Universität Bremen

Modulhandbuch

for Space Sciences and Technologies "Space-ST" (MPO 2020)

This module guide details the contents of the master's programme Space-ST and the course of studies.

Druckdatum: 13.10.2021

Übersicht nach Modulgruppen

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 semesters 2 and 3.

3. Specialization Areas

Specialization Areas are: Physics for Space Observations (PSO) 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 area of choice is Physics for Space Observation (PSO).

3. 2. Information Technologies for Space

4. 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.

5. Project & Master's Thesis Space-ST

Alphabetische Modulliste

Modul AMMDA: Applied Mathematical Methods and Data Analysis

Applied Mathematical Methods and Data Analysis
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Foundations	keine

Lerninhalte:

The course lectures cover the theoretical basis of the following subject areas:

- 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)

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 Python programming language and how to use Python to solve real-world problems from the course's topic areas.

Lernergebnisse / Kompetenzen:

Basic knowledge in mathematical methods for data analysis and their application using the Python programming language

Workloadberechnung:

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

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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr. Mihalis Vrekoussis
Häufigkeit:	**Dauer:**
WiSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
WiSe 20/21	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
6 / 180 Stunden	4 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform:	Prüfungsleistung
Klausur	

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	01-01-03-AMMDA-V Applied Mathematical Methods and Data Analysis
Häufigkeit: WiSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch	**Dozent(en):** Vrekoussis, Mihalis, Prof. Dr.
Lehrform(en): Vorlesung mit Übung	**Zugeordnete Modulprüfung:** Modulprüfung

Modul 01-01-03 AtPhy: Atmospheric Physics

Atmospheric Physics

MPO 2020

Modulzuordnung:	Empfohlene inhaltliche Voraussetzungen:
• Foundations	keine

Lerninhalte:

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

Lernergebnisse / Kompetenzen:

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.

Workloadberechnung:

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

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

Unterrichtsprache(n):	Modulverantwortliche[r]:
Englisch	Prof. Dr. John P. Burrows
Häufigkeit:	**Dauer:**
WiSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
WiSe 20/21	-

ECTS-Punkte / Arbeitsaufwand:	**SWS:**
6 / 180 Stunden	4 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Klausur	Prüfungsleistung

Modul ComSp: Communication Technologies for Space

Communication Technologies for Space

MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Foundations	Basics in linear algebra, calculus, differential equations, fourier transformation and physics (basics in electromagnetic waves) are recommended.

Lerninhalte:

- 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

Lernergebnisse / Kompetenzen:

As outcome, the students should be able to:

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

Workloadberechnung:

The module comprises a lecture and an exercise of 2 credit hours each.

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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Dr.-Ing. Carsten Bockelmann
Häufigkeit:	**Dauer:**
WiSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
SoSe 20	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
6 / 180 Stunden	4 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Klausur	Prüfungsleistung (90 min.)

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	01-29-03-ComSp Communication Technologies for Space Lecture and Exercise
Häufigkeit: WiSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch	**Dozent(en):** Bockelmann, Carsten, Dr.-Ing.
Lehrform(en): Vorlesung mit Übung	**Zugeordnete Modulprüfung:** Modulprüfung

Modul 01-15-03 CTh1(a): Control Theory 1 / Regelungstheorie 1

Control Theory 1

MPO v. 04.12.2019

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Foundations	keine

Lerninhalte:

- 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

References:

- 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

Lernergebnisse / Kompetenzen:

- Understanding and handling of state space methodology
- Design of state space controllers with different methods
- Observer design

Workloadberechnung:

The module comprises lectures and exercises of 4 credit 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

Unterrichtsprache(n): Englisch / Deutsch	**Modulverantwortliche[r]:** Prof. Dr.-Ing. Kai Michels
Häufigkeit: WiSe	**Dauer:** 1 Semester
Modul gültig seit: SoSe 20	**Modul gültig bis:** -
ECTS-Punkte / Arbeitsaufwand: 6 / 180 Stunden	**SWS:** 4 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	Mündliche oder schriftliche Prüfung

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	01-15-03-CTh1-V Control Theory 1
Häufigkeit: WiSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch / Deutsch	**Dozent(en):** Michels, Kai, Prof. Dr.-Ing.
Lehrform(en): Vorlesung Übung	**Zugeordnete Modulprüfung:** Modulprüfung

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

Science and Exploration Missions
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Foundations	keine

Lerninhalte:

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.

