Universität Bremen

Module guide

Space Sciences and Technologies (M.Sc.)

This module guide details the contents of the master programme Space Sciences and Technologies for informational purposes. Binding rules are set out by the specific examination regulations.

Druckdatum: 11.10.2019

Course of Studies: Master Programme Space Sciences and Technologies

Semester	Pflichtbereich (Compulsory Modules) + Modul Masterarbeit (inkl. Kolloquium) insgesamt 96 CP			Project (12 CP)	Wahlpflichtbereich (Compulsory Elective Modules, 12 CP)		Wahlbereich (Elective Modules, 12 CP)		∑ 120 Verteilung CP/Semester
					„Physics for Space Observation" (PSO) (Specialization)	„Information Technologies for Space" (ITS) (Specialization)	PSO	ITS	
1	**Foundations (30 CP)**								30
	Inverse Methods and Data Analysis, 6 CP	Control Theory I, 3 CP	Space Electronics, 6 CP						
	Science and Exploration Missions, 3 CP	Atmospheric Physics, 6 CP	Communication Technologies, 6 CP						
2	**Remote Sensing and Communication (24 CP)**				Remote Sensing of Ocean and Cryosphere, 6 CP	RF Frontend Devices and Circuits, 4 CP	Elective Course, 9 CP	Elective Course, 3 CP	30
	Channel Coding I, 3 CP	Sensors and Measurement Systems, 3 CP	Digital Image Processing, 3 CP			Architectures and Design Methodologies of Integrated Digital Systems, 4 CP			
		Space Lab, (3 von 6 CP)	Atmospheric Spectroscopy, 3 CP			Microfluidic Devices, 4 CP			
3	Communica-tion Networks for Space, 3 CP	Space Lab, (Fortsetzung 3 von 6 CP)		Project, 12 CP	Atmospheric Chemistry Modeling,3 CP		Elective Course, 3 CP	Elective Course, 9 CP	30
	Geodesy and Gravity, 3 CP				Atmospheric Aerosols, 3 CP				
4	Master Thesis, 30 CP								30

CP = Credit Points

Overview classified by module groups

1. Foundations

The foundation modules are compulsory and cover 30 CP during semester 1.

2. Remote Sensing and Communication

The modules in Remote Sensing and Communication are compulsory; they are recommended for semester 2 and 3.

3. Specialization Areas

Specialization Areas are: Physics for Space Observations (PSO) and Information Technologies for Space (ITS) The choice of a specialization and the respective modules are compulosry.

3. 1. Physics for Space Observation

These modules are compulsory if the specialization are of choice is Physics for Space Observation (PSO).

3. 2. Information Technologies for Space

4. Project & Master's Thesis Space-ST

5. Electives Space-ST

Electives can be chosen from this list of modules. Modules that are not listed here can be acknowledged upon individual request to be addressed to the examination board.

Alphabetical module list

Module 01-01-03 AtPhy: Atmospheric Physics

Atmospheric Physics

MPO 2014/2017

Module assignment:	Recommended content-related requirements:
• Foundations	none

Learning content:

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.).

References:

- 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

Learning outcome / Competence:

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 form ground based ship, aircraft and space based instrumentation, b) being employment in earth observation, earth science, meteorology, industry, or governmental and space agencies.

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 2 semester hours.

Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, examples: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr. John P. Burrows FRS
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 14/15	-

Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Studienleistung	
Examination format: Submodule examination	Successful participation in tutorials

Type of examination: Prüfungsleistung	
Examination format: Submodule examination	Either a written or an oral examination

Module courses

Course:	01-01-03-AtPhy-V Lecture Atmospheric Physics
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Burrows FRS, John P., Prof. Dr.
Teaching method(s): Lecture	**Associated module examination:** Prüfungsleistung

Course:	01-01-03-AtPhy-Ü Tutorial Atmospheric Physics
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Burrows FRS, John P., Prof. Dr.
Teaching method(s): Tutorial	**Associated module examination:** Studienleistung

Module 01-15-03 CTh1: Regelungstheorie I (Control Theory I)

Control Theory I

MPO 2017

Module assignment:	**Recommended content-related requirements:**
• Foundations	Lecture „Grundlagen der Regelungstechnik“ or equivalent knowledge about basics of control (bode diagrams, nyquist plots, nyquist stability criterion, PID controller design)

Learning content:

- 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
- Falb-Wolovitch controller design

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

Understanding and handling of state space methodology. Design of state space controllers with different methods, observer design.

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 42 h (3 h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 50 h

Total working hours: 120 h

Language of tuition:	**Module leader:**
English	Prof. Dr.-Ing. Kai Michels
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 17/18	-

Credit points / Workload:	**Contact hours:**
3 / 90 hours	3 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	Oral or written

Module courses

Course:	01-15-03-ChT1-V Lecture: Control Theory I
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Michels, Kai, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Course:	01-15-03-ChT1-Ü Exercise: Control Theory I
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Michels, Kai, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Module 01-15-03 ComT: Communication Technologies

Communication Technologies

MPO 2017

Module assignment:	**Recommended content-related requirements:**
• Foundations	Basics in linear algebra, calculus, differential equations, fourier transformation and physics (basics in electromagnetic waves) are recommended.

Learning content:

- 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

Learning outcome / Competence:

As outcome, the students should be able to:

- Explain basic communications concepts and theoretical foundations;
- Apply mathematical tools and concepts relevant in communictions;
- Explain and apply analog and digital modulation.

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 2 semester hours.

Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	**Module leader:**
English	Prof.Dr.-Ing. Armin Dekorsy
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 17/18	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	90 min.

