</td> <td>SWS/ contact hours</td> <td>28</td> <td>hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td>internship(s) with</td> <td></td> <td>sum of working hours</td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/></td> <td>seminar(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>total hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td>laboratory/laboratories with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>total hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td>tutorial(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/></td> <td>excursion(s) with</td> <td></td> <td>SWS contact hours in total</td> <td></td> <td>working hours</td> </tr> <tr> <td><input type="checkbox"/></td> <td colspan="5">other form of course (e.g. block seminar), namely this:</td> </tr> <tr> <td></td> <td colspan="5">Klicken Sie hier, um Text einzugeben.</td> </tr> <tr> <td></td> <td>with</td> <td>SWS / with totaly</td> <td>contact hours</td> <td><input type="checkbox"/> presence time</td> <td><input type="checkbox"/> working hours</td> </tr> <tr> <td></td> <td colspan="5">= sum of presence time and working hours:</td> </tr> <tr> <td></td> <td colspan="5">56</td> </tr> </table>	<input checked="" type="checkbox"/> 2	lecture(s) with	2	SWS/ contact hours	28	hours of presence time	<input type="checkbox"/>	seminar(s) with		SWS/ contact hours		hours of presence time	<input checked="" type="checkbox"/> 2	exercise(s) with	2	SWS/ contact hours	28	hours of presence time	<input type="checkbox"/>	internship(s) with		sum of working hours			<input type="checkbox"/>	seminar(s) with		SWS/ contact hours		total hours of presence time	<input type="checkbox"/>	laboratory/laboratories with		SWS/ contact hours		total hours of presence time	<input type="checkbox"/>	tutorial(s) with		SWS/ contact hours			<input type="checkbox"/>	excursion(s) with		SWS contact hours in total		working hours	<input type="checkbox"/>	other form of course (e.g. block seminar), namely this:						Klicken Sie hier, um Text einzugeben.						with	SWS / with totaly	contact hours	<input type="checkbox"/> presence time	<input type="checkbox"/> working hours		= sum of presence time and working hours:						56				
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	calculation of student workload (part b: preparation time and follow-up work/self-study)	<p>b) working hours for preparation/follow-up work of the course(s) and/or self-study</p> <p>= sum of working hours:</p> <p>56</p>																																																																														

	calculation of student workload (part c: exam preparation etc.)	c) exam preparation (incl. examination) = sum of working hours: 68
	calculation of student workload (total amount of hours including a) - c))	Total amount of the presence time and working hours a) to c): 180
1m	description of possible optional courses in the module	<u>Can a student choose between different courses within the module?</u> NO <u>Short description of selection option</u> Klicken Sie hier, um Text einzugeben.
1n	language(s) of instruction	<input type="checkbox"/> German <input checked="" type="checkbox"/> English <input type="checkbox"/> Spanish <input type="checkbox"/> French <input type="checkbox"/> Other, namely this: Klicken Sie hier, um Text einzugeben.
1o	frequency	<i>(regular cycle module is offered) e.g.: winter semester, yearly or summer semester, yearly or each semester</i> winter semester yearly Klicken Sie hier, um Text einzugeben.
1p	duration	one semester module Klicken Sie hier, um Text einzugeben.
1q	Literature (optional)	<ul style="list-style-type: none"> • K. Michels: Control Engineering (Script in German and English) German: • J. Lunze: Regelungstechnik 2 • O. Föllinger: Regelungstechnik • H. Unbehauen: Regelungstechnik II English: • Norman S. Nise: Control Systems Engineering
1r	more information on the module (optional)	Klicken Sie hier, um Text einzugeben.
2	INFORMATION ON THE MODULE EXAMINATION (see also AT Art. 5 section 8)	
2a	type of examination	<input checked="" type="checkbox"/> module exam; i.e. exam with only one component (MP) <input type="checkbox"/> combination exam, i.e. exam with several components (administered by instructors) (KP) <input type="checkbox"/> partial exam; i.e. exam with several components (administered by registrar) (TP)

2b	exam components or prerequisites (type, number)	<p><i>PL</i> = graded component of the examination <i>SL</i> = ungraded component of the examination, coursework <i>PVL</i> = prerequisite of the examination (see AT Art. 5 Section 10)</p> <p><input checked="" type="checkbox"/> PL number <input type="checkbox"/> SL number <input type="checkbox"/> PVL justification</p> <p>If necessary, further explanations: Klicken Sie hier, um Text einzugeben.</p>
2c	Give this information for combination examinations only: Weights (in percentage) of component grades	<p>PL 1: Klicken Sie hier, um Text einzugeben. PL 2: Klicken Sie hier, um Text einzugeben. PL 3: Klicken Sie hier, um Text einzugeben. PL 4: Klicken Sie hier, um Text einzugeben.</p> <p>If necessary, further comments: Klicken Sie hier, um Text einzugeben.</p>
2d	form of examination (see AT BPO/AT MPO Art. 8, 9 and 10)	<p><input type="checkbox"/> Assignment <input checked="" type="checkbox"/> Oral examination (single) <input type="checkbox"/> Presentation, oral <input checked="" type="checkbox"/> Written examination <input type="checkbox"/> Group examination, oral <input type="checkbox"/> Presentation and written assignment <input type="checkbox"/> Portfolio <input type="checkbox"/> Project report <input type="checkbox"/> Bachelor Thesis <input type="checkbox"/> Internship report <input type="checkbox"/> Colloquium <input type="checkbox"/> Master Thesis <input type="checkbox"/> Other (concrete definition is given in the examination regulations):</p> <p>Announcement at the begin of the semester</p>
2e	language(s) of instruction	<p><input type="checkbox"/> German <input checked="" type="checkbox"/> English <input type="checkbox"/> Spanish <input type="checkbox"/> French <input type="checkbox"/> Other, namely this:</p> <p>Klicken Sie hier, um Text einzugeben.</p>

module code /
 module title

Science and Exploration Missions

 date / version of the module
 description

Klicken Sie hier, um Text einzugeben.

1 INFORMATION ON THE MODULE		
1a	module code	Klicken Sie hier, um Text einzugeben.
1b	module title (German title)	Klicken Sie hier, um Text einzugeben.
1c	module title (English title)	Science and Exploration Missions
1d	credit points	3
1e	responsible for the module	Prof. Dr. rer. nat. Claus Lämmerzahl
1f	type of module	choose an option
1g	programs using the module	Klicken Sie hier, um Text einzugeben.
1h	organizational unit offering the module	Klicken Sie hier, um Text einzugeben.
1i	content-related prior knowledge or skills	Klicken Sie hier, um Text einzugeben.
1j	learning contents	<p>Introduction to completed and planned space missions:</p> <p>Examples are (i) Gravity Probe A for testing the gravitational redshift, (ii) Gravity Probe B for testing the gravitomagnetic Schiff effect, (iii) Cassini for Saturn exploration and testing the gravitational time delay, (iv) Pioneer for planetary exploration and testing the gravitational field in the Solar system, (v) MICROSCOPE for testing the Equivalence Principle, (vi) LISA for searching for gravitational waves and the technology mission LISA pathfinder, (vii) GRACE and GRACE-FO for satellite based geodesy, (viii) ACES on the ISS for testing relativity and establishing space-based metrology, (ix) further missions testing Special and General Relativity using quantum optics, (x) asteroid and comet missions HAYABUSA and Rosetta. For each mission the requirements on the payload technology, the spacecraft technology, and on the mission scenario will be derived.</p>

1k	learning outcomes/ competencies/ targeted competencies	Participants are able to discuss science cases for space and exploration missions, measurement schemes and payload as well as technology requirements on payload and mission.																																																																																												
1l	calculation of student workload (part a: calculation of presence time and working hours)	<p>The total amount of the presence time and working hours of the module has to be calculated additionally in the detailed calculation a) to c).</p> <p>a) detailed calculation: SWS / presence time/working hours in each course of the module</p> <table border="1"> <tr> <td><input checked="" type="checkbox"/></td> <td>2</td> <td>lecture(s) with</td> <td>2</td> <td>SWS/ contact hours</td> <td>28</td> <td>hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td>seminar(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td>exercise(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td>internship(s) with</td> <td></td> <td>sum of working hours</td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td>seminar(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>total hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td>laboratory/laboratories with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>total hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td>tutorial(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td>excursion(s) with</td> <td></td> <td>SWS contact hours in total</td> <td></td> <td>working hours</td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td colspan="5">other form of course (e.g. block seminar), namely this:</td> <td></td> </tr> <tr> <td colspan="7">Klicken Sie hier, um Text einzugeben.</td> </tr> <tr> <td></td> <td>with</td> <td>SWS / with totaly</td> <td></td> <td>contact hours</td> <td><input type="checkbox"/> presence time</td> <td><input type="checkbox"/> working hours</td> </tr> <tr> <td colspan="7">= sum of presence time and working hours:</td> </tr> <tr> <td colspan="7">Klicken Sie hier, um Text einzugeben.</td> </tr> </table>	<input checked="" type="checkbox"/>	2	lecture(s) with	2	SWS/ contact hours	28	hours of presence time	<input type="checkbox"/>		seminar(s) with		SWS/ contact hours		hours of presence time	<input type="checkbox"/>		exercise(s) with		SWS/ contact hours		hours of presence time	<input type="checkbox"/>		internship(s) with		sum of working hours			<input type="checkbox"/>		seminar(s) with		SWS/ contact hours		total hours of presence time	<input type="checkbox"/>		laboratory/laboratories with		SWS/ contact hours		total hours of presence time	<input type="checkbox"/>		tutorial(s) with		SWS/ contact hours			<input type="checkbox"/>		excursion(s) with		SWS contact hours in total		working hours	<input type="checkbox"/>		other form of course (e.g. block seminar), namely this:						Klicken Sie hier, um Text einzugeben.								with	SWS / with totaly		contact hours	<input type="checkbox"/> presence time	<input type="checkbox"/> working hours	= sum of presence time and working hours:							Klicken Sie hier, um Text einzugeben.						
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	calculation of student workload (part b: preparation time and follow-up work/self-study)	<p>b) working hours for preparation/follow-up work of the course(s) and/or self-study</p> <p>= sum of working hours: 42</p>																																																																																												

	calculation of student workload (part c: exam preparation etc.)	c) exam preparation (incl. examination) = sum of working hours: 20
	calculation of student workload (total amount of hours including a) - c)	Total amount of the presence time and working hours a) to c): 90
1m	description of possible optional courses in the module	<u>Can a student choose between different courses within the module?</u> NO <u>Short description of selection option</u> Klicken Sie hier, um Text einzugeben.
1n	language(s) of instruction	<input type="checkbox"/> German <input checked="" type="checkbox"/> English <input type="checkbox"/> Spanish <input type="checkbox"/> French <input type="checkbox"/> Other, namely this: Klicken Sie hier, um Text einzugeben.
1o	frequency	(regular cycle module is offered) e.g.: winter semester, yearly or summer semester, yearly or each semester winter semester yearly Klicken Sie hier, um Text einzugeben.
1p	duration	one semester module Klicken Sie hier, um Text einzugeben.
1q	Literature (optional)	A list of references will be provided at the start of the semester.
1r	more information on the module (optional)	Klicken Sie hier, um Text einzugeben.
2	INFORMATION ON THE MODULE EXAMINATION (see also AT Art. 5 section 8)	
2a	type of examination	<input checked="" type="checkbox"/> module exam; i.e. exam with only one component (MP) <input type="checkbox"/> combination exam, i.e. exam with several components (administered by instructors) (KP) <input type="checkbox"/> partial exam; i.e. exam with several components (administered by registrar) (TP)
2b	exam components or prerequisites (type, number)	<i>PL = graded component of the examination</i> <i>SL = ungraded component of the examination, coursework</i> <i>PVL = prerequisite of the examination (see AT Art. 5 Section 10)</i> <input type="checkbox"/> PL number <input type="checkbox"/> SL number <input type="checkbox"/> PVL justification If necessary, further explanations: Klicken Sie hier, um Text einzugeben.

2c	Give this information for combination examinations only: Weights (in percentage) of component grades	<p>PL 1: Klicken Sie hier, um Text einzugeben.</p> <p>PL 2: Klicken Sie hier, um Text einzugeben.</p> <p>PL 3: Klicken Sie hier, um Text einzugeben.</p> <p>PL 4: Klicken Sie hier, um Text einzugeben.</p> <p>If necessary, further comments: Klicken Sie hier, um Text einzugeben.</p>
2d	form of examination (see AT BPO/AT MPO Art. 8, 9 and 10)	<p> <input type="checkbox"/> Assignment <input checked="" type="checkbox"/> Oral examination (single) <input type="checkbox"/> Presentation, oral <input checked="" type="checkbox"/> Written examination <input type="checkbox"/> Group examination, oral <input type="checkbox"/> Presentation and written assignment <input type="checkbox"/> Portfolio <input type="checkbox"/> Project report <input type="checkbox"/> Bachelor Thesis <input type="checkbox"/> Internship report <input type="checkbox"/> Colloquium <input type="checkbox"/> Master Thesis <input type="checkbox"/> Other (concrete definition is given in the examination regulations): Announcement at the begin of the semester </p>
2e	language(s) of instruction	<p> <input type="checkbox"/> German <input type="checkbox"/> English <input type="checkbox"/> Spanish <input type="checkbox"/> French <input type="checkbox"/> Other, namely this: Klicken Sie hier, um Text einzugeben. </p>

module code /
module title

Space Electronics

 date / version of the module
description

Klicken Sie hier, um Text einzugeben.