Lernergebnisse / Kompetenzen:

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.

Workloadberechnung:

- 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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr. rer. nat. Claus Lämmerzahl
Häufigkeit:	**Dauer:**
WiSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
SoSe 20	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform:	Prüfungsleistung: Mündlich oder schriftlich
Bekanntgabe zu Beginn des Semesters	

Modul 01-29-03 SpEl(a): Space Electronics

Space Electronics

MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Foundations	Basic knowledge of semiconductors, analog and digital circuits

Lerninhalte:

- 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

Lernergebnisse / Kompetenzen:

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 radition-hard circuits.

Workloadberechnung:

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

Total working hours: 90 h

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr.-Ing. Alberto Garcia-Ortiz
Häufigkeit:	**Dauer:**
WiSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
SoSe 20	-

ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Klausur	Prüfungsleistung

Modul 01-01-03 AtSp: Atmospheric Spectroscopy
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Remote Sensing and Communication	keine

Lerninhalte:

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

Lernergebnisse / Kompetenzen:

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.

Workloadberechnung:

The module comprises a lecture and an exercise of 1 credit hour each.

- 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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr. rer.nat. Justus Notholt
Häufigkeit:	**Dauer:**
SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
WiSe 20/21	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform:	Prüfungsleistung
Bekanntgabe zu Beginn des Semesters	

Modul CNSp: Communication Networks for Space

Communication Networks for Space
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Remote Sensing and Communication	keine

Lerninhalte:
Introduction into communication networks. Internet protocols, Internet of things, wireless sensor networks, delay-tolerant networks, opportunistic networks. Space networks: types of spacecraft, orbits and paths, properties of space communication, types of data, quality-of-service requirements, space network architecture, protocols and bearer technologies for space networks, communication infrastructure of governmental and private space agencies.

References:

- J. Kurose/K. Ross: Computer Networking: A Top-Down Approach. 6th ed., Pearson Education, 2013.
- A. Förster: Wireless Sensor Networks. Wiley, 2016.
- J. Taylor: Deep Space Communications. Wiley, 2016.

Lernergebnisse / Kompetenzen:
The participants are able to describe exemplary systems of communication networks, know the basic design principles used for communication protocols on the different layers, can explain the special properties of space networks.

Workloadberechnung:

- 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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr. Anna Förster
Häufigkeit:	**Dauer:**
WiSe, SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
SoSe 20	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	3 Stunden

Modulprüfungen

Prüfungstyp: Kombinationsprüfung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	Successful assessment of homework assignments and a successful poster preparation and presentation (graded)

Modul 01-01-03 DIP: Digital Image Processing
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Remote Sensing and Communication	keine

Lerninhalte:

- Digital images, sampling
- Grey level transformations, color images
- Image enhancement using filters
- Image analysis methods using segmentation, feature extraction and classification
- Fourier transformation of digital images, linear filters in spatial and frequency domains
- Data compression, image coding, image formats

References:

- K. R. Castleman: Digital Image Processing. Prentice Hall, Englewood Cliffs, 1996.
- R. C. Gonzalez, R. E. Woods: Digital Image Processing. Addison-Wesley, Second Edition, 2002.
- B. Jähne: Digital Image Processing. Springer, 2002.
- J.C. Russ: The Image Processing Handbook, 5th Edision. CRC Press, 2006 (ISBN 0-8493-7254-2).
- R. A. Schowengerdt: Remote Sensing, Models and Methods for Image Processing. Academic Press, 1997.