Module courses

Course:	01-29-03-ComT-V Lecture Communication Technologies
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Bockelmann, Carsten, Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Course:	01-29-03-ComT-Ü Exercise Communication Technologies
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Bockelmann, Carsten, Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Module 01-01-03 IMDA: Inverse Methods and Data Analysis

Inverse Methods and Data Analysis
MPO 2014/2017

Module assignment:	**Recommended content-related requirements:**
• Foundations	none

Learning content:
Error analysis and statistics, techniques for the optimal solution of under and over determined systems of linear equations including methods for calculating variances and covariances of the solutions, concepts of resolution and methods to calculate them, practical examples and applications to test data sets from oceanography, image processing and remote sensing of the atmosphere, earth, outer space, and celestial bodies.

Learning outcome / Competence:
Basic knowledge in linear inverse methods

Calculating student workload:
The module comprises two courses: a lecture of 2 semester hours and an exercise of 2 semester hours.

Workload:
- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	**Module leader:**
English	apl. Prof. Reiner Schlitzer
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 14/15	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Prüfungsleistung	
Examination format:	Written or oral examination
Submodule examination	

Type of examination: Studienleistung	
Examination format:	Course performance: Successful assessment of example classes
Submodule examination	

Module courses

Course:	01-01-03-IMDA-Ü Tutorial
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Schlitzer, Reiner, apl. Prof. King, Emily Jeannette, Prof. Dr.
Teaching method(s): Tutorial	**Associated module examination:** Studienleistung

Course:	01-01-03-IMDA-V Lecture
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Schlitzer, Reiner, apl. Prof. King, Emily Jeannette, Prof. Dr.
Teaching method(s): Lecture	**Associated module examination:** Prüfungsleistung

Module 01-29-03 SEM: Science and Exploration Missions

Science and Exploration Missions

MPO 2017

Module assignment:	**Recommended content-related requirements:**
• Foundations	Basic courses in Physics on mechanics, electrodynamics, quantum mechanics.

Learning content:

Introduction to completed and planned space missions,

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.

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

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.

Calculating student workload:

The module comprises one lecture of 2 semester hours:

- Contact hours (lecture): 28 h (2 h x 14 weeks)
- Preparation, learning, exercises: 42 h (3 h x 14 weeks)
- Preparation for exam: 20 h

Total working hours: 90 h

Language of tuition:	**Module leader:**
English	Prof. Dr. rer. nat. Claus Lämmerzahl
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 17/18	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Prüfungsleistung	
Examination format: Submodule examination	Written or oral examination

Type of examination: Studienleistung	
Examination format: Submodule examination	Course performance (exercises)

Module courses

Course:	01-29-03-SEM-V Lecture and exercise: Science and Exploration Missions
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Lämmerzahl, Claus, Prof. Dr. rer. nat.
Teaching method(s):	**Associated module examination:**

Module 01-29-03 SpEl: Space Electronics

Space Electronics

MPO 2017

Module assignment:	**Recommended content-related requirements:**
• Foundations	Basic knowledge of semiconductors, analog and digital circuits

Learning content:

- 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

Learning outcome / Competence:

After this course, students are able to:

- 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 radiation hard circuits.

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 2 semester hours.

Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, examples: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	**Module leader:**
English	Prof. Dr.-Ing. Alberto Garcia-Ortiz
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]

The module is valid since: WiSe 17/18	**The module is valid until:** -
Credit points / Workload: 6 / 180 hours	**Contact hours:** 4 hours

Module examinations

Type of examination: Studienleistung	
Examination format: Submodule examination	Course performance: Successful assessment of exercise classes

Type of examination: Prüfungsleistung	
Examination format: Submodule examination	Written/oral examination

Module courses

Course:	01-29-03-SpEl-V Lecture Space Electronics
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Garcia-Ortiz, Alberto, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Course:	01-29-03-SpEl-Ü Tutorial Space Electronics
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Garcia-Ortiz, Alberto, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Module 01-01-03 AtSp: Atmospheric Spectroscopy

Atmospheric Spectroscopy
MPO v. 05.04.2017

Module assignment:	**Recommended content-related requirements:**
• Remote Sensing and Communication	none

Learning content:

- Prism and grating spectrometers
- Fourier-Transform-Spectroscopy
- Transitions
- Rotational spectra
- Vibrational spectra
- Rotational-vibrational spectra
- Remote sensing methods

Learning outcome / Competence:

Basics of spectroscopy, basics of molecular spectroscopy. Understanding and interpretation of measured spectra with regard to the structure of the molecules. Basics of prism, grating and FTIR-spectroscopy, understanding of remote sensing methods.

Calculating student workload:

The module comprises two courses: a lecture of 1 semester hours and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 28 h (2 h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 34 h

Total working hours: 90 h

Language of tuition:	**Module leader:**
English	Prof. Dr. rer.nat. Justus Notholt
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 17/18	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Studienleistung	
Examination format:	Course performance: Successful assessment of
Submodule examination	example classes and/or successful writing of an essay

Type of examination: Prüfungsleistung	
Examination format: Submodule examination	Written or oral examination

Module 01-15-03 CCod1: Channel Coding I

Channel Coding I

MPO 2017

Module assignment:	**Recommended content-related requirements:**
• Remote Sensing and Communication	Basics of communication technology and digital signal processing

Learning content:

1) Basic Concepts and channel models

2) Information theory

3) Linear block codes:

- Generator and parity check matrix
- Standard array and syndrome decoding
- Examples (SPC, Hamming, Simplex),
- Cyclic Codes (description by polynomials),
- Examples (CRC, BCH, Reed-Solomon),

4) Convolutional codes:

- Encoder structure and graphical representations
- Viterbi decoding
- Code properties

The practical application of teaching contents is developed by Matlab excercises.