1 INFORMATION ON THE MODULE		
1a	module code	Klicken Sie hier, um Text einzugeben.
1b	module title (German title)	Klicken Sie hier, um Text einzugeben.
1c	module title (English title)	Space Electronics
1d	credit points	3
1e	responsible for the module	Prof. Dr.-Ing. Alberto Garcia-Ortiz
1f	type of module	choose an option
1g	programs using the module	Klicken Sie hier, um Text einzugeben.
1h	organizational unit offering the module	Klicken Sie hier, um Text einzugeben.
1i	content-related prior knowledge or skills	Klicken Sie hier, um Text einzugeben.
1j	learning contents	<ul style="list-style-type: none"> • Radiation environments • MOS Device and radiation • Circuit Reliability basics • Single event effects on analog and digital circuits, memories • Displacement damage (DD) effects • Radiation hard device technologies and circuit design • Noise • gm/Id Method • Mismatch • Two pole opamps (OTA) • Feedback

1k	learning outcomes/ competencies/ targeted competencies	<p>After this course, students are able to:</p> <ul style="list-style-type: none"> • describe and characterize noise in electronics circuits, • apply the gm/Id sizing method to design amplifier circuits for advance CMOS technologies, • deal with process variations and mismatch, • understand the frequency behaviour of amplifier circuits, • understand and size compensation networks, • use feedback to modify circuit characteristics, • understand the impact of radiation on the behavior of circuits, • design radition-hard circuits. 																																																																																												
1l	calculation of student workload (part a: calculation of presence time and working hours)	<p>The total amount of the presence time and working hours of the module has to be calculated additionally in the detailed calculation a) to c).</p> <p>a) detailed calculation: SWS / presence time/working hours in each course of the module</p> <table border="1"> <tr> <td><input checked="" type="checkbox"/></td> <td>1</td> <td>lecture(s) with</td> <td>2</td> <td>SWS/ contact hours</td> <td>28</td> <td>hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td>seminar(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>hours of presence time</td> </tr> <tr> <td><input checked="" type="checkbox"/></td> <td>1</td> <td>exercise(s) with</td> <td>1</td> <td>SWS/ contact hours</td> <td>14</td> <td>hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td>internship(s) with</td> <td></td> <td>sum of working hours</td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td>seminar(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>total hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td>laboratory/laboratories with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td>total hours of presence time</td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td>tutorial(s) with</td> <td></td> <td>SWS/ contact hours</td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td>excursion(s) with</td> <td></td> <td>SWS contact hours in total</td> <td></td> <td>working hours</td> </tr> <tr> <td><input type="checkbox"/></td> <td></td> <td colspan="5">other form of course (e.g. block seminar), namely this:</td> <td></td> </tr> <tr> <td colspan="7">Klicken Sie hier, um Text einzugeben.</td> </tr> <tr> <td></td> <td>with</td> <td>SWS / with totaly</td> <td></td> <td>contact hours</td> <td><input type="checkbox"/></td> <td>presence time <input type="checkbox"/> working hours</td> </tr> <tr> <td colspan="7">= sum of presence time and working hours:</td> </tr> <tr> <td colspan="7">42</td> </tr> </table>	<input checked="" type="checkbox"/>	1	lecture(s) with	2	SWS/ contact hours	28	hours of presence time	<input type="checkbox"/>		seminar(s) with		SWS/ contact hours		hours of presence time	<input checked="" type="checkbox"/>	1	exercise(s) with	1	SWS/ contact hours	14	hours of presence time	<input type="checkbox"/>		internship(s) with		sum of working hours			<input type="checkbox"/>		seminar(s) with		SWS/ contact hours		total hours of presence time	<input type="checkbox"/>		laboratory/laboratories with		SWS/ contact hours		total hours of presence time	<input type="checkbox"/>		tutorial(s) with		SWS/ contact hours			<input type="checkbox"/>		excursion(s) with		SWS contact hours in total		working hours	<input type="checkbox"/>		other form of course (e.g. block seminar), namely this:						Klicken Sie hier, um Text einzugeben.								with	SWS / with totaly		contact hours	<input type="checkbox"/>	presence time <input type="checkbox"/> working hours	= sum of presence time and working hours:							42						
<input checked="" type="checkbox"/>	1	lecture(s) with	2	SWS/ contact hours	28	hours of presence time																																																																																								
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42																																																																																														
	calculation of student workload (part b: preparation time and follow-up work/self-study)	<p>b) working hours for preparation/follow-up work of the course(s) and/or self-study</p> <p>= sum of working hours:</p> <p>14</p>																																																																																												

	calculation of student workload (part c: exam preparation etc.)	c) exam preparation (incl. examination) = sum of working hours: 34
	calculation of student workload (total amount of hours including a) - c)	Total amount of the presence time and working hours a) to c): 90
1m	description of possible optional courses in the module	<u>Can a student choose between different courses within the module?</u> NO <u>Short description of selection option</u> Klicken Sie hier, um Text einzugeben.
1n	language(s) of instruction	<input type="checkbox"/> German <input checked="" type="checkbox"/> English <input type="checkbox"/> Spanish <input type="checkbox"/> French <input type="checkbox"/> Other, namely this: Klicken Sie hier, um Text einzugeben.
1o	frequency	<i>(regular cycle module is offered) e.g.: winter semester, yearly or summer semester, yearly or each semester</i> winter semester yearly Klicken Sie hier, um Text einzugeben.
1p	duration	one semester module Klicken Sie hier, um Text einzugeben.
1q	Literature (optional)	
1r	more information on the module (optional)	Klicken Sie hier, um Text einzugeben.
2	INFORMATION ON THE MODULE EXAMINATION (see also AT Art. 5 section 8)	
2a	type of examination	<input checked="" type="checkbox"/> module exam; i.e. exam with only one component (MP) <input type="checkbox"/> combination exam, i.e. exam with several components (administered by instructors) (KP) <input type="checkbox"/> partial exam; i.e. exam with several components (administered by registrar) (TP)
2b	exam components or prerequisites (type, number)	<i>PL = graded component of the examination</i> <i>SL = ungraded component of the examination, coursework</i> <i>PVL = prerequisite of the examination (see AT Art. 5 Section 10)</i> <input checked="" type="checkbox"/> PL number <input type="checkbox"/> SL number <input type="checkbox"/> PVL justification If necessary, further explanations: Klicken Sie hier, um Text einzugeben.

2c	Give this information for combination examinations only: Weights (in percentage) of component grades	<p>PL 1: Klicken Sie hier, um Text einzugeben.</p> <p>PL 2: Klicken Sie hier, um Text einzugeben.</p> <p>PL 3: Klicken Sie hier, um Text einzugeben.</p> <p>PL 4: Klicken Sie hier, um Text einzugeben.</p> <p>If necessary, further comments: Klicken Sie hier, um Text einzugeben.</p>
2d	form of examination (see AT BPO/AT MPO Art. 8, 9 and 10)	<p> <input type="checkbox"/> Assignment <input type="checkbox"/> Oral examination (single) <input type="checkbox"/> Presentation, oral <input checked="" type="checkbox"/> Written examination <input type="checkbox"/> Group examination, oral <input type="checkbox"/> Presentation and written assignment <input type="checkbox"/> Portfolio <input type="checkbox"/> Project report <input type="checkbox"/> Bachelor Thesis <input type="checkbox"/> Internship report <input type="checkbox"/> Colloquium <input type="checkbox"/> Master Thesis <input type="checkbox"/> Other (concrete definition is given in the examination regulations): Klicken Sie hier, um Text einzugeben. </p>
2e	language(s) of instruction	<p> <input type="checkbox"/> German <input checked="" type="checkbox"/> English <input type="checkbox"/> Spanish <input type="checkbox"/> French <input type="checkbox"/> Other, namely this: Klicken Sie hier, um Text einzugeben. </p>

Compulsory Modules

module code /
module title

Space Flight Theory

date / version of the module description	12.02.2019
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1 INFORMATION ON THE MODULE

1a	module code	
1b	module title (German title)	
1c	module title (English title)	Space Flight Theory
1d	credit points	9
1e	responsible for the module	Prof. Büskens
1f	type of module	compulsory module
1g	programs using the module	
1h	organizational unit offering the module	
1i	content-related prior knowledge or skills	none
1j	learning contents	<ul style="list-style-type: none"> •Trajectory computation and space flight analysis •Basic principles for designing and analysing a space mission
1k	learning outcomes/ competencies/ targeted competencies	Students have knowledge/responsibilities in: <ul style="list-style-type: none"> •Space mission analysis and design (tools) •Orbital and attitude dynamics •Modeling approaches of space environment

		<ul style="list-style-type: none"> •Satellite system modeling (thermal, sensors, actuators) •Definitions and technical terms of space applications and optimization •Mathematical models and problem statements relating to space applications •Using mathematical software •Numerical solution of mathematical problems
11	<p>calculation of student workload (part a: calculation of presence time and working hours)</p>	<p>The total amount of the presence time and working hours of the module has to be calculated additionally in the detailed calculation a) to c).</p> <p>a) detailed calculation: SWS / presence time/working hours in each course of the module</p> <hr/> <p>9 CP, 270 h</p> <p>Mission Analysis (2SWH)</p> <ul style="list-style-type: none"> •presence (L + EC): 28 h (2 SWH x 14 weeks) •learning + examples: 28 h (2 SWH x 14 weeks) •preparation for examination: 4*8h + 2h exam=34h <p>Mission Design (1SWH)</p> <ul style="list-style-type: none"> •presence (L + EC): 14 h (1 SWH x 14 weeks) •learning + examples: 14 h (1 SWH x 14 weeks) •preparation for examination: 2*8h + 2h exam=18 h <p>Trajectory Optimization (3SWH)</p> <ul style="list-style-type: none"> •presence (L + EC): 42 h (3 SWH x 14 weeks) •learning + examples: 42 h (3 SWH x 14 weeks) •preparation for examination: 6*8h + 2h exam = 50h <p>= sum of presence time and working hours:</p> <p>84 h</p>
	<p>calculation of student workload (part b: preparation time and follow-up work/self-study)</p>	<p>b) working hours for preparation/follow-up work of the course(s) and/or self-study</p> <p>= sum of working hours:</p> <p>84 h</p>
	<p>calculation of student workload (part c: exam preparation etc.)</p>	<p>c) exam preparation (incl. examination)</p> <p>= sum of working hours:</p> <p>102 h</p>

	<p>calculation of student workload</p> <p><i>(total amount of hours including a) - c)</i></p>	<p>Total amount of the presence time and working hours a) to c):</p> <p>270 h</p>
1m	<p>description of possible optional courses in the module</p>	<p><u>Short description of selection option</u></p> <p>Mission Analysis (Hallmann, Dr. Quantus) 3CP</p> <p>Mission Design (Dr. List) 1,5 CP</p> <p>Trajectory Optimization (Prof. Büskens, Dr. Knauer) 4,5CP</p>
1n	<p>language(s) of instruction</p>	<p><input checked="" type="checkbox"/> English</p>
1o	<p>frequency</p>	<p>Other, namely this:</p> <p>Annually</p>
1p	<p>duration</p>	<p>two semester module</p>
1q	<p>Literature <i>(optional)</i></p>	
1r	<p>more information on the module <i>(optional)</i></p>	<p>.</p>
2	<p>INFORMATION ON THE MODULE EXAMINATION (see also AT Art. 5 section 8)</p>	
2a	<p>type of examination</p>	<p><input checked="" type="checkbox"/> partial exam; i.e. exam with several components (administered by registrar) (TP)</p>
2b	<p>exam components or prerequisites <i>(type, number)</i></p>	<p><input checked="" type="checkbox"/> PL number</p>
2c	<p>Give this information for combination examinations only: Weights (in percentage) of component grades</p>	

2d	form of examination (see AT BPO/AT MPO Art. 8, 9 and 10)	
2e	language(s) of instruction	<input checked="" type="checkbox"/> English

module code /
module title

Space Environment and Testing

date / version of the module description	12.02.2019
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1 INFORMATION ON THE MODULE

1a	module code	
1b	module title (German title)	
1c	module title (English title)	Space Environment and Testing
1d	credit points	9
1e	responsible for the module	Prof. Braxmaier
1f	type of module	compulsory module
1g	programs using the module	
1h	organizational unit offering the module	
1i	content-related prior knowledge or skills	None
1j	learning contents	<ul style="list-style-type: none"> •Space environment and vehicle specification needs •Design and development of space vehicles •Proof and product assurance
1k	learning outcomes/ competencies/ targeted competencies	Students have knowledge/responsibilities in: <ul style="list-style-type: none"> •Space Environment and conditions of Satellites for scenarios close to Earth and in deep space

		<ul style="list-style-type: none"> •System design and analysis of launchers, satellites, landers, orbital systems •Multi-disciplinary interface relations between mission analysis, space flight mechanics, propulsion system, flight control, mechanical and thermal design •Ability of simplified modeling •Derivation of the essential dimensioning variables •Capability of system pre-design of space structures •Quality, reliability and risk •Influence of errors to costs •Methods to handle and control / Systems engineering •Influence to the development of Space technologies
11	<p>calculation of student workload <i>(part a: calculation of presence time and working hours)</i></p>	<p>The total amount of the presence time and working hours of the module has to be calculated additionally in the detailed calculation a) to c).</p> <p>a) detailed calculation: SWS / presence time/working hours in each course of the module</p> <hr/> <p>9 CP, 270 h</p> <p>Space Environment and S/C qualification (2SWH)</p> <ul style="list-style-type: none"> •presence (L + EC): 28 h (2 SWH x 14 weeks) •learning + examples: 28 h (2 SWH x 14 weeks) •preparation for examination: 4*8h + 2h exam=34h <p>Design of Space Vehicles (2SWH)</p> <ul style="list-style-type: none"> •presence (L + EC): 28 h (2 SWH x 14 weeks) •learning + examples: 28 h (2 SWH x 14 weeks) •preparation for examination: 4*8h + 2h exam=34h <p>Product Assurance & Space Technology (2SWH)</p> <ul style="list-style-type: none"> •presence (L + EC): 28 h (2 SWH x 14 weeks) •learning + examples: 28 h (2 SWH x 14 weeks) •preparation for examination: 4*8h + 2h exam=34h <p>= sum of presence time and working hours:</p> <p>84 h</p>