Lernergebnisse / Kompetenzen:
Fundamentals, basic concept and methods of digital image processing, enabling the students to identify and understand image processing problems (encountered in Environmental Physics, Space Science etc.) and to find appropriate solutions

Workloadberechnung:
The module comprises a lecture of 1 semester hour and an exercise of 1 credit hour each.

- 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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Dr. Christian Melsheimer Prof. Dr. Grunnar Spreen
Häufigkeit:	**Dauer:**
SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
WiSe 20/21	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Kombinationsprüfung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	Oral examination and successful assessment of exercise courses

Modul 01-29-03 GG: Geodesy and Gravity

Geodesy and Gravity

MPO 2020

Modulzuordnung:	Empfohlene inhaltliche Voraussetzungen:
• Remote Sensing and Communication	keine

Lerninhalte:

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

Lernergebnisse / Kompetenzen:

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.

Workloadberechnung:

- Contact hours (lecture + integrated 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

Unterrichtsprache(n):	Modulverantwortliche[r]:
Englisch	Prof. Dr. rer. nat. Claus Lämmerzahl
Häufigkeit:	**Dauer:**
WiSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
SoSe 20	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	Written or oral examination

Modul GNSS: The Global Navigation Satellite System

The Global Navigation Satellite System
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Remote Sensing and Communication	keine

Lerninhalte:

Understanding of the working principles of global navigation satellite systems.

This consists on (i) the physical requirements regarding the main working principles. Here clocks, the electromagnetic signals propagation in the Earth's atmosphere, and the targeted accuracy are discussed. In the second step (ii) the theoretical analysis of the whole problem has to be carried through. This includes basic effects of the moving clocks (special relativistic time dilation) and clocks in gravitational fields (gravitational redshift) and the calculation of the position from the clock signals. Moreover, theoretical concepts within geodesy regarding reference surfaces and coordinate systems such as WGS84 will be introduced. In the third part (iii) the technological realization is described.

References:

- Werner Mansfeld: Satellitenortung und Navigation. Grundlagen, Wirkungsweisen und Anwendung globaler Satellitennavigationssysteme. Vieweg, Wiesbaden 2010.
- Manfred Bauer: Vermessung und Ortung mit Satelliten. Globale Navigationssysteme (GNSS) und andere satellitengestützte Navigationssysteme. Wichmann, Berlin 2011
- B. Hoffmann-Wellenhof, H. Lichtenegger, and J. Collins: GPS - Theory and Practice, (Springer, Wien and New York, 2001)

Lernergebnisse / Kompetenzen:

Knowledge in and understanding of

- the physical and theoretical principles of positioning,
- GNSS satellites, payload, clocks;
- the technology requirements.

Workloadberechnung:

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

Total working hours: 90

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr. rer. nat. Claus Lämmerzahl Dr. Dennis Philipp
Häufigkeit:	**Dauer:**
SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
-	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	Written or oral examination

Modul 01-15-03 SAMS(a): Sensors and Measurement Systems

Sensors and Measurement Systems

MPO v. 04.12.2019

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Remote Sensing and Communication	keine

Lerninhalte:

- 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

Lernergebnisse / Kompetenzen:

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,u
- understand micromachining technologies for sensors.

Workloadberechnung:

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

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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr.-Ing. Björn Lüssem
Häufigkeit:	**Dauer:**
SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
SoSe 20	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
6 / 180 Stunden	4 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Klausur	Prüfungsleistung

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	01-15-03-SAMS(a)-V Sensors and Measurement Systems
Häufigkeit: SoSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch	**Dozent(en):** Lüssem, Björn, Prof. Dr.-Ing.
Lehrform(en): Vorlesung Übung	**Zugeordnete Modulprüfung:** Modulprüfung

Modul LSpa1: Space Lab Part 1
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Remote Sensing and Communication	keine

Lerninhalte:
A set of practical measurements of meteorological quantities, atmospheric trace gases, ocean currents, environmental radioactivity, and absorption cross-sections using different techniques is performed by the students under supervision of tutors. The measurements obtained in the lab will then be analysed, and the experiment, its background and the results as well as their interpretation be documented in a written report.