Learning outcome / Competence:

Channel Coding I is a one-semester course. The aim is to provide a basic understanding how channel coding works and to present the most important code families. Moreover, results obtained from information theory show the ultimate limits theoretically achievable with optimal codes. After this course, the students should be able to:

- Explain the principle of channel coding,
- Explain the ultimate limits from information theory,
- Perform encoding and decoding for linear block and convolutional codes,
- Grade the performance of different codes.

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 42 h (3 h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 20 h

Total working hours: 90 h

Language of tuition:	**Module leader:**
English	Dr.-Ing. Dirk Wübben

Frequency: SoSe, once a year	**Duration:** 1 semester[s]
The module is valid since: WiSe 17/18	**The module is valid until:** -
Credit points / Workload: 3 / 90 hours	**Contact hours:** 3 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	

Module courses

Course:	01-03-15-CCod1-V Lecture Channel Coding I
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: German / English	**University teacher(s):** Wübben, Dirk, Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Course:	01-15-03-CCod1-Ü Tutorial Channel Coding I
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: German / English	**University teacher(s):** Wübben, Dirk, Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Module 01-29-03 CNS: Communication Networks for Space

Communication Networks for Space
MPO 2017

Module assignment:	Recommended content-related requirements:
• Remote Sensing and Communication	none

Learning content:

Distributed Systems, ISO/OSI 7 Layer Reference Model for Open Communication, Formal Specification Methods for Protocols (SDL), Data Link Layer, Network Layer, Transport Layer, Application Oriented Layers, Local Area Networks, Wide Area Networks, Network Control: (virtual) connections, Routing, Addressing, Flow Control, System Examples: TCP/IP, Wireless LAN, opportunistic and delay-tolerant networks.

References:

- Walrand, J.: Communication Networks, A first course, WCB/McGraw-Hill 1998, ISBN 0-256-17404-0.
- Tanenbaum, A.S.: Computer Networks, Prentice Hall 1996, ISBN 0-13 349945-6 (and newer editions).
- Ross/Kurose, Computer Networking: A Top Down Approach, 4th ed., Addison-Wesley, July 2007.

Learning outcome / Competence:

The participants are able to describe exemplary systems of communication networks, name and explain the layers of a communication network, know the basic technologies used for communication protocols, know basic error handling mechanisms for communication protocols.

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 1 semester hour.

Workload:

- Attendance (lecture + exercise): 42 h (3 h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 20 h

Total working hours: 90 h

Language of tuition:	Module leader:
English	Prof. Dr. Anna Förster
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 17/18	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	3 hours

Module examinations

Type of examination: Studienleistung	
Examination format: Submodule examination	Course performance: Successful assessment of homework assignments and a successful poster preparation and presentation

Type of examination: Prüfungsleistung	
Examination format: Submodule examination	Poster presentation graded

Module courses

Course:	01-15-03-CNS-V Lecture Communication Networks: Systems
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Könsgen, Andreas, Dr. Förster, Anna, Prof. Dr.
Teaching method(s):	**Associated module examination:**

Course:	01-15-03-CNS-Ü Exercise Communication Networks: Systems
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Könsgen, Andreas, Dr. Förster, Anna, Prof. Dr.
Teaching method(s):	**Associated module examination:**

Module 01-01-03 DIP: Digital Image Processing

Digital Image Processing
MPO 2014/2017

Module assignment:	**Recommended content-related requirements:**
• Remote Sensing and Communication	none

Learning content:

- Digital image, sampling
- Image enhancement using filters
- Image analysis methods using segmentation, feature extraction and classification
- Fourier transformation of digital image, linear filters in spatial and frequency domains
- Data compression

Learning outcome / Competence:
Fundamentals of digital image processing

Calculating student workload:
The module comprises two courses: a lecture of 1 semester hour and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 28 h (2 h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 34 h

Total working hours: 90 h

Language of tuition:	**Module leader:**
English	Dr. Christian Melsheimer
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 14/15	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Studienleistung	
Examination format: Submodule examination	Course performance: Successful assessment of example classes and/or successful writing of an essay

Type of examination: Prüfungsleistung	
Examination format: Announcement at the begin of the semester	Written/oral examination

Module courses

Course:	01-01-03-DIP-V Lecture Digital Image Processing
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Melsheimer, Christian, Dr.
Teaching method(s): Lecture	**Associated module examination:** Prüfungsleistung

Course:	01-01-03-DIP-Ü Tutorial Digital Image Processing
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Melsheimer, Christian, Dr.
Teaching method(s): Tutorial	**Associated module examination:** Studienleistung

Module 01-29-03 GG: Geodesy and Gravity

Geodesy and Gravity

MPO v. 05.04.2017

Module assignment:	**Recommended content-related requirements:**
• Remote Sensing and Communication	none

Learning content:

Classical geodesy

- Repetition of Newtonian gravitational theory
- Multipole moments of the Earth and the gravitational field of the Earth
- Definition of the geoid on the rotating Earth
- Equation of motion for satellites
- Calculation of satellite orbits
- Description of orbits for satellite formation flight and extraction of the gravitational field

Relativistic geodesy

- Elements of relativistic gravity theory
- Post-Newtonian solution for the gravitational field of the Earth
- Definition of the geoid
- Clocks in the gravitational field: clock geodesy
- Relativistic satellite orbits, basic effects

Learning outcome / Competence:

The students gain knowledge of notions of nonrelativistic gravity theory, knowledge of basic notions of geodesy, an understanding of methods to measure the gravitational fields, knowledge of basic principles of relativistic gravity and an understanding of clock geodesy.