	<p>calculation of student workload</p> <p><i>(part b: preparation time and follow-up work/self-study)</i></p>	<p>b) working hours for preparation/follow-up work of the course(s) and/or self-study</p> <p>= sum of working hours:</p> <p>84 h</p>
	<p>calculation of student workload</p> <p><i>(part c: exam preparation etc.)</i></p>	<p>c) exam preparation (incl. examination)</p> <p>= sum of working hours:</p> <p>102 h</p>
	<p>calculation of student workload</p> <p><i>(total amount of hours including a) - c)</i></p>	<p>Total amount of the presence time and working hours a) to c):</p> <p>270 h</p>
1m	<p>description of possible optional courses in the module</p>	<p><u>Short description of selection option</u></p> <p>Space Environment and S/C qualification (Prof. Dittus) 3CP</p> <p>Design of Space Vehicles (Prof. Rittweger) 3CP</p> <p>Product Assurance & Space Technology (Prof. Braxmaier, Dr.-Ing. Grosse) 3CP</p>
1n	<p>language(s) of instruction</p>	<p><input checked="" type="checkbox"/> English</p>
1o	<p>frequency</p>	<p>Other, namely this:</p> <p>Annually</p>
1p	<p>duration</p>	<p>two semester module</p>
1q	<p>Literature <i>(optional)</i></p>	
1r	<p>more information on the module <i>(optional)</i></p>	<p>.</p>
2	<p>INFORMATION ON THE MODULE EXAMINATION (see also AT Art. 5 section 8)</p>	
2a	<p>type of examination</p>	<p><input checked="" type="checkbox"/> partial exam; i.e. exam with several components (administered by registrar) (TP)</p>

2b	exam components or prerequisites (<i>type, number</i>)	<input checked="" type="checkbox"/> PL number
2c	Give this information for combination examinations only: Weights (in percentage) of component grades	
2d	form of examination (see AT BPO/AT MPO Art. 8, 9 and 10)	
2e	language(s) of instruction	<input checked="" type="checkbox"/> English

module code /
module title

Satellite Systems

date / version of the module description	12.02.2019
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1 INFORMATION ON THE MODULE

1a	module code	
1b	module title (German title)	
1c	module title (English title)	Satellite Systems
1d	credit points	9
1e	responsible for the module	Prof. Dittus
1f	type of module	compulsory module
1g	programs using the module	
1h	organizational unit offering the module	
1i	content-related prior knowledge or skills	
1j	learning contents	<ul style="list-style-type: none"> •Thermal control at space vehicles •Analysis of space systems •Structural design and engineering
1k	learning outcomes/ competencies/ targeted competencies	Students have knowledge/responsibilities in: <ul style="list-style-type: none"> •Thermal Control System of a Satellite

		<ul style="list-style-type: none"> •Design process •Analysis of light weight structures with reasonable methods •Building of simplified physical models •Capability of pre-dimensioning of space structures •Fundamentals of space project management (theory) •Fundamentals of space systems and concurrent engineering (theory) •Application of concurrent engineering in the frame of an example project (Phase 0/A design level)
1)	<p>calculation of student workload <i>(part a: calculation of presence time and working hours)</i></p>	<p>The total amount of the presence time and working hours of the module has to be calculated additionally in the detailed calculation a) to c).</p> <p>a) detailed calculation: SWS / presence time/working hours in each course of the module</p> <hr/> <p>9 CP, 270 h</p> <p>Thermal Control of Satellites (2SWH)</p> <ul style="list-style-type: none"> •presence (L + EC): 28 h (2 SWH x 14 weeks) •learning + examples: 28 h (2 SWH x 14 weeks) •preparation for examination: 4*8h + 2h exam=34h <p>Structural Design and Analysis (2SWH)</p> <ul style="list-style-type: none"> •presence (L + EC): 28 h (2 SWH x 14 weeks) •learning + examples: 28 h (2 SWH x 14 weeks) •preparation for examination: 4*8h + 2h exam=34h <p>Space Systems Engineering / Concurrent Engineering (2SWH)</p> <ul style="list-style-type: none"> •presence (L + EC): 28 h (2 SWH x 14 weeks) •learning + examples: 28 h (2 SWH x 14 weeks) •preparation for examination: 4*8h + 2h exam=34h <p>= sum of presence time and working hours:</p> <p>84 h</p>
	<p>calculation of student workload <i>(part b: preparation time and follow-up work/self-study)</i></p>	<p>b) working hours for preparation/follow-up work of the course(s) and/or self-study</p> <p>= sum of working hours:</p> <p>84 h</p>

	calculation of student workload <i>(part c: exam preparation etc.)</i>	c) exam preparation (incl. examination) = sum of working hours: 102 h
	calculation of student workload <i>(total amount of hours including a) - c)</i>	Total amount of the presence time and working hours a) to c): 270 h
1m	description of possible optional courses in the module	<u>Can a student choose between different courses within the module?</u> NO Thermal Control of Satellites (Prof. Dittus) 3CP Structural Design and Analysis (Prof. Rittweger) 3CP Space Systems Engineering / Concurrent Engineering (Dr. Romberg) 3CP
1n	language(s) of instruction	<input checked="" type="checkbox"/> English
1o	frequency	Other, namely this: Annually
1p	duration	two semester module
1q	Literature <i>(optional)</i>	
1r	more information on the module <i>(optional)</i>	
2	INFORMATION ON THE MODULE EXAMINATION (see also AT Art. 5 section 8)	
2a	type of examination	<input checked="" type="checkbox"/> partial exam; i.e. exam with several components (administered by registrar) (TP)
2b	exam components or prerequisites <i>(type, number)</i>	<input checked="" type="checkbox"/> PL number

2c	Give this information for combination examinations only: Weights (in percentage) of component grades	
2d	form of examination (see AT BPO/AT MPO Art. 8, 9 and 10)	
2e	language(s) of instruction	<input checked="" type="checkbox"/> English

module code /
module title

Subsystems

date / version of the module description	12.02.2019
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1 INFORMATION ON THE MODULE

1a	module code	
1b	module title (German title)	
1c	module title (English title)	Subsystems
1d	credit points	9
1e	responsible for the module	Prof. Rittweger
1f	type of module	compulsory module
1g	programs using the module	
1h	organizational unit offering the module	
1i	content-related prior knowledge or skills	None
1j	learning contents	<ul style="list-style-type: none"> •Subsystems for Space Missions •Propulsion and Attitude Control Systems •Power and Thermal systems •Command & Data Handling

1k	learning outcomes/ competencies/ targeted competencies	<p>Students have knowledge/responsibilities in</p> <ul style="list-style-type: none"> •Design for orbital and interplanetary spacecraft (Phase 0/A/B) •Design of spacecraft subsystems: Power, propulsion, C&DH, AOCS, thermal, telecom, structure •Functional principles of all major types of space propulsion. •Main components of chemical rocket propulsion and their most important design criteria •Informed assessment of advantages and disadvantages of the different concepts and understanding the challenges to future developments •Overview of design, concepts and elements of a navigation and control subsystem for a spacecraft and their functions •Typical sensors and actuators used for spacecraft navigation and control •Methods for state estimation used in spacecraft navigation systems •Concepts for controlling spacecraft
1l	calculation of student workload <i>(part a: calculation of presence time and working hours)</i>	<p>The total amount of the presence time and working hours of the module has to be calculated additionally in the detailed calculation a) to c).</p> <p>a) detailed calculation: SWS / presence time/working hours in each course of the module</p> <hr/> <p>9 CP, 270 h</p> <p>Orbital Systems (2SWH)</p> <ul style="list-style-type: none"> •presence (L + EC): 28 h (2 SWH x 14 weeks) •learning + examples: 28 h (2 SWH x 14 weeks) •preparation for examination: 4*8h + 2h exam=34h <p>Space Propulsion Systems 1 (2SWH)</p> <ul style="list-style-type: none"> •presence (L + EC): 28 h (2 SWH x 14 weeks) •learning + examples: 28 h (2 SWH x 14 weeks) •preparation for examination: 4*8h + 2h exam=34h <p>Spacecraft Navigation and Control (2SWH)</p> <ul style="list-style-type: none"> •presence (L + EC): 28 h (2 SWH x 14 weeks) •learning + examples: 28 h (2 SWH x 14 weeks) •preparation for examination: 4*8h + 2h exam=34h <p>= sum of presence time and working hours:</p> <p>84 h</p>

	<p>calculation of student workload</p> <p><i>(part b: preparation time and follow-up work/self-study)</i></p>	<p>b) working hours for preparation/follow-up work of the course(s) and/or self-study</p> <p>= sum of working hours:</p> <p>84 h</p>
	<p>calculation of student workload</p> <p><i>(part c: exam preparation etc.)</i></p>	<p>c) exam preparation (incl. examination)</p> <p>= sum of working hours:</p> <p>102 h</p>
	<p>calculation of student workload</p> <p><i>(total amount of hours including a) - c))</i></p>	<p>Total amount of the presence time and working hours a) to c):</p> <p>270 h</p>
1m	<p>description of possible optional courses in the module</p>	<p><u>Short description of selection option</u></p> <p>Orbital Systems (Dr. Rickmers) 3CP</p> <p>Space Propulsion Systems 1 (Dr. Sippel) 3CP Spacecraft Navigation and Control (Dr. Theil) 3CP</p>
1n	<p>language(s) of instruction</p>	<p><input checked="" type="checkbox"/> English</p>
1o	<p>frequency</p>	<p>Other, namely this:</p> <p>Annually</p>
1p	<p>duration</p>	<p>two semester module</p>
1q	<p>Literature <i>(optional)</i></p>	
1r	<p>more information on the module <i>(optional)</i></p>	
2	<p>INFORMATION ON THE MODULE EXAMINATION (see also AT Art. 5 section 8)</p>	
2a	<p>type of examination</p>	<p><input checked="" type="checkbox"/> partial exam; i.e. exam with several components (administered by registrar) (TP)</p>

2b	exam components or prerequisites (<i>type, number</i>)	<input checked="" type="checkbox"/> PL number
2c	Give this information for combination examinations only: Weights (in percentage) of component grades	
2d	form of examination (see AT BPO/AT MPO Art. 8, 9 and 10)	
2e	language(s) of instruction	<input checked="" type="checkbox"/> English

Elective Modules

3 Fatigue and Loads

Klicken Sie hier, um Text einzugeben.

3a	Lehrveranstaltungstitel <i>title of the course</i>	Fatigue and Loads
3b	Kennziffer und Titel des/der Modul(e), in dem/denen die Lehrveranstaltung eingebunden ist <i>Module code and module title in which this course is contained.</i>	Elective Modules
3c	Häufigkeit <i>frequency</i>	z.B.: WS, jährl. oder SoSe, jährl. oder WS und SoSe etc. <i>e.g.: winter semester, yearly or summer semester yearly or each semester.</i> Wintersemester jährlich yearly Klicken Sie hier, um Text einzugeben.
3d	Gibt es parallele Veranstaltungen? <i>Is the course offered several times (parallel)?</i>	Wählen Sie ein Element aus. Erläuterung <i>Description:</i> Klicken Sie hier, um Text einzugeben.
3e	Unterrichtssprache(n) <i>language(s) of instruction</i>	<input type="checkbox"/> Deutsch <i>German</i> <input checked="" type="checkbox"/> Englisch <i>English</i> <input type="checkbox"/> Spanisch <i>Spanish</i> <input type="checkbox"/> Französisch <i>French</i> <input type="checkbox"/> Sonstige, und zwar: <i>Other, namely this:</i> Klicken Sie hier, um Text einzugeben.
3f	Leistungen, die an die Lehrveranstaltungen gebunden zu erbringen sind (<i>Benennung nach Art und Anzahl</i>) <i>exam components or prerequisites tied to this course (type, number)</i>	PL = Prüfungsleistung (benoteter Bestandteil einer MP/KP/TP) <i>Graded component of the examination</i> SL = Studienleistung (unbenoteter Bestandteil einer MP/KP/TP) <i>Ungraded component of the examination</i> PVL = Prüfungsvorleistung (Studienleistung vor einer Modulprüfung, nach § 5 Abs. 10 AT BPO bzw. MPO 2010) <i>prerequisite of the examination (see AT Art. 5 Section 10)</i> <input checked="" type="checkbox"/> PL Anzahl <i>number</i> <input type="checkbox"/> SL Anzahl <i>number</i> <input type="checkbox"/> PVL Begründung <i>justification</i> Ggf. weitere Erläuterungen zu den Prüfungs- und Studienleistungen: <i>If necessary, further explanations:</i> Klicken Sie hier, um Text einzugeben.