Lernergebnisse / Kompetenzen:
Participants learn to perform measurements central to Space Sciences and Technologies using scientific techniques and methods. They learn to analyse the measurements and to document the results in a written report.

Workloadberechnung:
- Contact hours (lecture): 24 h (6 h x 4 weeks)
- Contact hours (lab): 12 h (6 h x 2 weeks)
- Preparation, reports: 24 h (2 x 12 weeks)
- Preparation for exam: 30h

Total working hours: 90 h

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Dr. Andreas Richter Dr. Christian Mertens
Häufigkeit:	**Dauer:**
SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
SoSe 20	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Kombinationsprüfung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	Examination performance: Oral examination and reports

Modul LSpa2: Space Lab Part 2
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Remote Sensing and Communication	keine

Lerninhalte:
Application of control basics, measurements of Embedded Systems and Communications.

Lernergebnisse / Kompetenzen:
Participants learn

- the basics of control and measurement techniques in Space Sciences and Technologies;
- the basic structure and concepts of communications systems for space;
- implementation and visualization of communications algorithms and concepts via Matlab or Python;
- performance measurements of communication protocols using a simulation tool.

Workloadberechnung:
The module comprises lectures and lab work.

- Contact hours: 28 h (2 h x 14 weeks)
- Reports: 42 h (3 x 14 weeks)
- Preparation: 20h

Total working hours: 90 h

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr.-Ing. Kai Michels Prof. Dr. Anna Förster, Prof. Dr. Armin Dekorsy
Häufigkeit:	**Dauer:**
WiSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
SoSe 20	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Portfolio	Successful conduct of experiments, reports thereof

Modul 01-16-03 CliS1: Climate System I
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Specialization Areas / Physics for Space Observation	keine

Lerninhalte:

- Climate on earth
- Climate variations
- The climate system
- Energy balance models
- Radiation & convection
- The role of the ocean in climate

Lernergebnisse / Kompetenzen:
Knowledge in and understanding of climate physics

Workloadberechnung:
The module comprises a lecture and an exercise of 1 credit hour each.

- 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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr. Torsten Kanzow
Häufigkeit:	**Dauer:**
SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
WiSe 20/21	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	3 Stunden

Modulprüfungen

Prüfungstyp: Kombinationsprüfung	
Prüfungsform: Kombinationsprüfung	Written examination and exercises

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

Remote Sensing of Ocean and Cryosphere

MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Specialization Areas / Physics for Space Observation	-

Lerninhalte:

- Concepts for satellite remote sensing of the ocean and cryosphere
- Microwave radar and radiometer observations of sea and land ice and of sea surface temperature and salinity
- Altimetry for sea surface height, circulation, sea level and ice thickness change
- Optical satellite data for ocean color and sea ice
- Error analysis and statistics
- Practical examples and applications to use satellite data sets from oceanography and cryosphere
- Satellite data processing

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

Lernergebnisse / Kompetenzen:

Students gain knowledge in basics and application of remote sensing of sea ice extent, type, drift and thickness, ice shelves and glaciers, sea surface height, winds over the ocean, waves, ocean color, surface temperature and salinity, sea level rise, ocean color and other remote sensing applications for ocean and cryosphere.

Workloadberechnung:

The module comprises a lecture and an exercise of 2 semester hours each.

- Attendance (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, examples: 56 h (4 h x 14 weeks)
- Preparation of reports: 68 h (17 h x 4 reports)

Total working hours: 180 h

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Dr. Gunnar SPREEN Dr., Prof. Dr. Astrid Bracher, Prof. Dr. Christian Haas, Dr. Mariana Soppa, Dr. Ilaria Stendardo
Häufigkeit:	**Dauer:**
SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
WiSe 17/18	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
6 / 180 Stunden	4 Stunden

Modulprüfungen

Prüfungstyp: Prüfungsleistung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	Course performance: Successful assessment of exercise reports

Prüfungstyp: Studienleistung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	Written examination by submitting reports

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	01-29-03 RSOC Remote Sensing of Ocean and Cryosphere
Häufigkeit: SoSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch	**Dozent(en):**
Lehrform(en):	**Zugeordnete Modulprüfung:**

Modul AtCM1(a): Atmospheric Chemistry Modelling: Part 1 (Theory)
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Specialization Areas / Physics for Space Observation	keine

Lerninhalte:

- 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
- Concepts of inverse modelling

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

Lernergebnisse / Kompetenzen:
Participants:

- 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.