Calculating student workload:

The module comprises two courses: a lecture of 1 semester hours and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 28 h (2 h x 14 weeks)
- Preparation, learning, exercises: 42 h (3 h x 14 weeks)
- Preparation for exam: 20 h

Total working hours: 90 h

Language of tuition:	**Module leader:**
English	Prof. Dr. rer. nat. Claus Lämmerzahl
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 17/18	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Studienleistung	
Examination format: Submodule examination	Course performance: Successful assessment of exercise classes and/or successful writing of an essay

Type of examination: Prüfungsleistung	
Examination format: Submodule examination	Written/oral examination

Module courses

Course:	01-29-03-GG-V Geodesy and Gavity
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Lämmerzahl, Claus, Prof. Dr. rer. nat.
Teaching method(s):	**Associated module examination:**

Module 01-15-03 SAMS: Sensors and Measurement Systems

Sensors and Measurement Systems

MPO 2017

Module assignment:	**Recommended content-related requirements:**
• Remote Sensing and Communication	Basics of electrical engineering and electrical measurement are recommended.

Learning content:

- Basics of Sensors
- Thermal Sensors
- Sensor Technology
- Force and Pressure Sensors
- Inertial Sensors
- Magnetic Sensors
- Flow Sensors

References:

- Walter Lang: Sensors and Measurement systems, ISBN-10: 877022028X

Learning outcome / Competence:

After this course, students should be able to:

- Name and explain important sensors,
- Apply characterization parameters for sensors,
- Choose sensors for a given application and apply them,
- Understand micromachining technologies for sensors.

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 42 h (3 h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 20 h

Total working hours: 90 h

Language of tuition:	**Module leader:**
English	Prof. Dr.-Ing. Walter Lang
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 17/18	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	3 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Written examination

Module courses

Course:	01-15-03-SAMS-V Lecture Sensors and Measurement Systems
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Lang, Walter, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Course:	01-15-03-SAMS-Ü Tutorial Sensors and Measurement Systems
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Lang, Walter, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Module 01-29-03 LSPA: Space Lab
Space Lab
MPO v. 05.04.2017

Module assignment:	**Recommended content-related requirements:**
• Remote Sensing and Communication	none

Learning content:
Measurements of meteorological quantities, atmospheric trace gases, ocean currents, environmental radioactivity, absorption cross-sections, measurements of Embedded Systems and Communications.

Learning outcome / Competence:
Participants learn the basics of measurement techniques in Space Sciences and Technologies.

Calculating student workload:
The module comprises lectures and lab work.

Workload:

- Contact hours (lecture): 18 h (6 h x 3 weeks)
- Contact hours (lab): 24 h (2 h x 12 weeks)
- Preparation, reports: 84 h (7 x 12 weeks)
- Preparation for exam: 54 h

Total working hours: 180 h

Language of tuition:	**Module leader:**
English	N.N. PD Dr. Annette Ladstätter-Weißenmayer, Dr. A. Richter, Prof. Dr.-Ing. A. Garcia-Ortiz, Prof. Dr.-Ing. A. Dekorsy, Prof. Dr.-Ing. A. Förster, Prof. Dr.-Ing. K Michels
Frequency: WiSe, SoSe	**Duration:** 2 semester[s]
The module is valid since: WiSe 17/18	**The module is valid until:** -
Credit points / Workload: 6 / 180 hours	**Contact hours:** 2 hours

Module examinations

Type of examination: Prüfungsleistung	
Examination format: Submodule examination	Oral examination

Type of examination: Studienleistung	
Examination format: Submodule examination	Course performance: reports

Module courses

Course:	01-29-03-LSPA-V Space lab lecture and practical
Frequency: WiSe, SoSe	**Are there parallel courses?** no
Language: English	**University teacher(s):** Richter, Andreas, Dr. Könsgen, Andreas, Dr. Wübben, Dirk, Dr.-Ing. Michels, Kai, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Module 01-01-03 AtA: Atmospheric Aerosols

Atmospheric Aerosols
MPO v. 05.04.2017

Module assignment:	**Recommended content-related requirements:**
• Specialization Areas / Physics for Space Observation	none

Learning content:

- Description of atmospheric aerosols, their composition and measuring methods
- Introduction to radiative transfer in the troposphere with emphasis on aerosols and clouds

Learning outcome / Competence:

Advanced knowledge of the atmosphere and light scattering

Calculating student workload:

The module comprises two courses: a lecture of 1 semester hour and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 28 h (2 h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 34 h

Total working hours: 90 h

Language of tuition:	**Module leader:**
English	Dr. Marco Vountas
Frequency:	**Duration:**
WiSe, once a year	
The module is valid since:	**The module is valid until:**
WiSe 17/18	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Studienleistung	
Examination format:	Course performance: Successful assessment of example classes and/or successful writing of an essay

Type of examination: Prüfungsleistung	
Examination format: Announcement at the begin of the semester	Written/oral examination

Module courses

Course:	01-01-03-AtA-V Lecture Atmospheric Aerosols
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Vountas, Marco, Dr.
Teaching method(s):	**Associated module examination:**

Course:	01-01-03-AtA-Ü Exercise Atmospheric Aerosols
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Vountas, Marco, Dr.
Teaching method(s):	**Associated module examination:**

Module 01-01-03 AtCM1: Atmospheric Chemistry Modelling

Atmospheric Chemistry Modelling

MPO vom 14.02.2018

Module assignment:	**Recommended content-related requirements:**
• Specialization Areas / Physics for Space Observation	none

Learning content:

- Concept of chemistry transport models
- Atmospheric Chemical Composition/Processes Model equations and numerical approaches focusing on the: a) formulation of atmospheric rates, and b) numerical methods for chemical systems
- Surface fluxes/emissions
- Observations and model evaluations
- Inverse modeling for atmospheric chemistry

A list of references will be provided at the start of the semester

Learning outcome / Competence:

Participants will have the chance to:

- get a theoretical overview of the concepts of numerical atmospheric chemistry modelling
- review fundamentals of atmospheric chemistry and physics,
- formulate model equations and numerical (differential) approaches for various systems focusing on atmospheric chemistry mechanisms and
- assess the role of chemistry transport models as components of the atmospheric observing system.