3g	Dozent/in bzw. Dozenten/Dozentinnen <i>instructor(s)</i>	Wählen Sie ein Element aus.																																																					
3h	Lehrveranstaltungsart und Semesterwochenstunden (SWS = Semesterwochenstunden) <i>course format and total weekly hours per semester (SWS = weekly hours per semester/ contact hours)</i>	<table border="1"> <tr> <td data-bbox="497 488 523 524"><input type="checkbox"/></td> <td data-bbox="539 488 877 542">Anzahl <i>number</i> Vorlesung(en) mit jeweils <i>lecture(s) with</i></td> <td data-bbox="922 488 1008 542">Anzahl <i>number</i> SWS (mit ges. <i>SWS (with tot.</i></td> <td data-bbox="1203 488 1289 542">Anzahl <i>number</i> Stunden Präsenzzeit <i>hours of presence time)</i></td> </tr> <tr> <td data-bbox="497 645 523 680"><input type="checkbox"/></td> <td data-bbox="651 645 861 698">Seminar(en) mit jeweils <i>seminar(s) with</i></td> <td data-bbox="1034 645 1168 698">SWS (mit ges. <i>SWS (with tot.</i></td> <td data-bbox="1321 645 1532 698">Stunden Präsenzzeit <i>hours of presence time)</i></td> </tr> <tr> <td data-bbox="497 801 523 837"><input type="checkbox"/></td> <td data-bbox="651 801 845 855">Übung(en) mit jeweils <i>exercise(s) with</i></td> <td data-bbox="1034 801 1168 855">SWS (mit ges. <i>SWS (with tot.</i></td> <td data-bbox="1321 801 1532 855">Stunden Präsenzzeit <i>hours of presence time)</i></td> </tr> <tr> <td data-bbox="497 967 523 1003"><input type="checkbox"/></td> <td data-bbox="651 967 861 1021">Praktikum/Praktika (mit <i>internship(s) (with</i></td> <td data-bbox="1034 922 1168 1057">insgesamt Arbeitsstunden) <i>sum of working hours)</i></td> <td></td> </tr> <tr> <td data-bbox="497 1102 523 1137"><input type="checkbox"/></td> <td data-bbox="651 1102 861 1155">Begleitseminar(en) mit je <i>seminar(s) with</i></td> <td data-bbox="1034 1102 1168 1155">SWS (mit ges. <i>SWS (with tot.</i></td> <td data-bbox="1321 1102 1506 1155">Stunden Präsenzzeit <i>hours of presence time)</i></td> </tr> <tr> <td data-bbox="497 1227 523 1263"><input type="checkbox"/></td> <td data-bbox="651 1227 893 1281">Laborpraktikum/-praktika je <i>laboratory/laboratories with</i></td> <td data-bbox="1034 1227 1168 1281">SWS (mit ges. <i>SWS (with tot.</i></td> <td data-bbox="1321 1227 1506 1281">Stunden Präsenzzeit <i>hours of presence time)</i></td> </tr> <tr> <td data-bbox="497 1361 523 1397"><input type="checkbox"/></td> <td data-bbox="651 1361 852 1415">Tutorium/Tutorien (mit <i>tutorial(s) (with</i></td> <td data-bbox="1034 1317 1168 1451">insg. Stunden Präsenzzeit <i>hours of presence time)</i></td> <td></td> </tr> <tr> <td data-bbox="497 1505 523 1541"><input type="checkbox"/></td> <td data-bbox="651 1505 874 1559">Exkursion(en) mit jeweils <i>excursion(s) with</i></td> <td data-bbox="1034 1505 1168 1559">SWS (mit ges. <i>SWS (with tot.</i></td> <td data-bbox="1321 1505 1442 1559">Arbeitsstunden <i>working hours)</i></td> </tr> <tr> <td data-bbox="497 1639 523 1675"><input type="checkbox"/></td> <td colspan="3" data-bbox="651 1639 1232 1702">sonstige Lehrveranstaltung (z.B. Blockveranstaltungen), und zwar: <i>other form of course (e.g. block seminar), namely this:</i></td> </tr> <tr> <td colspan="4" data-bbox="497 1738 944 1774">Klicken Sie hier, um Text einzugeben.</td> </tr> <tr> <td data-bbox="513 1809 561 1863">mit je <i>with</i></td> <td data-bbox="708 1809 868 1863">SWS / mit insges. <i>SWS / with totally</i></td> <td data-bbox="1015 1809 1091 1863">Stunden <i>hours</i></td> <td data-bbox="1129 1809 1289 1863"><input type="checkbox"/> Präsenzzeit <i>presence time</i></td> <td data-bbox="1340 1809 1506 1863"><input type="checkbox"/> Arbeitsstunden <i>working hours</i></td> </tr> <tr> <td colspan="4" data-bbox="497 1926 1302 1962">= Summe der Präsenzzeit und Arbeitsstunden <i>sum of presence time and working hours:</i></td> </tr> <tr> <td colspan="4" data-bbox="497 1971 951 2007">Klicken Sie hier, um Text einzugeben.</td> </tr> </table>	<input type="checkbox"/>	Anzahl <i>number</i> Vorlesung(en) mit jeweils <i>lecture(s) with</i>	Anzahl <i>number</i> SWS (mit ges. <i>SWS (with tot.</i>	Anzahl <i>number</i> Stunden Präsenzzeit <i>hours of presence time)</i>	<input type="checkbox"/>	Seminar(en) mit jeweils <i>seminar(s) with</i>	SWS (mit ges. <i>SWS (with tot.</i>	Stunden Präsenzzeit <i>hours of presence time)</i>	<input type="checkbox"/>	Übung(en) mit jeweils <i>exercise(s) with</i>	SWS (mit ges. <i>SWS (with tot.</i>	Stunden Präsenzzeit <i>hours of presence time)</i>	<input type="checkbox"/>	Praktikum/Praktika (mit <i>internship(s) (with</i>	insgesamt Arbeitsstunden) <i>sum of working hours)</i>		<input type="checkbox"/>	Begleitseminar(en) mit je <i>seminar(s) with</i>	SWS (mit ges. <i>SWS (with tot.</i>	Stunden Präsenzzeit <i>hours of presence time)</i>	<input type="checkbox"/>	Laborpraktikum/-praktika je <i>laboratory/laboratories with</i>	SWS (mit ges. <i>SWS (with tot.</i>	Stunden Präsenzzeit <i>hours of presence time)</i>	<input type="checkbox"/>	Tutorium/Tutorien (mit <i>tutorial(s) (with</i>	insg. Stunden Präsenzzeit <i>hours of presence time)</i>		<input type="checkbox"/>	Exkursion(en) mit jeweils <i>excursion(s) with</i>	SWS (mit ges. <i>SWS (with tot.</i>	Arbeitsstunden <i>working hours)</i>	<input type="checkbox"/>	sonstige Lehrveranstaltung (z.B. Blockveranstaltungen), und zwar: <i>other form of course (e.g. block seminar), namely this:</i>			Klicken Sie hier, um Text einzugeben.				mit je <i>with</i>	SWS / mit insges. <i>SWS / with totally</i>	Stunden <i>hours</i>	<input type="checkbox"/> Präsenzzeit <i>presence time</i>	<input type="checkbox"/> Arbeitsstunden <i>working hours</i>	= Summe der Präsenzzeit und Arbeitsstunden <i>sum of presence time and working hours:</i>				Klicken Sie hier, um Text einzugeben.			
<input type="checkbox"/>	Anzahl <i>number</i> Vorlesung(en) mit jeweils <i>lecture(s) with</i>	Anzahl <i>number</i> SWS (mit ges. <i>SWS (with tot.</i>	Anzahl <i>number</i> Stunden Präsenzzeit <i>hours of presence time)</i>																																																				
<input type="checkbox"/>	Seminar(en) mit jeweils <i>seminar(s) with</i>	SWS (mit ges. <i>SWS (with tot.</i>	Stunden Präsenzzeit <i>hours of presence time)</i>																																																				
<input type="checkbox"/>	Übung(en) mit jeweils <i>exercise(s) with</i>	SWS (mit ges. <i>SWS (with tot.</i>	Stunden Präsenzzeit <i>hours of presence time)</i>																																																				
<input type="checkbox"/>	Praktikum/Praktika (mit <i>internship(s) (with</i>	insgesamt Arbeitsstunden) <i>sum of working hours)</i>																																																					
<input type="checkbox"/>	Begleitseminar(en) mit je <i>seminar(s) with</i>	SWS (mit ges. <i>SWS (with tot.</i>	Stunden Präsenzzeit <i>hours of presence time)</i>																																																				
<input type="checkbox"/>	Laborpraktikum/-praktika je <i>laboratory/laboratories with</i>	SWS (mit ges. <i>SWS (with tot.</i>	Stunden Präsenzzeit <i>hours of presence time)</i>																																																				
<input type="checkbox"/>	Tutorium/Tutorien (mit <i>tutorial(s) (with</i>	insg. Stunden Präsenzzeit <i>hours of presence time)</i>																																																					
<input type="checkbox"/>	Exkursion(en) mit jeweils <i>excursion(s) with</i>	SWS (mit ges. <i>SWS (with tot.</i>	Arbeitsstunden <i>working hours)</i>																																																				
<input type="checkbox"/>	sonstige Lehrveranstaltung (z.B. Blockveranstaltungen), und zwar: <i>other form of course (e.g. block seminar), namely this:</i>																																																						
Klicken Sie hier, um Text einzugeben.																																																							
mit je <i>with</i>	SWS / mit insges. <i>SWS / with totally</i>	Stunden <i>hours</i>	<input type="checkbox"/> Präsenzzeit <i>presence time</i>	<input type="checkbox"/> Arbeitsstunden <i>working hours</i>																																																			
= Summe der Präsenzzeit und Arbeitsstunden <i>sum of presence time and working hours:</i>																																																							
Klicken Sie hier, um Text einzugeben.																																																							

3i	Beschreibung der Lehrveranstaltung <i>Description of the course</i>	Klicken Sie hier, um Text einzugeben.
3j	Literatur (ergänzend zu den Literaturangaben auf Modulebene, siehe 2 f) (Fakultativ) <i>Literature (in addition to 2f) (optional)</i>	Klicken Sie hier, um Text einzugeben.
3k	Sonstige Angaben zur Veranstaltung, und zwar ... (Fakultativ) <i>More information on the course, namely this ... (optional)</i>	Klicken Sie hier, um Text einzugeben.

Space ST

3 Cost Estimations for Space Systems

Klicken Sie hier, um Text einzugeben.

3a	Lehrveranstaltungstitel <i>title of the course</i>	Cost Estimations for Space Systems
3b	Kennziffer und Titel des/der Modul(e), in dem/denen die Lehrveranstaltung eingebunden ist <i>Module code and module title in which this course is contained.</i>	Elective Modules
3c	Häufigkeit <i>frequency</i>	<p>z.B.: WS, jährl. oder SoSe, jährl. oder WS und SoSe etc. e.g.: winter semester, yearly or summer semester yearly or each semester.</p> <p>Wintersemester jährlich yearly</p> <p>Klicken Sie hier, um Text einzugeben.</p>

3d	<p>Gibt es parallele Veranstaltungen?</p> <p><i>Is the course offered several times (parallel)?</i></p>	<p>NEIN NO</p> <p>Erläuterung <i>Description:</i></p> <p>Klicken Sie hier, um Text einzugeben.</p>
3e	<p>Unterrichtssprache(n)</p> <p><i>language(s) of instruction</i></p>	<p><input type="checkbox"/> Deutsch <i>German</i> <input checked="" type="checkbox"/> Englisch <i>English</i> <input type="checkbox"/> Spanisch <i>Spanish</i> <input type="checkbox"/> Französisch <i>French</i></p> <p><input type="checkbox"/> Sonstige, und zwar: <i>Other, namely this:</i></p> <p>Klicken Sie hier, um Text einzugeben.</p>
3f	<p>Leistungen, die an die Lehrveranstaltungen gebunden zu erbringen sind (<i>Benennung nach Art und Anzahl</i>)</p> <p><i>exam components or prerequisites tied to this course (type, number)</i></p>	<p>PL = Prüfungsleistung (benoteter Bestandteil einer MP/KP/TP) <i>Graded component of the examination</i> SL = Studienleistung (unbenoteter Bestandteil einer MP/KP/TP) <i>Ungraded component of the examination</i> PVL = Prüfungsvorleistung (Studienleistung vor einer Modulprüfung, nach § 5 Abs. 10 AT BPO bzw. MPO 2010) <i>prerequisite of the examination (see AT Art. 5 Section 10)</i></p> <p><input checked="" type="checkbox"/> PL Anzahl number <input type="checkbox"/> SL Anzahl number <input type="checkbox"/> PVL Begründung <i>justification</i></p> <p>Ggf. weitere Erläuterungen zu den Prüfungs- und Studienleistungen: <i>If necessary, further explanations:</i></p> <p>Klicken Sie hier, um Text einzugeben.</p>
3g	<p>Dozent/in bzw. Dozenten/Dozentinnen</p> <p><i>instructor(s)</i></p>	<p>Wahlpflichtmodul</p>

3h

Lehrveranstaltungsart und Semesterwochenstunden (SWS = Semesterwochenstunden)
course format and total weekly hours per semester (SWS = weekly hours per semester/ contact hours)

<input checked="" type="checkbox"/>	14	Vorlesung(en) mit jeweils <i>lecture(s) with</i>	2	SWS (mit ges. SWS) <i>(with tot. SWS)</i>	28	Stunden Präsenzzeit <i>hours of presence time)</i>
<input type="checkbox"/>		Seminar(en) mit jeweils <i>seminar(s) with</i>		SWS (mit ges. SWS) <i>(with tot. SWS)</i>		Stunden Präsenzzeit <i>hours of presence time)</i>
<input type="checkbox"/>		Übung(en) mit jeweils <i>exercise(s) with</i>		SWS (mit ges. SWS) <i>(with tot. SWS)</i>		Stunden Präsenzzeit <i>hours of presence time)</i>
<input type="checkbox"/>		Praktikum/Praktika (mit internship(s) (with		insgesamt Arbeitsstunden) <i>sum of working hours)</i>		
<input type="checkbox"/>		Begleitseminar(en) mit je <i>seminar(s) with</i>		SWS (mit ges. SWS) <i>(with tot. SWS)</i>		Stunden Präsenzzeit <i>hours of presence time)</i>
<input type="checkbox"/>		Laborpraktikum/-praktika je <i>laboratory/laboratories with</i>		SWS (mit ges. SWS) <i>(with tot. SWS)</i>		Stunden Präsenzzeit <i>hours of presence time)</i>
<input type="checkbox"/>		Tutorium/Tutorien (mit <i>tutorial(s) (with</i>		insg. Stunden Präsenzzeit) <i>hours of presence time)</i>		
<input type="checkbox"/>		Exkursion(en) mit jeweils <i>excursion(s) with</i>		SWS (mit ges. SWS) <i>(with tot. SWS)</i>		Arbeitsstunden <i>working hours)</i>
<input type="checkbox"/>		sonstige Lehrveranstaltung (z.B. Blockveranstaltungen), und zwar: <i>other form of course (e.g. block seminar), namely this:</i>				

Klicken Sie hier, um Text einzugeben.

mit je SWS / mit insges. Stunden Präsenzzeit Arbeitsstunden
with SWS / *with totally* hours *presence time* *working hours*

= Summe der Präsenzzeit und Arbeitsstunden | *sum of presence time and working hours:*
90 (28h lectures + 28h follow-up work + 34h exam preparation)

3i	Beschreibung der Lehrveranstaltung <i>Description of the course</i>	The students will learn about: <ul style="list-style-type: none"> •Cost estimation and cost engineering applications in industry •Key cost estimation methods and applicability per program phase •Awareness of cost estimation models/tools commonly applied within the space sector •Parametric approach, Cost-Estimation-Relationship (CER) theory, and cost model development •Performing basic cost estimation for selected space programs at system level •Life cycle cost (LCC) theory, incl. Basis of Estimate (BoE) adjustments and Cost-Risk analysis
3j	Literatur (ergänzend zu den Literaturangaben auf Modulebene, siehe 2 f) (Fakultativ) <i>Literature (in addition to 2f) (optional)</i>	Optional literature for further reading: <ul style="list-style-type: none"> - Steward, Rodney D., Cost Estimating (e.g. 2nd Ed., 1991) - Wertz, J.R., Larson, W.J., Reducing Space Mission Cost, 1996 - NASA Cost Estimating Handbook, version 4.0, Feb. 2015 - ISPA Parametric Estimating Handbook, 4th Ed., April 2008
3k	Sonstige Angaben zur Veranstaltung, und zwar ... (Fakultativ) <i>More information on the course, namely this ... (optional)</i>	Klicken Sie hier, um Text einzugeben.