Workloadberechnung:
The module comprises a lecture and an exercise of 1 credit hour each.
Workload:

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

Total working hours: 90 h

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr. Mihalis Vrekoussis Dr. Nikos Daskalakis + Dr. Alexander Poulidis
Häufigkeit:	**Dauer:**
WiSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
WiSe 20/21	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	Oral examination

Modul 01-15-03 BiM: BioMEMS

BioMEMS

MPO v. 04.12.2019

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Specialization Areas / Information Technologies for Space	keine

Lerninhalte:

- Organisation, introduction, basics of microfluidics and BioMEMS
- Flow control: valves and pumps
- Sensors and analysis in BioMEMS devices
- Technology and packaging
- Examples of BioMEMS devices
- Modeling and simulation of microfluidic structures

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

Lernergebnisse / Kompetenzen:

An overview is given of the developments in the area of microfluidic and BioMEMS devices from the early start (where especially silicon integrated valves and pumps were 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 in which COMSOL is used for the simulation of microfluidic elements is included. A series of examples of currently investigated BioMEMS 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 and BioMEMS devices,
- understand fabrication technologies for microfluidic and BioMEMS devices.

Workloadberechnung:

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

Workload:

- Contact hours: 56 h (4 h/week x 14 weeks)
- Preparation: 28 h (2 h/week x 14 weeks)
- Learning and exercises: 28 h (2 h/week x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr.-Ing. Michael Vellekoop
Häufigkeit:	**Dauer:**
SoSe	1 Semester

Modul gültig seit: SoSe 20	**Modul gültig bis:** -
ECTS-Punkte / Arbeitsaufwand: 6 / 180 Stunden	**SWS:** 4 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	Portfolio aus schriftlicher Prüfung und Simulationsaufgaben

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	01-15-03-BiM-V BioMEMS
Häufigkeit: SoSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch	**Dozent(en):** Vellekoop, Michael, Prof. Dr.-Ing.
Lehrform(en): Vorlesung Übung	**Zugeordnete Modulprüfung:** Modulprüfung

Modul 01-15-03 DiTe(a): Digital Technology

Digital Technology

MPO v. 04.12.2019

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Specialization Areas / Information Technologies for Space	keine

Lerninhalte:

- Timing strategies
- Non-programmable hardware modules
- Programmable hardware modules
- Selected algregraic and Boolean operations
- Introduction to digital coding

Lernergebnisse / Kompetenzen:

Die Studierenden

- erlernen spezielle Fähigkeiten zur Realisierung funktionsspezifischer digitaler, kombinatorischer und komplexer sequentieller Schaltungen;
- erwerben Grundwissen zur Realisierung digitaler Module;
- erlernen verschiedene Strategien für die Realisierung digitaler Module (z.B. Datenpfad+Steuerpfad, Synchron vs. Asynchron, Programmierbarkeit, …);
- beherrschen Entwurfs- und Analysemethoden von Schaltnetzen und Schaltwerken;
- erlernen spezielle Fähigkeiten zur Realisierung funktionsspezifischer digitaler Systeme.

Workloadberechnung:

The module comprises lecture and exercises of 2 credit hours each.