Concepts of inverse modelling will be also presented.

Calculating student workload:

The module comprises two courses: a lecture of 1 semester hour and an exercise of 1 semester hour.

Workload:

- Attendance (lecture + exercise): 28 h (2 h x 14 weeks)
- Preparation, learning, exercises: 42 h (3 h x 14 weeks)
- Preparation for exam: 20 h

Total working hours: 90 h

Language of tuition:	**Module leader:**
English	Prof. Dr. Mihalis Vrekoussis
Frequency:	**Duration:**
WiSe, once a year	
The module is valid since:	**The module is valid until:**
SoSe 18	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Studienleistung	
Examination format: Submodule examination	Successful assessment of example classes and/or successful writing of an essay

Type of examination: Prüfungsleistung	
Examination format: Submodule examination	Written/oral examination

Module courses

Course:	01-01-03-AtCM1-V Lecture and Excercise Atmospheric Chemistry Modelling
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Vrekoussis, Mihalis, Prof. Dr.
Teaching method(s):	**Associated module examination:**

Module 01-29-03 RSOC: Remote Sensing of Ocean and Cryosphere

Remote Sensing of Ocean and Cryosphere
MPO v. 05.04.2017

Module assignment:	**Recommended content-related requirements:**
• Specialization Areas / Physics for Space Observation	none

Learning content:

- Error analysis and statistics
- Techniques for the optimal solution of under and over determined systems of linear equations including methods for calculating variances and covariances of the solutions
- Concepts of resolution and methods to calculate them
- Practical examples and applications to test data sets from oceanography
- Image processing
- Atmospheric remote sensing

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

Students gain background knowledge in basics and application of remote sensing of sea ice extent and thickness, sea surface height, winds over the ocean, waves, ocean bottom, surface temperature and salinity, ocean color and other remote sensing applications for ocean and cryosphere.

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 2 semester hours.

Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, examples: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	**Module leader:**
English	Prof. Dr. Monika Rhein Prof. Dr. Astrid Bracher, Dr. Georg Heygster, Dr. Gunnar Spreen, Prof. Dr. Christian Haas, Prof. Dr. Ben Marzeion
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 17/18	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Prüfungsleistung	
Examination format: Announcement at the begin of the semester	Written/oral examination

Type of examination: Studienleistung	
Examination format:	Course performance: Successful assessment of exercise classes

Module courses

Course:	01-29-03-RSOC-V Vorlesung Remote Sensing of the Ocean and Cryosphere
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Rhein, Monika, Prof. Dr.
Teaching method(s):	**Associated module examination:**

Module 01-15-03 DIDS: Architekturen und Entwurfsmethodik integrierter digitaler Systeme
Architectures and Design Methodologies of Integrated Digital Systems
MPO 2013/2015/2017

Module assignment:	**Recommended content-related requirements:**
• Specialization Areas / Information Technologies for Space	none

Learning content:

- Design tools and abstractions levels
- Physical design: floorplanning and placement; routing and wire estimation; DRC and LVS
- Design-for-Test: scan-based design, boundary scan; BIST
- Test architectures for SoCs
- Test generation and error diagnosis: ATPG; fault simulation

Learning outcome / Competence:
The students will learn the design methodologies, theoretical algorithms, and tools used for the development of microelectronic integrated systems, as well as the strategies regarding their practical implementation with industrial CAD tools. The students will be able to implement a complex microelectronic integrated digital system guaranteeing its correctness and testability.

Calculating student workload:
The module comprises two courses: a lecture of 2 semester hours and an exercise of 1 semester hour.

- Contact hours (L + EC): 42 h (3 SWH x 14 weeks)
- Preparation, learning and exercises: 28 h (2 h/week x 14 weeks)
- Preparation for exam: 50 h

Total working hours: 120 h

Language of tuition:	**Module leader:**
English	Prof. Dr.-Ing. Alberto Garcia-Ortiz
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 13/14	-
Credit points / Workload:	**Contact hours:**
4 / 120 hours	3 hours

Module examinations

Type of examination: Modulprüfung	
Examination format:	Written or oral (90 respectively 30 min)
Module examination	

Module courses

Course:	01-15-03-DIDS-V Lecture Architectures and Design Methodologies of Integrated Digital Systems
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Garcia-Ortiz, Alberto, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Course:	01-15-03-DIDS-Ü Exercise Architectures and Design Methodologies of Integrated Digital Systems
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Garcia-Ortiz, Alberto, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Module 01-15-03 MiD: Microfluidic Devices

Microfluidic Devices

MPO 2013/2015

Module assignment:	Recommended content-related requirements:
• Specialization Areas / Information Technologies for Space	none

Learning content:

- Organisation, introduction, basics of microfluidics
- Flow control: valves and pumps
- Sensors and analysis in µfluidic devices
- Technology and packaging
- Design
- Examples of microfluidic devices

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

An overview is given of the developments in the area of microfluidic devices from the early start (where especially silicon integrated valves and pumps where investigated) to the lab-on-a-chip devices of today. The functionality of the sensors and actuators, the technologies applied, and the design of fluidic chips will be discussed. Some basic fluidics aspects will be presented and a practical (LÜ) in which COMSOL is used for the simulation of microfluidic elements is included. A series of examples of currently investigated microfluidic devices will be shown, e.g. chips for capillary electrophoresis, cytometry and optofluidics.