3 FEM Simulations for the Design of Space Systems

2020

3a	Lehrveranstaltungstitel <i>title of the course</i>	FEM Simulations for the Design of Space Systems
3b	Kennziffer und Titel des/der Modul(e), in dem/denen die Lehrveranstaltung eingebunden ist <i>Module code and module title in which this course is contained.</i>	Elective Modules
3c	Häufigkeit <i>frequency</i>	z.B.: WS, jährl. oder SoSe, jährl. oder WS und SoSe etc. <i>e.g.: winter semester, yearly or summer semester yearly or each semester.</i> Wintersemester jährlich yearly Klicken Sie hier, um Text einzugeben.
3d	Gibt es parallele Veranstaltungen? <i>Is the course offered several times (parallel)?</i>	Wählen Sie ein Element aus. Erläuterung <i>Description:</i> Klicken Sie hier, um Text einzugeben.
3e	Unterrichtssprache(n) <i>language(s) of instruction</i>	<input type="checkbox"/> Deutsch <i>German</i> <input checked="" type="checkbox"/> Englisch <i>English</i> <input type="checkbox"/> Spanisch <i>Spanish</i> <input type="checkbox"/> Französisch <i>French</i> <input type="checkbox"/> Sonstige, und zwar: <i>Other, namely this:</i> Klicken Sie hier, um Text einzugeben.
3f	Leistungen, die an die Lehrveranstaltungen gebunden zu erbringen sind (<i>Benennung nach Art und Anzahl</i>) <i>exam components or prerequisites tied to this course (type, number)</i>	PL = Prüfungsleistung (benoteter Bestandteil einer MP/KP/TP) <i>Graded component of the examination</i> SL = Studienleistung (unbenoteter Bestandteil einer MP/KP/TP) <i>Ungraded component of the examination</i> PVL = Prüfungsvorleistung (Studienleistung vor einer Modulprüfung, nach § 5 Abs. 10 AT BPO bzw. MPO 2010) <i>prerequisite of the examination (see AT Art. 5 Section 10)</i> <input type="checkbox"/> PL Anzahl <i>number</i> <input type="checkbox"/> SL Anzahl <i>number</i> <input type="checkbox"/> PVL Begründung <i>justification</i> Ggf. weitere Erläuterungen zu den Prüfungs- und Studienleistungen: <i>If necessary, further explanations:</i> Klicken Sie hier, um Text einzugeben.

3g	Dozent/in bzw. Dozenten/Dozentinnen <i>instructor(s)</i>	Wählen Sie ein Element aus.						
3h	Lehrveranstaltungsart und Semesterwochenstunden (SWS = Semesterwochenstunden) <i>course format and total weekly hours per semester (SWS = weekly hours per semester/ contact hours)</i>	<input checked="" type="checkbox"/> 2	Vorlesung(en) mit jeweils <i>lecture(s) with</i>	4	SWS (mit ges. SWS) <i>(with tot.</i>	4	Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Seminar(en) mit jeweils <i>seminar(s) with</i>		SWS (mit ges. SWS) <i>(with tot.</i>		Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Übung(en) mit jeweils <i>exercise(s) with</i>		SWS (mit ges. SWS) <i>(with tot.</i>		Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Praktikum/Praktika (mit internship(s) (with		insgesamt Arbeitsstunden) <i>sum of working hours)</i>			
		<input type="checkbox"/>	Begleitseminar(en) mit je <i>seminar(s) with</i>		SWS (mit ges. SWS) <i>(with tot.</i>		Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Laborpraktikum/-praktika je <i>laboratory/laboratories with</i>		SWS (mit ges. SWS) <i>(with tot.</i>		Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Tutorium/Tutorien (mit <i>tutorial(s) (with</i>		insg. Stunden Präsenzzeit) <i>hours of presence time)</i>			
		<input type="checkbox"/>	Exkursion(en) mit jeweils <i>excursion(s) with</i>		SWS (mit ges. SWS) <i>(with tot.</i>		Arbeitsstunden <i>working hours)</i>	
		<input type="checkbox"/>	sonstige Lehrveranstaltung (z.B. Blockveranstaltungen), und zwar: <i>other form of course (e.g. block seminar), namely this:</i>					
		Klicken Sie hier, um Text einzugeben.						
		mit je <i>with</i>	SWS / mit insges. SWS / <i>with totally</i>	Stunden <i>hours</i>	<input type="checkbox"/> Präsenzzeit <i>presence time</i>	<input type="checkbox"/> Arbeitsstunden <i>working hours</i>		
		= Summe der Präsenzzeit und Arbeitsstunden <i>sum of presence time and working hours:</i>						
		Klicken Sie hier, um Text einzugeben.						

3i	Beschreibung der Lehrveranstaltung <i>Description of the course</i>	Klicken Sie hier, um Text einzugeben.
3j	Literatur (ergänzend zu den Literaturangaben auf Modulebene, siehe 2 f) (Fakultativ) <i>Literature (in addition to 2f) (optional)</i>	Klicken Sie hier, um Text einzugeben.
3k	Sonstige Angaben zur Veranstaltung, und zwar ... (Fakultativ) <i>More information on the course, namely this ... (optional)</i>	Klicken Sie hier, um Text einzugeben.

3 Specification of Embedded Systems

Klicken Sie hier, um Text einzugeben.

3a	Lehrveranstaltungstitel <i>title of the course</i>	Specification of Embedded Systems
3b	Kennziffer und Titel des/der Modul(e), in dem/denen die Lehrveranstaltung eingebunden ist <i>Module code and module title in which this course is contained.</i>	03-ME-702.03
3c	Häufigkeit <i>frequency</i>	z.B.: WS, jährl. oder SoSe, jährl. oder WS und SoSe etc. <i>e.g.: winter semester, yearly or summer semester yearly or each semester.</i> Sommersemester jährlich <i>yearly</i> Klicken Sie hier, um Text einzugeben.
3d	Gibt es parallele Veranstaltungen? <i>Is the course offered several times (parallel)?</i>	NEIN <i>NO</i> Erläuterung <i>Description:</i> No course in 2021, due to sabbatical
3e	Unterrichtssprache(n) <i>language(s) of instruction</i>	<input type="checkbox"/> Deutsch <i>German</i> <input checked="" type="checkbox"/> Englisch <i>English</i> <input type="checkbox"/> Spanisch <i>Spanish</i> <input type="checkbox"/> Französisch <i>French</i> <input type="checkbox"/> Sonstige, und zwar: <i>Other, namely this:</i> Klicken Sie hier, um Text einzugeben.
3f	Leistungen, die an die Lehrveranstaltungen gebunden zu erbringen sind (<i>Benennung nach Art und Anzahl</i>) <i>exam components or prerequisites tied to this course (type, number)</i>	PL = Prüfungsleistung (benoteter Bestandteil einer MP/KP/TP) <i>Graded component of the examination</i> SL = Studienleistung (unbenoteter Bestandteil einer MP/KP/TP) <i>Ungraded component of the examination</i> PVL = Prüfungsvorleistung (Studienleistung vor einer Modulprüfung, nach § 5 Abs. 10 AT BPO bzw. MPO 2010) <i>prerequisite of the examination (see AT Art. 5 Section 10)</i> <input checked="" type="checkbox"/> PL Anzahl <i>number</i> <input type="checkbox"/> SL Anzahl <i>number</i> <input type="checkbox"/> PVL Begründung <i>justification</i> Ggf. weitere Erläuterungen zu den Prüfungs- und Studienleistungen: <i>If necessary, further explanations:</i> Klicken Sie hier, um Text einzugeben.

3g	Dozent/in bzw. Dozenten/Dozentinnen <i>instructor(s)</i>	Wahlpflichtmodul					
3h	Lehrveranstaltungsart und Semesterwochenstunden (SWS = Semesterwochenstunden) <i>course format and total weekly hours per semester (SWS = weekly hours per semester/ contact hours)</i>	<input checked="" type="checkbox"/> 13	Vorlesung(en) mit jeweils <i>lecture(s) with</i>	2	SWS (mit ges. SWS (with tot.	26	Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Seminar(en) mit jeweils <i>seminar(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input checked="" type="checkbox"/> 5	Übung(en) mit jeweils <i>exercise(s) with</i>	8	SWS (mit ges. SWS (with tot.	40	Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Praktikum/Praktika (mit <i>internship(s) with</i>		insgesamt Arbeitsstunden) <i>sum of working hours)</i>		
		<input type="checkbox"/>	Begleitseminar(en) mit je <i>seminar(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Laborpraktikum/-praktika je <i>laboratory/laboratories with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input checked="" type="checkbox"/> 13	Tutorium/Tutorien (mit <i>tutorial(s) (with</i>	2	insg. Stunden Präsenzzeit) <i>hours of presence time)</i>		
		<input type="checkbox"/>	Exkursion(en) mit jeweils <i>excursion(s) with</i>		SWS (mit ges. SWS (with tot.		Arbeitsstunden <i>working hours)</i>
		<input type="checkbox"/>	sonstige Lehrveranstaltung (z.B. Blockveranstaltungen), und zwar: <i>other form of course (e.g. block seminar), namely this:</i>				
		Klicken Sie hier, um Text einzugeben.					
		mit je <i>with</i>	SWS / mit insges. SWS / <i>with totally</i>	Stunden <i>hours</i>	<input type="checkbox"/> Präsenzzeit <i>presence time</i>	<input type="checkbox"/> Arbeitsstunden <i>working hours</i>	
		= Summe der Präsenzzeit und Arbeitsstunden <i>sum of presence time and working hours:</i>					
		180 (including 80h for exam preparation)					

3i	<p>Beschreibung der Lehrveranstaltung</p> <p><i>Description of the course</i></p>	<p>Development of specification models for embedded control systems and cyber-physical systems, using the modelling formalism UML/SysML. Automated code generation for embedded Systems from UML/SysML Models. For 6 ECTS credit points, all lectures and tutorials need to be attended. The oral examination covers both UML/SysML modelling and code generation. For 3 ECTS, only the first half of the lectures and tutorials concerned with modelling only needed to be attended. The oral examination only covers modelling with UML/SysML.</p> <p>Learning outcomes:</p> <p>Learn how to model the expected behavior of an embedded control system with real-time constraints.</p> <p>Learn how to use the formal modelling language UML/SysML, based on real-world examples from the automotive industry</p> <p>Learn how to elaborate models using a state-of-the-art tool (e.g. Papyrus/Eclipse)</p> <p>Learn how to generate efficient C-code automatically from a model</p> <p>Learn how to set up an efficient domain framework supporting execution of generated code in real-time</p>
3j	<p>Literatur (ergänzend zu den Literaturangaben auf Modulebene, siehe 2 f) (Fakultativ)</p> <p><i>Literature (in addition to 2f) (optional)</i></p>	<ol style="list-style-type: none"> 1. OMG ® Unified Modeling Language ® (OMG UML ®), Version 2.5.1, 2017. Available under http://www.omg.org/spec/UML/2.5.1 2. OMG Systems Modeling Language, Version 1.5, 2017. Available under http://www.omg.org/spec/SysML/1.5/ 3. Sanford Friedenthal, Alan Moore, and Rick Steiner. A Practical Guide to SysML. Elsevier 2015.
3k	<p>Sonstige Angaben zur Veranstaltung, und zwar ... (Fakultativ)</p> <p><i>More information on the course, namely this ... (optional)</i></p>	<p>Klicken Sie hier, um Text einzugeben.</p>

3 Scientific Payloads

Klicken Sie hier, um Text einzugeben.

3a	Lehrveranstaltungstitel <i>title of the course</i>	Scientific Payloads
3b	Kennziffer und Titel des/der Modul(e), in dem/denen die Lehrveranstaltung eingebunden ist <i>Module code and module title in which this course is contained.</i>	Elective Modules
3c	Häufigkeit <i>frequency</i>	<p>z.B.: WS, jährl. oder SoSe, jährl. oder WS und SoSe etc. <i>e.g.: winter semester, yearly or summer semester yearly or each semester.</i></p> <p>Sommersemester jährlich <i>yearly</i></p> <p>Klicken Sie hier, um Text einzugeben.</p>
3d	Gibt es parallele Veranstaltungen? <i>Is the course offered several times (parallel)?</i>	<p>NEIN <i>NO</i></p> <p>Erläuterung <i>Description:</i></p> <p>Klicken Sie hier, um Text einzugeben.</p>
3e	Unterrichtssprache(n) <i>language(s) of instruction</i>	<p><input type="checkbox"/> Deutsch <i>German</i> <input checked="" type="checkbox"/> Englisch <i>English</i> <input type="checkbox"/> Spanisch <i>Spanish</i> <input type="checkbox"/> Französisch <i>French</i></p> <p><input type="checkbox"/> Sonstige, und zwar: <i>Other, namely this:</i></p> <p>Klicken Sie hier, um Text einzugeben.</p>
3f	Leistungen, die an die Lehrveranstaltungen gebunden zu erbringen sind (<i>Benennung nach Art und Anzahl</i>) <i>exam components or prerequisites tied to this course (type, number)</i>	<p>PL = Prüfungsleistung (benoteter Bestandteil einer MP/KP/TP) <i>Graded component of the examination</i> SL = Studienleistung (unbenoteter Bestandteil einer MP/KP/TP) <i>Ungraded component of the examination</i> PVL = Prüfungsvorleistung (Studienleistung vor einer Modulprüfung, nach § 5 Abs. 10 AT BPO bzw. MPO 2010) <i>prerequisite of the examination (see AT Art. 5 Section 10)</i></p> <p><input checked="" type="checkbox"/> PL Anzahl <i>number</i> <input type="checkbox"/> SL Anzahl <i>number</i> <input type="checkbox"/> PVL Begründung <i>justification</i></p> <p>Ggf. weitere Erläuterungen zu den Prüfungs- und Studienleistungen: <i>If necessary, further explanations:</i></p> <p>Klicken Sie hier, um Text einzugeben.</p>