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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr.-Ing. Alberto Garcia-Ortiz
Häufigkeit:	**Dauer:**
WiSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
SoSe 20	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
6 / 180 Stunden	4 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Klausur	Prüfungsleistung

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	01-15-03-DiTe(a)-V Digital Technology
Häufigkeit: WiSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch	**Dozent(en):** Garcia-Ortiz, Alberto, Prof. Dr.-Ing.
Lehrform(en): Vorlesung mit Übung	**Zugeordnete Modulprüfung:** Modulprüfung

Modul 01-15-03 RFC(a): RF Frontend Devices and Circuits

RF Frontend Devices and Circuits
MPO v. 04.12.2019

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Specialization Areas / Information Technologies for Space	keine

Lerninhalte:

- Two-port circuits
- Noise in electronic circuits (thermal noise, noise figure, noise temperature, Friis formula, antenna noise, etc.)
- Fundamentals of non-linear devices (gain compression, desensitization, IP2, IP3 points, …)
- RF devices & RF circuits and frontends (amplifier, mixer, oscillator)

A list of references is given in the manuscript.

Lernergebnisse / Kompetenzen:

After successful completion of this module the students:

- can describe two-port circuits by matrices (Z, Y, ABCD, …)
- know the basic schematics of typical transmitter and receiver circuits
- can analyze the noise performance of receiver circuits
- can perform a signal and noise budget analysis of typical wireless communication links (microwave backhaul systems, mobile communications, satellite communications)
- can analyze the non-linear behavior of practical RF devices (amplifier, mixer)
- can design and analyze fundamental oscillator topologies
- are able to discuss the pros and cons of different RF frontend architectures and can design first basic analogue RF frontend circuits.

Workloadberechnung:

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

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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr.-Ing. Martin Schneider
Häufigkeit:	**Dauer:**
SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
SoSe 20	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
6 / 180 Stunden	4 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Klausur	Prüfungsleistung

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	01-15-03-RFC(a)-V RF Frontend Devices and Circuits
Häufigkeit: SoSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch	**Dozent(en):** Schneider, Martin, Prof. Dr.-Ing.
Lehrform(en): Vorlesung Übung	**Zugeordnete Modulprüfung:** Modulprüfung

Modul 01-01-03 BGC: Biogeochemistry
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Electives Space-ST	keine

Lerninhalte:

- 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.

Lernergebnisse / Kompetenzen:
Advanced biogeochemistry

Workloadberechnung:
The module comprises a lecture and an exercise of 1 credit hour each.

- 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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Dr. Annette Ladstätter-Weißenmayer
Häufigkeit:	**Dauer:**
SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
WiSe 20/21	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform:	Written or oral examination
Bekanntgabe zu Beginn des Semesters	

Modul 01-01-03 Dyn1: Dynamics I
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Electives Space-ST	keine

Lerninhalte:

- 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

Lernergebnisse / Kompetenzen:
Understanding of the basic dynamical processes in atmosphere and ocean; learning how to interpret physical equations physically

Workloadberechnung:
The module comprises a lecture and an exercise of 2 semester hours each.

- 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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr. Thomas Jung
Häufigkeit:	**Dauer:**
WiSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
WiSe 20/21	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
6 / 180 Stunden	4 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform:	Prüfungsleistung
Klausur	

Modul 01-01-03-CliM1: Climate Modelling: Part 1
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Electives Space-ST	No formal requirements

Lerninhalte:
Introduction to Climate Modelling
Types of Climate Models
Components of Atmosphere Ocean General Circulation Models (AO-GCMs)
Fundamentals and representation in GCMs: Radiation
Fundamentals and representation in GCMs: Dynamics of the Atmosphere
Fundamentals and representation in GCMs: Ocean and sea ice component
Fundamentals and representation in GCMs: Land component
Parametrizations in climate models
Steps in climate model formulation
Frequently Asked Questions IPCC Assessment Reports
Introduction to the ICON climate model
Computational exercises with the ICON model: running a climate model
Computation exercises in Python: plotting ICON model output

Lernergebnisse / Kompetenzen:
Overview how a climate model works and how to set up a climate model simulation (without covering all details); getting some first experience with running a climate model and plotting its output using python

Workloadberechnung:
- Contact hours (lecture and exercise): 28 h (block course 5 days)
- Preparation, learning + examples: 42 h
- Preparation for exam: 20 h

Total working hours: 90 h

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr. Veronika Eyring
Häufigkeit:	**Dauer:**
SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
WiSe 20/21	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	Written or oral examination

Modul 01-03-RingSp-V: Fascination Space

Fascination Space – On the scientific and practical use of astronautics
MPO v. 05.04.2017

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Electives Space-ST	None

Lerninhalte:

- Asteroids - impact risk and mitigation options
- What do satellites tell us about the earth climate?
- Glancing towards the edge of the universe: James Webb & Hubble
- Satellite geodesy
- Gravity waves in space
- Mathematics in space
- and others

The contents of this seminar series might be slightly adjusted in the course of the term.