After this course, students are able to:

- understand the basics of microfluidics,
- understand and explain the functioning of µfluidic devices,
- apply characterization parameters for (elements of) µfluidic devices,
- understand fabrication technologies for microfluidic devices.

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 1 semester hour.

Workload:

- Contact hours : 42 h (3 SWH x 14 weeks)
- Preparation: 14 h (1 SWH x 14 weeks)
- Learning and exercises: 24h (2 h/week x 14 weeks)
- Preparation for exam: 40 h

Total working hours: 120 h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Michael Vellekoop
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]

The module is valid since: WiSe 13/14	**The module is valid until:** -
Credit points / Workload: 4 / 120 hours	**Contact hours:** 3 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Prüfungsleistung

Module courses

Course:	01-15-03-MiD-V Lecture: Microfluidic Devices
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Vellekoop, Michael, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Course:	01-15-03-MiD-Ü Exercise: Microfluidic Devices
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Vellekoop, Michael, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Module 01-15-03 RFC: RF Frontend Devices and Circuits

RF Frontend Devices and Circuits

MPO 2013/2015/2017

Module assignment:	**Recommended content-related requirements:**
• Specialization Areas / Information Technologies for Space	none

Learning content:

- Two-port circuits
- Noise in electronic circuits
- Fundamentals of non-linear devices
- RF devices & RF circuits and frontends

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

This course aims at teaching the fundamental working principles of analogue RF frontend devices and circuits that are the main building blocks of fixed and mobile devices for wireless communications (GSM, WLAN, UMTS, RFID, etc.) as well as for sensors like radar sensors.

After this course students should understand the basic principles of RF devices like amplifiers, mixers, oscillators, PLL's, and frequency synthesizers. The fundamentals of two-port circuits, electronic noise, and effects of non-linearities are addressed at first. Based on these theoretical parts students should be able to discuss the pros and cons of different RF frontend architectures and to design first basic analogue RF frontend circuits

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 42 h (3 h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 50 h

Total working hours: 120 h

Language of tuition:	**Module leader:**
English	Prof. Dr.-Ing. Martin Schneider
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 13/14	-
Credit points / Workload:	**Contact hours:**
4 / 120 hours	3 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Written exam 120 min.

Module courses

Course:	01-15-03-RFC-V Lecture: RF Frontend Devices and Circuits
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Schneider, Martin, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Course:	01-15-03-RFC-Ü Exercise: RF Frontend Devices and Circuits
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Schneider, Martin, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Module 01-29-03 PrSpa: Project
Project
MPO v. 05.04.2017

Module assignment:	**Recommended content-related requirements:**
• Project & Master's Thesis Space-ST	none

Learning content:
The content is related to the respective area of research of the individual project. The project is carried out in the laboratories of the Institute of Environmental Physics / Electrical Engineering / Alfred-Wegener-Institut or at a cooperating institute or entity under individual instruction (practical training).

Preparation of a report / dissertation on a possible research project, which - as a rule - should be closely related to the topic subsequent Master's Research Dissertation (Master Thesis).

Learning outcome / Competence:
The students should be able to:

- transfer a scientific problem/question into an experimental and/or theoretical study,
- develop successful strategies for the planning and conducting of scientific studies,
- be able to summarize and present preliminary scientific results in a thesis paper.

Calculating student workload:
Working hours: 360 h

Language of tuition:	**Module leader:**
English	Prof. Dr. John P. Burrows FRS Lecturers of Department 1 Physics/Electrical Engineering
Frequency:	**Duration:**
WiSe, SoSe	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 17/18	-
Credit points / Workload:	**Contact hours:**
12 / 360 hours	-

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	Successful assessment of the project

Module 01-29-03 ThsSpa: Masterarbeit (inkl. Kolloquium)

Master's Thesis

MPO 05.04.2017

Module assignment:	**Recommended content-related requirements:**
• Project & Master's Thesis Space-ST	Passing of all the mandatory exams of the module sections “Compulsory”, “Compulsory Elective” and the module “project”.

Learning content:

The students learn to:

- transfer a scientific problem/question into an experimental and/or theoretical study,
- develop successful strategies for the planning and conducting of scientific studies,
- conduct a critical evaluation, assessment and discussion of own scientific results,
- summarize and present scientific results in a thesis and in a colloquium.

Learning outcome / Competence:

The students are enabled to transfer a scientific problem/question into an experimental and/or theoretical study, to develop successful strategies for the planning and conducting of scientific studies and to summarize and present scientific results.

Calculating student workload:

Working hours: 900 h

Language of tuition:	**Module leader:**
English	N.N. Lectureres of Department 1 Physics/Electrical Engineering
Frequency: WiSe, SoSe	**Duration:** 1 semester[s]
The module is valid since: WiSe 17/18	**The module is valid until:** -
Credit points / Workload: 30 / 900 hours	**Contact hours:** -

Module examinations

Type of examination: Masterarbeit	
Examination format: Master Thesis, first examiner	1. Gutachter

Type of examination: Kolloquium	
Examination format: Colloquium	Kolloquium

Module 01-01-03 BGC: Biogeochemistry

Biogeochemistry
MPO v. 05.04.2017

Module assignment:	**Recommended content-related requirements:**
• Electives Space-ST	none

Learning content:

- Global biochemical cycles of elements
- Important biophysical processes in atmosphere and ocean
- Carbon, methane, nitrogen and water cycles
- Greenhouse gases

A list of references will be provided at the start of the semester.