3g	Dozent/in bzw. Dozenten/Dozentinnen <i>instructor(s)</i>	Wahlpflichtmodul					
3h	Lehrveranstaltungsart und Semesterwochenstunden (SWS = Semesterwochenstunden) <i>course format and total weekly hours per semester (SWS = weekly hours per semester/ contact hours)</i>	<input checked="" type="checkbox"/> 14	Vorlesung(en) mit jeweils <i>lecture(s) with</i>	2	SWS (mit ges. SWS (with tot.	28	Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Seminar(en) mit jeweils <i>seminar(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Übung(en) mit jeweils <i>exercise(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Praktikum/Praktika (mit <i>internship(s) (with</i>		insgesamt Arbeitsstunden) <i>sum of working hours)</i>		
		<input type="checkbox"/>	Begleitseminar(en) mit je <i>seminar(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Laborpraktikum/-praktika je <i>laboratory/laboratories with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Tutorium/Tutorien (mit <i>tutorial(s) (with</i>		insg. Stunden Präsenzzeit) <i>hours of presence time)</i>		
		<input type="checkbox"/>	Exkursion(en) mit jeweils <i>excursion(s) with</i>		SWS (mit ges. SWS (with tot.		Arbeitsstunden <i>working hours)</i>
<input type="checkbox"/>	sonstige Lehrveranstaltung (z.B. Blockveranstaltungen), und zwar: <i>other form of course (e.g. block seminar), namely this:</i>						
Klicken Sie hier, um Text einzugeben.							
mit je <i>with</i>	SWS / mit insges. SWS / <i>with totally</i>	Stunden <i>hours</i>	<input type="checkbox"/> Präsenzzeit <i>presence time</i>	<input type="checkbox"/> Arbeitsstunden <i>working hours</i>			
= Summe der Präsenzzeit und Arbeitsstunden <i>sum of presence time and working hours:</i>							
90h (26h lecture + 62 self studies/exam preparation)							

3i	Beschreibung der Lehrveranstaltung <i>Description of the course</i>	Klicken Sie hier, um Text einzugeben.
3j	Literatur (<i>ergänzend zu den Literaturangaben auf Modulebene, siehe 2 f)</i> (Fakultativ) <i>Literature (in addition to 2f) (optional)</i>	Klicken Sie hier, um Text einzugeben.
3k	Sonstige Angaben zur Veranstaltung, und zwar ... (<i>Fakultativ</i>) <i>More information on the course, namely this ... (optional)</i>	Klicken Sie hier, um Text einzugeben.

3 Applied Numerical Fluid Mechanics

Klicken Sie hier, um Text einzugeben.

3a	Lehrveranstaltungstitel <i>title of the course</i>	Applied Numerical Fluid Mechanics
3b	Kennziffer und Titel des/der Modul(e), in dem/denen die Lehrveranstaltung eingebunden ist <i>Module code and module title in which this course is contained.</i>	Elective Modules
3c	Häufigkeit <i>frequency</i>	z.B.: WS, jährl. oder SoSe, jährl. oder WS und SoSe etc. <i>e.g.: winter semester, yearly or summer semester yearly or each semester.</i> Sommersemester jährlich <i>yearly</i> Klicken Sie hier, um Text einzugeben.
3d	Gibt es parallele Veranstaltungen? <i>Is the course offered several times (parallel)?</i>	NEIN <i>NO</i> Erläuterung <i>Description:</i> Klicken Sie hier, um Text einzugeben.
3e	Unterrichtssprache(n) <i>language(s) of instruction</i>	<input type="checkbox"/> Deutsch <i>German</i> <input checked="" type="checkbox"/> Englisch <i>English</i> <input type="checkbox"/> Spanisch <i>Spanish</i> <input type="checkbox"/> Französisch <i>French</i> <input type="checkbox"/> Sonstige, und zwar: <i>Other, namely this:</i> Klicken Sie hier, um Text einzugeben.
3f	Leistungen, die an die Lehrveranstaltungen gebunden zu erbringen sind (<i>Benennung nach Art und Anzahl</i>) <i>exam components or prerequisites tied to this course (type, number)</i>	PL = Prüfungsleistung (benoteter Bestandteil einer MP/KP/TP) <i>Graded component of the examination</i> SL = Studienleistung (unbenoteter Bestandteil einer MP/KP/TP) <i>Ungraded component of the examination</i> PVL = Prüfungsvorleistung (Studienleistung vor einer Modulprüfung, nach § 5 Abs. 10 AT BPO bzw. MPO 2010) <i>prerequisite of the examination (see AT Art. 5 Section 10)</i> <input checked="" type="checkbox"/> PL Anzahl <i>number</i> <input type="checkbox"/> SL Anzahl <i>number</i> <input type="checkbox"/> PVL Begründung <i>justification</i> Ggf. weitere Erläuterungen zu den Prüfungs- und Studienleistungen: <i>If necessary, further explanations:</i> Klicken Sie hier, um Text einzugeben.

3g	Dozent/in bzw. Dozenten/Dozentinnen <i>instructor(s)</i>	Wahlpflichtmodul						
3h	Lehrveranstaltungsart und Semesterwochenstunden (SWS = Semesterwochenstunden) <i>course format and total weekly hours per semester (SWS = weekly hours per semester/ contact hours)</i>	<input type="checkbox"/> 13	Vorlesung(en) mit jeweils <i>lecture(s) with</i>	2	SWS (mit ges. SWS (with tot.	26	Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Seminar(en) mit jeweils <i>seminar(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Übung(en) mit jeweils <i>exercise(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Praktikum/Praktika (mit <i>internship(s) (with</i>		insgesamt Arbeitsstunden) <i>sum of working hours)</i>			
		<input type="checkbox"/>	Begleitseminar(en) mit je <i>seminar(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Laborpraktikum/-praktika je <i>laboratory/laboratories with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Tutorium/Tutorien (mit <i>tutorial(s) (with</i>		insg. Stunden Präsenzzeit) <i>hours of presence time)</i>			
		<input type="checkbox"/>	Exkursion(en) mit jeweils <i>excursion(s) with</i>		SWS (mit ges. SWS (with tot.		Arbeitsstunden <i>working hours)</i>	
		<input type="checkbox"/>	sonstige Lehrveranstaltung (z.B. Blockveranstaltungen), und zwar: <i>other form of course (e.g. block seminar), namely this:</i>					
		Klicken Sie hier, um Text einzugeben.						
		mit je <i>with</i>	SWS / mit insges. SWS / <i>with totally</i>	Stunden <i>hours</i>	<input type="checkbox"/> Präsenzzeit <i>presence time</i>	<input type="checkbox"/> Arbeitsstunden <i>working hours</i>		
		= Summe der Präsenzzeit und Arbeitsstunden <i>sum of presence time and working hours:</i>						
		90h (26h lecture + 62h self studies /exam preparation)						

3i	Beschreibung der Lehrveranstaltung <i>Description of the course</i>	Introduction of CFD (I), Introduction of CFD (II), Turbulence modeling (I), Multiphase flow II, Computational heat transfer, Convection in porous media (I), Convection in porous media (II), Multiphase flow (I), Computational combustion (I), Computational combustion (II), Introduction of OpenFoam, Summary
3j	Literatur (ergänzend zu den Literaturangaben auf Modulebene, siehe 2 f) (Fakultativ) <i>Literature (in addition to 2f) (optional)</i>	Klicken Sie hier, um Text einzugeben.
3k	Sonstige Angaben zur Veranstaltung, und zwar ... (Fakultativ) <i>More information on the course, namely this ... (optional)</i>	Knowledge of fluid mechanics is required.

3 On Board Data Handling

Klicken Sie hier, um Text einzugeben.

3a	Lehrveranstaltungstitel <i>title of the course</i>	On Board Data Handling
3b	Kennziffer und Titel des/der Modul(e), in dem/denen die Lehrveranstaltung eingebunden ist <i>Module code and module title in which this course is contained.</i>	Elective Modules
3c	Häufigkeit <i>frequency</i>	z.B.: WS, jährl. oder SoSe, jährl. oder WS und SoSe etc. <i>e.g.: winter semester, yearly or summer semester yearly or each semester.</i> Sommersemester jährlich yearly Klicken Sie hier, um Text einzugeben.
3d	Gibt es parallele Veranstaltungen? <i>Is the course offered several times (parallel)?</i>	NEIN NO Erläuterung <i>Description:</i> Klicken Sie hier, um Text einzugeben.
3e	Unterrichtssprache(n) <i>language(s) of instruction</i>	<input type="checkbox"/> Deutsch <i>German</i> <input checked="" type="checkbox"/> Englisch <i>English</i> <input type="checkbox"/> Spanisch <i>Spanish</i> <input type="checkbox"/> Französisch <i>French</i> <input type="checkbox"/> Sonstige, und zwar: <i>Other, namely this:</i> Klicken Sie hier, um Text einzugeben.
3f	Leistungen, die an die Lehrveranstaltungen gebunden zu erbringen sind (<i>Benennung nach Art und Anzahl</i>) <i>exam components or prerequisites tied to this course (type, number)</i>	PL = Prüfungsleistung (benoteter Bestandteil einer MP/KP/TP) <i>Graded component of the examination</i> SL = Studienleistung (unbenoteter Bestandteil einer MP/KP/TP) <i>Ungraded component of the examination</i> PVL = Prüfungsvorleistung (Studienleistung vor einer Modulprüfung, nach § 5 Abs. 10 AT BPO bzw. MPO 2010) <i>prerequisite of the examination (see AT Art. 5 Section 10)</i> <input checked="" type="checkbox"/> PL Anzahl <i>number</i> <input type="checkbox"/> SL Anzahl <i>number</i> <input type="checkbox"/> PVL <i>Begründung</i> <i>justification</i> Ggf. weitere Erläuterungen zu den Prüfungs- und Studienleistungen: <i>If necessary, further explanations:</i> Klicken Sie hier, um Text einzugeben.

3g	Dozent/in bzw. Dozenten/Dozentinnen <i>instructor(s)</i>	Wahlpflichtmodul						
3h	Lehrveranstaltungsart und Semesterwochenstunden (SWS = Semesterwochenstunden) <i>course format and total weekly hours per semester (SWS = weekly hours per semester/ contact hours)</i>	<input type="checkbox"/> 13	Vorlesung(en) mit jeweils <i>lecture(s) with</i>	2	SWS (mit ges. SWS (with tot.	26	Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Seminar(en) mit jeweils <i>seminar(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Übung(en) mit jeweils <i>exercise(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Praktikum/Praktika (mit <i>internship(s) (with</i>		insgesamt Arbeitsstunden) <i>sum of working hours)</i>			
		<input type="checkbox"/>	Begleitseminar(en) mit je <i>seminar(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Laborpraktikum/-praktika je <i>laboratory/laboratories with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>	
		<input type="checkbox"/>	Tutorium/Tutorien (mit <i>tutorial(s) (with</i>		insg. Stunden Präsenzzeit) <i>hours of presence time)</i>			
		<input type="checkbox"/>	Exkursion(en) mit jeweils <i>excursion(s) with</i>		SWS (mit ges. SWS (with tot.		Arbeitsstunden <i>working hours)</i>	
		<input type="checkbox"/>	sonstige Lehrveranstaltung (z.B. Blockveranstaltungen), und zwar: <i>other form of course (e.g. block seminar), namely this:</i>					
		Klicken Sie hier, um Text einzugeben.						
		mit je <i>with</i>	SWS / mit insges. SWS / <i>with totally</i>	Stunden <i>hours</i>	<input type="checkbox"/> Präsenzzeit <i>presence time</i>	<input type="checkbox"/> Arbeitsstunden <i>working hours</i>		
		= Summe der Präsenzzeit und Arbeitsstunden <i>sum of presence time and working hours:</i>						
		90h (26h lecture + 62h self studies / exam preparation)						

3i	Beschreibung der Lehrveranstaltung <i>Description of the course</i>	Klicken Sie hier, um Text einzugeben.
3j	Literatur (<i>ergänzend zu den Literaturangaben auf Modulebene, siehe 2 f</i>) (Fakultativ) <i>Literature (in addition to 2f) (optional)</i>	Klicken Sie hier, um Text einzugeben.
3k	Sonstige Angaben zur Veranstaltung, und zwar ... (Fakultativ) <i>More information on the course, namely this ... (optional)</i>	Klicken Sie hier, um Text einzugeben.

3 Fluid Handling in Spacecraft

Klicken Sie hier, um Text einzugeben.

3a	Lehrveranstaltungstitel <i>title of the course</i>	Fluid Handling in Spacecraft
3b	Kennziffer und Titel des/der Modul(e), in dem/denen die Lehrveranstaltung eingebunden ist <i>Module code and module title in which this course is contained.</i>	Elective Modules
3c	Häufigkeit <i>frequency</i>	z.B.: WS, jährl. oder SoSe, jährl. oder WS und SoSe etc. <i>e.g.: winter semester, yearly or summer semester yearly or each semester.</i> Sommersemester jährlich <i>yearly</i> Klicken Sie hier, um Text einzugeben.
3d	Gibt es parallele Veranstaltungen? <i>Is the course offered several times (parallel)?</i>	NEIN <i>NO</i> Erläuterung <i>Description:</i> Klicken Sie hier, um Text einzugeben.
3e	Unterrichtssprache(n) <i>language(s) of instruction</i>	<input type="checkbox"/> Deutsch <i>German</i> <input checked="" type="checkbox"/> Englisch <i>English</i> <input type="checkbox"/> Spanisch <i>Spanish</i> <input type="checkbox"/> Französisch <i>French</i> <input type="checkbox"/> Sonstige, und zwar: <i>Other, namely this:</i> Klicken Sie hier, um Text einzugeben.
3f	Leistungen, die an die Lehrveranstaltungen gebunden zu erbringen sind (<i>Benennung nach Art und Anzahl</i>) <i>exam components or prerequisites tied to this course (type, number)</i>	PL = Prüfungsleistung (benoteter Bestandteil einer MP/KP/TP) <i>Graded component of the examination</i> SL = Studienleistung (unbenoteter Bestandteil einer MP/KP/TP) <i>Ungraded component of the examination</i> PVL = Prüfungsvorleistung (Studienleistung vor einer Modulprüfung, nach § 5 Abs. 10 AT BPO bzw. MPO 2010) <i>prerequisite of the examination (see AT Art. 5 Section 10)</i> <input checked="" type="checkbox"/> PL Anzahl <i>number</i> <input type="checkbox"/> SL Anzahl <i>number</i> <input type="checkbox"/> PVL Begründung <i>justification</i> Ggf. weitere Erläuterungen zu den Prüfungs- und Studienleistungen: <i>If necessary, further explanations:</i> Klicken Sie hier, um Text einzugeben.