Learning outcome / Competence:
Advanced biogeochemistry

Calculating student workload:
The module comprises two courses: a lecture of 1 semester hour and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 28 h (2 h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 34 h

Total working hours: 90 h

Language of tuition:	**Module leader:**
English	Dr. Annette Ladstätter-Weißenmayer
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 17/18	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Studienleistung	
Examination format:	Course performance: Successful assessment of example classes and/or successful writing of an essay

Type of examination: Prüfungsleistung	
Examination format: Announcement at the begin of the semester	Written/oral examination

Module 01-01-03 Dyn1: Dynamics I

Dynamics I

MPO 2014/2017

Module assignment:	Recommended content-related requirements:
• Electives Space-ST	none

Learning content:

- Governing equations
- Conservation laws
- Balances
- Circulation and vorticity
- Large-scale circulation
- Planetary boundary layer
- Rossby waves

References:

Holton: An Introduction to Dynamic Meterorology, Elsevier Academic Press
Marshall and Plumb: Atmosphere, Ocean, and Climate Dynamics, An
Wallace and Hobbs, Atmospheric Science: An Introductory Survey, Academic Press

Learning outcome / Competence:

Understanding of the basic dynamical processes in atmosphere and ocean.

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 2 semester hour.

Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr. Thomas Jung
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 14/15	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Prüfungsleistung	
Examination format: Announcement at the begin of the semester	Written/oral examination

Type of examination: Studienleistung	
Examination format: Announcement at the begin of the semester	Course performance: Successful assessment of example classes

Module courses

Course:	Exercise Dynamics I
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Jung, Thomas, Prof. Dr.
Teaching method(s): Tutorial	**Associated module examination:** Studienleistung

Course:	Lecture Dynamics I
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Jung, Thomas, Prof. Dr.
Teaching method(s): Lecture	**Associated module examination:** Prüfungsleistung

Module 01-29-03 Eng E: Engineering Ethics

Engineering Ethics
MPO v. 05.04.2017

Module assignment:	**Recommended content-related requirements:**
• Electives Space-ST	none

Learning content:

- Basic moral concepts
- Basic moral theories and values and their rationale
- Codes of Ethics (examples from Associations and Agencies)
- Case Studies from engineering
- Professional ideals, social and environmental responsibility

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

After the course the students will be able to

- discuss and apply professional codes of ethics;
- distinguish normative from descriptive judgements;
- describe basic norms, values and ethical theories;
- determine conditions of responsibility;
- apply norms and theories to concrete cases in engineering and identify ethical issues at different stages.

Calculating student workload:

The module comprises one course: a lecture of 1 semester hours and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 28 h (2 h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation of report and exam: 34 h

Total working hours: 90 h

Language of tuition:	**Module leader:**
English	Prof. Dr. Dagmar Borchers MA Björn Haferkamp
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 17/18	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Studienleistung	
Examination format: Announcement at the begin of the semester	Protokoll

Type of examination: Prüfungsleistung	
Examination format: Oral	Oral Examination

Module courses

Course:	01-29-03-EnE-V Lecture Engineering Ethics
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):**
Teaching method(s):	**Associated module examination:**

Module 01-15-03 InS: Integrierte Schaltungen (Integrated Circuits)

Integrated Circuits

MPO 2017

Module assignment:	**Recommended content-related requirements:**
• Electives Space-ST	Basics of electrical engineering and analog integrated circuits

Learning content:

- Noise
- gm/Id Method
- Mismatch
- Two-pole opamps (OTA)
- Feedback

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

After this course, students are able to:

- 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 modifiy circuit charateristics.

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 42 h (3 h x 14 weeks)
- Preparation, learning, exercises: 14 h (1 h x 14 weeks)
- Preparation for exam: 34 h

Total working hours: 90 h

Language of tuition:	**Module leader:**
English	Prof. Dr.-Ing. Steffen Paul
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 17/18	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	3 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Oral	Oral Examination (30 minutes)

Module courses

Course:	01-15-03-InS-V Lecture: Integrated Circuits
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Paul, Steffen, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Course:	01-15-03-InS-Ü Exercise: Integrated Circuits
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Paul, Steffen, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Module 04-M30-CEM-SFI-1: On-Board Data Handling

On-Board Data Handling
MPO 05.04.2017

Module assignment:	**Recommended content-related requirements:**
• Electives Space-ST	none

Learning content:

On-Board Data Handling (OBDH) includes all aspects from payload data processing to mission critical control tasks. The OBDH system can in principle be considered as an embedded system that is subject to strong requirements with respect to reliability and availability in harsh environments with minimal or no maintenance.

The lecture considers various aspects from general mission scenarios and their impact on the OBDH system, examples for typical architecture, techniques for Failure Detection Isolation and Recovery (FDIR) and approaches for guaranteeing functional correctness of the hardware and/or software. Relevant standards are introduced.

A coarse table of contents reads as follows:

- Mission scenarios and implications on the OBDH system
- Tasks for OBDH
- Standards for space applications
- Architectures for OBDH system considered as embedded systems
- Hardware and software solutions
- Functional correctness

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

The students should be able to explain typical scenarios for space missions, to understand and derive mission-specific requirements for the On-Board Data Handling (OBDH) system, to explain relevant standards, to explain and justify typical test approaches for OBDH systems, to understanding approaches for Failure Detection Isolation and Recovery (FDIR) and to have the ability to specify an OBDH system.