3g	Dozent/in bzw. Dozenten/Dozentinnen <i>instructor(s)</i>	Wahlpflichtmodul					
3h	Lehrveranstaltungsart und Semesterwochenstunden (SWS = Semesterwochenstunden) <i>course format and total weekly hours per semester (SWS = weekly hours per semester/ contact hours)</i>	<input checked="" type="checkbox"/> 14	Vorlesung(en) mit jeweils <i>lecture(s) with</i>	2	SWS (mit ges. SWS (with tot.	28	Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Seminar(en) mit jeweils <i>seminar(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Übung(en) mit jeweils <i>exercise(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Praktikum/Praktika (mit <i>internship(s) (with</i>		insgesamt Arbeitsstunden) <i>sum of working hours)</i>		
		<input type="checkbox"/>	Begleitseminar(en) mit je <i>seminar(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Laborpraktikum/-praktika je <i>laboratory/laboratories with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Tutorium/Tutorien (mit <i>tutorial(s) (with</i>		insg. Stunden Präsenzzeit) <i>hours of presence time)</i>		
		<input type="checkbox"/>	Exkursion(en) mit jeweils <i>excursion(s) with</i>		SWS (mit ges. SWS (with tot.		Arbeitsstunden <i>working hours)</i>
<input type="checkbox"/>	sonstige Lehrveranstaltung (z.B. Blockveranstaltungen), und zwar: <i>other form of course (e.g. block seminar), namely this:</i>						
Klicken Sie hier, um Text einzugeben.							
mit je <i>with</i>	SWS / mit insges. SWS / <i>with totally</i>	Stunden <i>hours</i>	<input type="checkbox"/> Präsenzzeit <i>presence time</i>	<input type="checkbox"/> Arbeitsstunden <i>working hours</i>			
= Summe der Präsenzzeit und Arbeitsstunden <i>sum of presence time and working hours:</i>							
90h (28h lecture + 62h self studies / exam preparation)							

3i	<p>Beschreibung der Lehrveranstaltung</p> <p><i>Description of the course</i></p>	<p>Subsystems of spacecraft</p> <p>Orbital mechanics</p> <p>Propulsion systems</p> <p>Mission design</p> <p>Governing equations</p> <p>Two-dimensional analysis of liquid/gas interface</p> <p>Dynamic behavior of liquids</p> <p>Liquid sloshing in closed containers</p> <p>Task of propellant management systems</p> <p>Basics of capillary rise</p> <p>Capillary rise in porous media</p> <p>Screen resistance and bubble point</p> <p>Design of propellant management components</p> <p><u>Learning outcomes:</u></p> <p>Understanding the connection between accelerations of a spacecraft and liquid behavior</p> <p>Connection between thrust, acceleration, and propellant demand</p> <p>Understanding fluid mechanics on tank scale, component scale, and subcomponent scale</p> <p>Design tools for two-dimensional situations</p> <p>Design equations for propellant management devices</p>
3j	<p>Literatur (ergänzend zu den Literaturangaben auf Modulebene, siehe 2 f) (Fakultativ)</p> <p><i>Literature (in addition to 2f) (optional)</i></p>	<p>H. Norman Abramson, The dynamic behavior of liquids in moving containers with applications to space vehicle technology, NASA, USA, 1966</p> <p>Frank Dodge, The new dynamic of liquids in moving containers, Southwest Research Institute, San Antonio, TX, USA, 2000</p> <p>Charles D. Brown, Elements of Spacecraft design, AIAA, Reston VA, USA, 2002</p> <p>Charles D. Brown, Spacecraft Propulsion, AIAA, Reston, VA, USA, 1995</p> <p>Frank M. White, Fluid Mechanics, McGraw-Hill, New York, USA, 2009</p> <p>Raouf A. Ibrahim, Liquid Sloshing Dynamics, Cambridge University Press, UK, 2005</p>
3k	<p>Sonstige Angaben zur Veranstaltung, und zwar ... (Fakultativ)</p> <p><i>More information on the course, namely this ... (optional)</i></p>	<p>Klicken Sie hier, um Text einzugeben.</p>

3 Research and Exploration Missions

Klicken Sie hier, um Text einzugeben.

3a	Lehrveranstaltungstitel <i>title of the course</i>	Research and Exploration Missions
3b	Kennziffer und Titel des/der Modul(e), in dem/denen die Lehrveranstaltung eingebunden ist <i>Module code and module title in which this course is contained.</i>	Elective Modules
3c	Häufigkeit <i>frequency</i>	z.B.: WS, jährl. oder SoSe, jährl. oder WS und SoSe etc. <i>e.g.: winter semester, yearly or summer semester yearly or each semester.</i> Sommersemester jährlich yearly Klicken Sie hier, um Text einzugeben.
3d	Gibt es parallele Veranstaltungen? <i>Is the course offered several times (parallel)?</i>	NEIN NO Erläuterung <i>Description:</i> Klicken Sie hier, um Text einzugeben.
3e	Unterrichtssprache(n) <i>language(s) of instruction</i>	<input type="checkbox"/> Deutsch <i>German</i> <input checked="" type="checkbox"/> Englisch <i>English</i> <input type="checkbox"/> Spanisch <i>Spanish</i> <input type="checkbox"/> Französisch <i>French</i> <input type="checkbox"/> Sonstige, und zwar: <i>Other, namely this:</i> Klicken Sie hier, um Text einzugeben.
3f	Leistungen, die an die Lehrveranstaltungen gebunden zu erbringen sind (<i>Benennung nach Art und Anzahl</i>) <i>exam components or prerequisites tied to this course (type, number)</i>	PL = Prüfungsleistung (benoteter Bestandteil einer MP/KP/TP) <i>Graded component of the examination</i> SL = Studienleistung (unbenoteter Bestandteil einer MP/KP/TP) <i>Ungraded component of the examination</i> PVL = Prüfungsvorleistung (Studienleistung vor einer Modulprüfung, nach § 5 Abs. 10 AT BPO bzw. MPO 2010) <i>prerequisite of the examination (see AT Art. 5 Section 10)</i> <input checked="" type="checkbox"/> PL Anzahl <i>number</i> <input type="checkbox"/> SL Anzahl <i>number</i> <input type="checkbox"/> PVL Begründung <i>justification</i> Ggf. weitere Erläuterungen zu den Prüfungs- und Studienleistungen: <i>If necessary, further explanations:</i> Klicken Sie hier, um Text einzugeben.

3g	Dozent/in bzw. Dozenten/Dozentinnen <i>instructor(s)</i>	Wahlpflichtmodul					
3h	Lehrveranstaltungsart und Semesterwochenstunden (SWS = Semesterwochenstunden) <i>course format and total weekly hours per semester (SWS = weekly hours per semester/ contact hours)</i>	<input checked="" type="checkbox"/> 2	Vorlesung(en) mit jeweils <i>lecture(s) with</i>	14	SWS (mit ges. SWS (with tot.	28	Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Seminar(en) mit jeweils <i>seminar(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Übung(en) mit jeweils <i>exercise(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Praktikum/Praktika (mit internship(s) (with		insgesamt Arbeitsstunden) <i>sum of working hours)</i>		
		<input type="checkbox"/>	Begleitseminar(en) mit je <i>seminar(s) with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Laborpraktikum/-praktika je <i>laboratory/laboratories with</i>		SWS (mit ges. SWS (with tot.		Stunden Präsenzzeit <i>hours of presence time)</i>
		<input type="checkbox"/>	Tutorium/Tutorien (mit <i>tutorial(s) (with</i>		insg. Stunden Präsenzzeit) <i>hours of presence time)</i>		
		<input type="checkbox"/>	Exkursion(en) mit jeweils <i>excursion(s) with</i>		SWS (mit ges. SWS (with tot.		Arbeitsstunden <i>working hours)</i>
		<input type="checkbox"/>	sonstige Lehrveranstaltung (z.B. Blockveranstaltungen), und zwar: <i>other form of course (e.g. block seminar), namely this:</i>				
		Klicken Sie hier, um Text einzugeben.					
		mit je <i>with</i>	SWS / mit insges. SWS / <i>with totally</i>	Stunden <i>hours</i>	<input type="checkbox"/> Präsenzzeit <i>presence time</i>	<input type="checkbox"/> Arbeitsstunden <i>working hours</i>	
		= Summe der Präsenzzeit und Arbeitsstunden <i>sum of presence time and working hours:</i>					
		90h (28h lectures + 62h self studies / exam preparation)					

3i	Beschreibung der Lehrveranstaltung <i>Description of the course</i>	Klicken Sie hier, um Text einzugeben.
3j	Literatur (ergänzend zu den Literaturangaben auf Modulebene, siehe 2 f) (Fakultativ) <i>Literature (in addition to 2f) (optional)</i>	Klicken Sie hier, um Text einzugeben.
3k	Sonstige Angaben zur Veranstaltung, und zwar ... (Fakultativ) <i>More information on the course, namely this ... (optional)</i>	Klicken Sie hier, um Text einzugeben.

Space ST

3 Human Exploration & Habitation

Klicken Sie hier, um Text einzugeben.

3a	Lehrveranstaltungstitel <i>title of the course</i>	Human Exploration & Habitation
3b	Kennziffer und Titel des/der Modul(e), in dem/denen die Lehrveranstaltung eingebunden ist <i>Module code and module title in which this course is contained.</i>	Klicken Sie hier, um Text einzugeben.
3c	Häufigkeit <i>frequency</i>	z.B.: WS, jährl. oder SoSe, jährl. oder WS und SoSe etc. e.g.: winter semester, yearly or summer semester yearly or each semester. Sommersemester jährlich yearly Klicken Sie hier, um Text einzugeben.

3d	<p>Gibt es parallele Veranstaltungen?</p> <p><i>Is the course offered several times (parallel)?</i></p>	<p>NEIN NO</p> <p>Erläuterung <i>Description:</i></p> <p>Klicken Sie hier, um Text einzugeben.</p>
3e	<p>Unterrichtssprache(n)</p> <p><i>language(s) of instruction</i></p>	<p><input type="checkbox"/> Deutsch <i>German</i> <input checked="" type="checkbox"/> Englisch <i>English</i> <input type="checkbox"/> Spanisch <i>Spanish</i> <input type="checkbox"/> Französisch <i>French</i></p> <p><input type="checkbox"/> Sonstige, und zwar: <i>Other, namely this:</i></p> <p>Klicken Sie hier, um Text einzugeben.</p>
3f	<p>Leistungen, die an die Lehrveranstaltungen gebunden zu erbringen sind (<i>Benennung nach Art und Anzahl</i>)</p> <p><i>exam components or prerequisites tied to this course (type, number)</i></p>	<p>PL = Prüfungsleistung (benoteter Bestandteil einer MP/KP/TP) <i>Graded component of the examination</i> SL = Studienleistung (unbenoteter Bestandteil einer MP/KP/TP) <i>Ungraded component of the examination</i> PVL = Prüfungsvorleistung (Studienleistung vor einer Modulprüfung, nach § 5 Abs. 10 AT BPO bzw. MPO 2010) <i>prerequisite of the examination (see AT Art. 5 Section 10)</i></p> <p><input type="checkbox"/> PL Anzahl number <input checked="" type="checkbox"/> SL Anzahl number <input type="checkbox"/> PVL Begründung <i>justification</i></p> <p>Ggf. weitere Erläuterungen zu den Prüfungs- und Studienleistungen: <i>If necessary, further explanations:</i></p> <p>Written examination and oral presentation</p>
3g	<p>Dozent/in bzw. Dozenten/Dozentinnen</p> <p><i>instructor(s)</i></p>	<p>Wählen Sie ein Element aus.</p>

3h

Lehrveranstaltungsart und Semesterwochenstunden (SWS = Semesterwochenstunden)
course format and total weekly hours per semester (SWS = weekly hours per semester/ contact hours)

<input checked="" type="checkbox"/>	14	Vorlesung(en) mit jeweils <i>lecture(s) with</i>	2	SWS (mit ges. SWS <i>(with tot.</i>	28	Stunden Präsenzzeit) <i>hours of presence time)</i>
<input type="checkbox"/>		Seminar(en) mit jeweils <i>seminar(s) with</i>		SWS (mit ges. SWS <i>(with tot.</i>		Stunden Präsenzzeit) <i>hours of presence time)</i>
<input type="checkbox"/>		Übung(en) mit jeweils <i>exercise(s) with</i>		SWS (mit ges. SWS <i>(with tot.</i>		Stunden Präsenzzeit) <i>hours of presence time)</i>
<input type="checkbox"/>		Praktikum/Praktika (mit internship(s) <i>(with</i>		insgesamt Arbeitsstunden) <i>sum of working hours)</i>		
<input type="checkbox"/>		Begleitseminar(en) mit je <i>seminar(s) with</i>		SWS (mit ges. SWS <i>(with tot.</i>		Stunden Präsenzzeit) <i>hours of presence time)</i>
<input type="checkbox"/>		Laborpraktikum/-praktika je <i>laboratory/laboratories with</i>		SWS (mit ges. SWS <i>(with tot.</i>		Stunden Präsenzzeit) <i>hours of presence time)</i>
<input type="checkbox"/>		Tutorium/Tutorien (mit <i>tutorial(s) (with</i>		insg. Stunden Präsenzzeit) <i>hours of presence time)</i>		
<input type="checkbox"/>		Exkursion(en) mit jeweils <i>excursion(s) with</i>		SWS (mit ges. SWS <i>(with tot.</i>		Arbeitsstunden) <i>working hours)</i>
<input type="checkbox"/>		sonstige Lehrveranstaltung (z.B. Blockveranstaltungen), und zwar: <i>other form of course (e.g. block seminar), namely this:</i>				

Klicken Sie hier, um Text einzugeben.

mit je SWS / mit insges. Stunden Präsenzzeit Arbeitsstunden
with SWS / *with totally* hours *presence time* *working hours*

= Summe der Präsenzzeit und Arbeitsstunden | *sum of presence time and working hours:*

90 (28 lectures + 28 follow-up work + 34 exam preparation)

Learning content:

In the past five decades more than 550 humans ventured into space, most of them into the low-Earth orbit and a few of them even to the Moon using different vehicles. The astronauts performed experiments, were part of experiments themselves, built infrastructure, and even repaired them in space. According to many international exploration roadmaps, the future of human space flight is seen in the establishment of planetary outposts and habitats on the Moon and Mars.

Sustained human presence in space is challenging and requires a large number of technologies to maintain environment control, to provide water, oxygen, food and to keep astronauts healthy and psychologically fit. Currently physical/chemical life support systems and regular resupply missions represent the back-bone of each life support system. In the future, bio-regenerative life support systems and principles such as algae reactors and higher plant cultivation in conjunction with in-situ resources and advanced manufacturing methods will initially reduce and ultimately eliminate basic consumables from the logistics chain. Minimizing this need for resupply while ensuring human safety will allow astronauts to travel further and stay longer in space than ever before.

Interconnecting different technologies into life support architectures is a complex task and many requirements need to be fulfilled in order to guarantee the survival of the astronauts. Already today, astronauts and scientists experiment how working and living conditions on a planetary surface can be simulated. During analogue- and isolation studies on Earth in extreme environments, such as deserts, polar regions, and caves, essential knowledge in the operation of new technologies can be gained.

Students gain knowledge in:

- History of human spaceflight (Animals in space, Mercury, Gemini, Apollo, Salyut, Spacelab, Mir, Space Shuttle, ISS, Tiangong, Artemis, Musk, Moon Village, Space tourism)
- Life support systems (human requirements, life support functions, physical-chemical technologies, bio-regenerative technologies, fire safety, technology trade-offs with ESM)
- Life support architectures (ISS ECLSS, closed-loop systems, resupply strategies, exemplary calculations/diagrams, simulation)
- Analogue and isolation studies (Bios-3, Biosphere, CEEF, Lunar Palace, Hi-Seas, MDRS, CAVES, NEEMO, Concordia/Antarctica, EDEN ISS, Mars500)
- Habitat design/space architecture
- ISRU (prospecting, excavating, processing, manufacturing, interconnections with ECLSS)
- Resupply vs. advanced in-situ manufacturing
- Space suits and EVA
- Astronaut selection and training
- Humans in Space (human factors, physiology, space medicine, issues in micro- or low gravity)
- International programmatic roadmaps on human exploration

3j	Literatur (ergänzend zu den Literaturangaben auf Modulebene, siehe 2 f) (Fakultativ) <i>Literature (in addition to 2f) (optional)</i>	Klicken Sie hier, um Text einzugeben.
3k	Sonstige Angaben zur Veranstaltung, und zwar ... (Fakultativ) <i>More information on the course, namely this ... (optional)</i>	Klicken Sie hier, um Text einzugeben.

3 Philosophy of Cosmology, Space and Space Travel

Klicken Sie hier, um Text einzugeben.

3a	Lehrveranstaltungstitel <i>title of the course</i>	Philosophy of Cosmology, Space and Space Travel
3b	Kennziffer und Titel des/der Modul(e), in dem/denen die Lehrveranstaltung eingebunden ist <i>Module code and module title in which this course is contained.</i>	Elective Modules
3c	Häufigkeit <i>frequency</i>	z.B.: WS, jährl. oder SoSe, jährl. oder WS und SoSe etc. e.g.: winter semester, yearly or summer semester yearly or each semester. Wintersemester jährlich yearly Klicken Sie hier, um Text einzugeben.
3d	Gibt es parallele Veranstaltungen? <i>Is the course offered several times (parallel)?</i>	NEIN NO Erläuterung <i>Description:</i> Klicken Sie hier, um Text einzugeben.
3e	Unterrichtssprache(n) <i>language(s) of instruction</i>	<input type="checkbox"/> Deutsch <i>German</i> <input checked="" type="checkbox"/> Englisch <i>English</i> <input type="checkbox"/> Spanisch <i>Spanish</i> <input type="checkbox"/> Französisch <i>French</i> <input type="checkbox"/> Sonstige, und zwar: <i>Other, namely this:</i> Klicken Sie hier, um Text einzugeben.
3f	Leistungen, die an die Lehrveranstaltungen gebunden zu erbringen sind (<i>Benennung nach Art und Anzahl</i>) <i>exam components or prerequisites tied to this course (type, number)</i>	PL = Prüfungsleistung (benoteter Bestandteil einer MP/KP/TP) <i>Graded component of the examination</i> SL = Studienleistung (unbenoteter Bestandteil einer MP/KP/TP) <i>Ungraded component of the examination</i> PVL = Prüfungsvorleistung (Studienleistung vor einer Modulprüfung, nach § 5 Abs. 10 AT BPO bzw. MPO 2010) <i>prerequisite of the examination (see AT Art. 5 Section 10)</i> <input checked="" type="checkbox"/> PL Anzahl <i>number</i> <input type="checkbox"/> SL Anzahl <i>number</i> <input type="checkbox"/> PVL Begründung <i>justification</i> Ggf. weitere Erläuterungen zu den Prüfungs- und Studienleistungen: <i>If necessary, further explanations:</i> Klicken Sie hier, um Text einzugeben.

3g	Dozent/in bzw. Dozenten/Dozentinnen <i>instructor(s)</i>	Wahlpflichtmodul					
3h Lehrveranstaltungsart und Semesterwochenstunden (SWS = Semesterwochenstunden) <i>course format and total weekly hours per semester (SWS = weekly hours per semester/ contact hours)</i>		<input type="checkbox"/> Anzahl <i>number</i>	Vorlesung(en) mit jeweils <i>lecture(s) with</i>	Anzahl <i>number</i>	SWS (mit ges. SWS) <i>(with tot. SWS)</i>	Anzahl <i>number</i>	Stunden Präsenzzeit <i>hours of presence time</i>
		<input checked="" type="checkbox"/> 2	Seminar(en) mit jeweils <i>seminar(s) with</i>	14	SWS (mit ges. SWS) <i>(with tot. SWS)</i>	28	Stunden Präsenzzeit <i>hours of presence time</i>
		<input type="checkbox"/>	Übung(en) mit jeweils <i>exercise(s) with</i>		SWS (mit ges. SWS) <i>(with tot. SWS)</i>		Stunden Präsenzzeit <i>hours of presence time</i>
		<input type="checkbox"/>	Praktikum/Praktika (mit <i>internship(s) with</i>		insgesamt Arbeitsstunden <i>sum of working hours</i>		
		<input type="checkbox"/>	Begleitseminar(en) mit je <i>seminar(s) with</i>		SWS (mit ges. SWS) <i>(with tot. SWS)</i>		Stunden Präsenzzeit <i>hours of presence time</i>
		<input type="checkbox"/>	Laborpraktikum/-praktika je <i>laboratory/laboratories with</i>		SWS (mit ges. SWS) <i>(with tot. SWS)</i>		Stunden Präsenzzeit <i>hours of presence time</i>
		<input type="checkbox"/>	Tutorium/Tutorien (mit <i>tutorial(s) with</i>		insg. Stunden Präsenzzeit <i>hours of presence time</i>		
		<input type="checkbox"/>	Exkursion(en) mit jeweils <i>excursion(s) with</i>		SWS (mit ges. SWS) <i>(with tot. SWS)</i>		Arbeitsstunden <i>working hours</i>
			<input type="checkbox"/> sonstige Lehrveranstaltung (z.B. Blockveranstaltungen), und zwar: <i>other form of course (e.g. block seminar), namely this:</i> Klicken Sie hier, um Text einzugeben. mit je <i>with</i> SWS / mit insges. <i>SWS / with totally</i> Stunden <i>hours</i> <input type="checkbox"/> Präsenzzeit <i>presence time</i> <input type="checkbox"/> Arbeitsstunden <i>working hours</i> = Summe der Präsenzzeit und Arbeitsstunden <i>sum of presence time and working hours:</i> 90				

3i	<p>Beschreibung der Lehrveranstaltung</p> <p><i>Description of the course</i></p>	<p>Course Content:</p> <p>This course covers philosophical questions about cosmology and about the exploration of terra incognita related to space. First, we cover the meaning of exploration for mankind in general (exploration of new territories as well as of laws of the physical world and laws in general). Second, we specialize to questions related to space: What is the idea behind a finite or infinite world? What does the exploration of space mean for the “position” of mankind within the Universe, for the world view of human beings? What would it mean for mankind if the search for extraterrestrial life will be successful? In what sense can cosmology missions “uncover” the dynamics of the universe from the Big Bang to the far future? What concept of time is involved here and what counts as evidence and why?</p> <p>Learning outcome/learning goals:</p> <ul style="list-style-type: none"> • Knowledge of basic notions from the philosophy of the natural sciences (natural law, space, time, infinity, ...) • Basic insights into the aims of scientific inquiry and the generation of scientific knowledge (by means of examples from the history of cosmology) • Ideas involved in human self-understanding related to “other worlds” or extraterrestrial life • Basic knowledge of cosmology.
3j	<p>Literatur (<i>ergänzend zu den Literaturangaben auf Modulebene, siehe 2 f</i>) (<i>Fakultativ</i>)</p> <p><i>Literature (in addition to 2f) (optional)</i></p>	<p>[Will be announced at the beginning of the course.]</p>
3k	<p>Sonstige Angaben zur Veranstaltung, und zwar ... (<i>Fakultativ</i>)</p> <p><i>More information on the course, namely this ... (optional)</i></p>	<p>Klicken Sie hier, um Text einzugeben.</p>

Master Project

module code /
 module title

Master Project

date / version of the module description	12.02.2019
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1 INFORMATION ON THE MODULE

1a	module code	
1b	module title (German title)	
1c	module title (English title)	Master Project
1d	credit points	12
1e	responsible for the module	MPA Space Engineering
1f	type of module	elective module
1g	programs using the module	
1h	organizational unit offering the module	
1i	content-related prior knowledge or skills	None
1j	learning contents	The student has to work on an applied or scientific project during the working time. Result should be finishing a project or a clear defined part of it.
1k	learning outcomes/ competencies/ targeted competencies	Students have knowledge/responsibilities in <ul style="list-style-type: none"> •working on a scientific topic •concluding scientific results in a collaborating team

		<ul style="list-style-type: none"> •project management •concluding scientific results in textform •discussing and presenting own results •communication and presentation techniques
1l	<p>calculation of student workload</p> <p><i>(part a: calculation of presence time and working hours)</i></p>	<p>The total amount of the presence time and working hours of the module has to be calculated additionally in the detailed calculation a) to c).</p> <p>a) detailed calculation: SWS / presence time/working hours in each course of the module</p>
	<p>calculation of student workload</p> <p><i>(part b: preparation time and follow-up work/self-study)</i></p>	
	<p>calculation of student workload</p> <p><i>(part c: exam preparation etc.)</i></p>	
	<p>calculation of student workload</p> <p><i>(total amount of hours including a) - c))</i></p>	<p>Total amount of the presence time and working hours a) to c): 360 h</p>
1m	<p>description of possible optional courses in the module</p>	
1n	<p>language(s) of instruction</p>	<input checked="" type="checkbox"/> English
1o	<p>frequency</p>	<p>each semester</p>
1p	<p>duration</p>	<p>two semester module</p> <p>project has to absolved within one study year</p> <p>topic is defined in study planning of study programs</p>
1q	<p>Literature <i>(optional)</i></p>	
1r	<p>more information on the module <i>(optional)</i></p>	

2	INFORMATION ON THE MODULE EXAMINATION (see also AT Art. 5 section 8)	
2a	type of examination	
2b	exam components or prerequisites (<i>type, number</i>)	
2c	Give this information for combination examinations only: Weights (in percentage) of component grades	
2d	form of examination (see AT BPO/AT MPO Art. 8, 9 and 10)	
2e	language(s) of instruction	<input checked="" type="checkbox"/> English

Master Thesis

module code /
module title

Master Thesis

date / version of the module description	12.02.2019
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1 INFORMATION ON THE MODULE		
1a	module code	
1b	module title (German title)	
1c	module title (English title)	Master Thesis
1d	credit points	30
1e	responsible for the module	
1f	type of module	compulsory module
1g	programs using the module	
1h	organizational unit offering the module	
1i	content-related prior knowledge or skills	None
1j	learning contents	The student has to work on an applied or scientific project during the working time. Result should be finishing a project or a clear defined part of it.
1k	learning outcomes/ competencies/ targeted competencies	Students have knowledge/responsibilities in <ul style="list-style-type: none"> •long-time working on a scientific topic •making recherches of previous research results

		<ul style="list-style-type: none"> •developing own theories •discussing and comparing other work with own results •concluding results in a written thesis
1l	<p>calculation of student workload</p> <p><i>(part a: calculation of presence time and working hours)</i></p>	<p>The total amount of the presence time and working hours of the module has to be calculated additionally in the detailed calculation a) to c).</p> <p>a) detailed calculation: SWS / presence time/working hours in each course of the module</p>
	<p>calculation of student workload</p> <p><i>(part b: preparation time and follow-up work/self-study)</i></p>	
	<p>calculation of student workload</p> <p><i>(part c: exam preparation etc.)</i></p>	
	<p>calculation of student workload</p> <p><i>(total amount of hours including a) - c)</i></p>	
1m	<p>description of possible optional courses in the module</p>	
1n	<p>language(s) of instruction</p>	<input checked="" type="checkbox"/> English
1o	<p>frequency</p>	
1p	<p>duration</p>	<p>Corresponding MPO</p>
1q	<p>Literature <i>(optional)</i></p>	

1r	more information on the module (<i>optional</i>)	
2	INFORMATION ON THE MODULE EXAMINATION (see also AT Art. 5 section 8)	
2a	type of examination	
2b	exam components or prerequisites (<i>type, number</i>)	
2c	Give this information for combination examinations only: Weights (in percentage) of component grades	
2d	form of examination (see AT BPO/AT MPO Art. 8, 9 and 10)	<input checked="" type="checkbox"/> Master Thesis <input checked="" type="checkbox"/> Other (concrete definition is given in the examination regulations): Presentation of results
2e	language(s) of instruction	<input checked="" type="checkbox"/> English