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 42 h (3 h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 20 h

Total working hours: 90 h

Language of tuition:	**Module leader:**
English	Dr. Frank Dannemann
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 17/18	-

Credit points / Workload:	**Contact hours:**
3 / 90 hours	3 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	Oral examination

Module courses

Course:	04-M30-CEM-SFI-1 On-Board Data Handling
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Dannemann, Frank, Dr.
Teaching method(s):	**Associated module examination:**

Module 01-01-03 PDAP: Practical Data Analysis with Python

Practical Data Analysis with Python
MPO 2014/2017

Module assignment:	**Recommended content-related requirements:**
• Electives Space-ST	none

Learning content:

The course will touch on the following subjects:

- "But this worked yesterday, before I made some changes ..." or: An introduction to version control.
- Getting started: How to setup your own computer for data analysis in Python.
- Hands-on introduction to the Python scientific ecosystem: Arrays and mathematical operations, using NumPy.
- Labeled arrays or how to intuitively work with data, using Pandas and xarray.
- Reading and writing data in common file formats.
- Making both meaningful and beautiful plots, using matplotlib.
- Statistical analysis in Python using the SciPy and Statsmodels packages.
- Parameter estimation / regression using SciPy.
- An overview of the most common special-topic libraries for the research areas covered by the students' study programmes.
- Working with geoscientific data and plotting maps, using Cartopy and Shapely.
- Other data analysis tasks needed by the students for their study program, upon demand.

References:

- VanderPlas, Jake: Python Data Science Handbook, O'Reilly, 2016 (freely available online at https://jakevdp.github.io/PythonDataScienceHandbook/)

Learning outcome / Competence:

Upon successful completion of this course, the student will be able to work with scientific data using the Python scientific programming ecosystem, including the whole scientific data lifecycle (reading data, statistical analysis, plotting, storing results), following modern scientific programming best practices (e.g., version control, reproducibility, documentation, …).

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 28 h (2 h x 14 weeks)
- Preparation, learning, exercises: 26 h (2 h x 13 weeks)
- Preparation for exam: 36 h

Total working hours: 90 h

Language of tuition:	**Module leader:**
German	Dr. Andreas HILBOLL
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]

The module is valid since: WiSe 16/17	The module is valid until: -
Credit points / Workload: 3 / 90 hours	**Contact hours:** 2 hours

Module examinations

Type of examination: Studienleistung	
Examination format:	Course performance: Successful assessment of example classes and/or successful writing of an essay

Type of examination: Prüfungsleistung	
Examination format: Seminar paper	Homework projects (graded)

Module courses

Course:	01-01-03-PDAP-V Lecture and Exercise: Practical Data Analysis with Python
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** HILBOLL, Andreas, Dr.
Teaching method(s):	**Associated module examination:**

Module 01-01-03 StEA: Statistics and Error Analysis

Statistics and Error Analysis
MPO 2014/2017

Module assignment:	Recommended content-related requirements:
• Electives Space-ST	none

Learning content:

- Random variables
- Probability
- Density and distribution functions
- Expectation values
- Covariance and correlation
- Error propagation
- Statistical tests

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

Introduction to statistics, error calculation and data analysis

Calculating student workload:

The module comprises two courses: a lecture of 1 semester hours and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 28 h (2 h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 34 h

Total working hours: 90 h

Language of tuition:	Module leader:
English	apl. Prof. Reiner Schlitzer
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 14/15	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Prüfungsleistung	
Examination format:	Written/oral examination
Announcement at the begin of the semester	

Type of examination: Studienleitung	
Examination format: Announcement at the begin of the semester	Course performance: Successful assessment of example classes and/or successful writing of an essay

Module courses

Course:	Exercise Statistics and Error Analysis
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Schlitzer, Reiner, apl. Prof.
Teaching method(s): Tutorial	**Associated module examination:** Studienleitung

Course:	Lecture Statistics and Error Analysis
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Schlitzer, Reiner, apl. Prof.
Teaching method(s): Lecture	**Associated module examination:** Prüfungsleistung

Module 01-15-03 WCom: Wireless Communications

Wireless Communications

MPO 2017

Module assignment:	Recommended content-related requirements:
• Electives Space-ST	Lecture "Communication Technologies", Basics of communications technologies, stochastic (digital) signal processing, system theory

Learning content:

- Mobile Radio Channels: Power Delay Profile, Doppler Spectrum, Jakes-Spectrum, Channel Modelling, Rayleigh-Fading/Rician Channels
- Multi-Carrier Transmission: Basics, Ambiguity-Function, F/T-Grid, Principles of CP-OFDM, Detectors for CP-OFDM, PAPR/Crest Factor, Out-of-Band radiation, LTE
- CDMA: Principles, spreading sequence design system models, Single-User Machted Filter Bank, Rake Receiver, Multi-User Detection (MF, LS, MMSE), Radio System principles
- MIMO: Principles and system model, spatial duplexing, BLAST

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

After this course, the students will have a basic knowledge on wireless communications with the ability to design modern communication systems. In particular, they should be able to:

- model mobile radio channels, apply their expertise to perform analysis of digital wireless transmission;
- apply knowledge on the design of modern solutions for mobiles (OFDM, CDMA, MIMO):
- combine existing Matlab-Modules for the simulation of mobile communication systems.

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 42 h (3 h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 20 h

Total working hours: 90 h

Language of tuition:	Module leader:
English	Prof.Dr.-Ing. Armin Dekorsy
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 17/18	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	3 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Written examination

Module courses

Course:	01-15-03-WCom-V Lecture Wireless Communications
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Dekorsy, Armin, Prof.Dr.-Ing.
Teaching method(s):	**Associated module examination:**

Course:	01-15-03-WCom-Ü Exercise Wireless Communications
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Dekorsy, Armin, Prof.Dr.-Ing.
Teaching method(s):	**Associated module examination:**