Lernergebnisse / Kompetenzen:

The students will learn about science missions in space, in particular the science case, the mission scenario and the technological challenges. Furthermore, they gain an understanding of how certain aspects of space research are transferred into everyday life and practical use. And they will get an overview on past, current and future space missions.

Workloadberechnung:

Workload:

- Presence (L): 14 h (2 h x 7 weeks)
- follow-up and protocols: 21 h (2 h x 7 weeks)
- preparation of a seminar talk and an essay: 62 h

Total working hours: 90 h

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr. rer. nat. Claus Lämmerzahl PD Dr. rer. nat. Annette Ladstätter-Weißenmayer, Experts from the field of space research and applications serve as guest lecturers.
Häufigkeit: SoSe	**Dauer:** 1 Semester
Modul gültig seit: SoSe 18	**Modul gültig bis:** -
ECTS-Punkte / Arbeitsaufwand: 3 / 90 Stunden	**SWS:** 1 Stunden

Modulprüfungen

Prüfungstyp: Studienleistung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	follow-up and protocols

Prüfungstyp: Prüfungsleistung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	preparation of a seminar talk and an essay

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	01-03-RingSp-V Fascination Space - On the scientific and practical use of astronautics
Häufigkeit: SoSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch	**Dozent(en):**
Lehrform(en): Vorlesung	**Zugeordnete Modulprüfung:**

Modul 01-15-03 CCod(a): Channel Coding

Channel Coding
MPO v. 04.12.2019

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Electives Space-ST	Basics of Communication Technologies or equivalent

Lerninhalte:

- Information Theory
- Blockcodes
- Convolutional Codes
- Concatenated Codes

Lernergebnisse / Kompetenzen:

After this course, the students should be able to

- understand the fundamentals of information theory and the concept of channel coding;
- understand the fundamentals of block and convolutional codes;
- apply encoding and decoding algorithms;
- understand the concept of concatenated codes and iterative decoding.

Workloadberechnung:

The module comprises a lecture with exercises of 2 credit hours:

- Contact hours (lectures and exercises): 28 h (2 h x 14 weeks)
- Preparation, learning and exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 34 h

Total working hours: 90 h

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Dr.-Ing. Dirk Wübben
Häufigkeit:	**Dauer:**
SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
SoSe 20	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform:	Prüfungsleistung
Mündlich	

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	01-15-03-CCod(a)-V Channel Coding
Häufigkeit: SoSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch	**Dozent(en):** Wübben, Dirk, Dr.-Ing.
Lehrform(en): Vorlesung Übung	**Zugeordnete Modulprüfung:** Modulprüfung

Modul 01-15-03 InS(a): Integrated Circuits

Integrated Circuits
MPO v. 04.12.2019

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Electives Space-ST	keine

Lerninhalte:

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

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

Lernergebnisse / Kompetenzen:

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.

Workloadberechnung:

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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr.-Ing. Steffen Paul
Häufigkeit:	**Dauer:**
WiSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
SoSe 20	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
6 / 180 Stunden	4 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Klausur	Prüfungsleistung

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	01-15-03-InS(a)-V Integrated Circuits
Häufigkeit: WiSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch	**Dozent(en):** Paul, Steffen, Prof. Dr.-Ing.
Lehrform(en): Vorlesung Übung	**Zugeordnete Modulprüfung:** Modulprüfung

Modul 01-15-03 WCom(a): Wireless Communications

Wireless Communications

MPO v. 04.12.2019

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Electives Space-ST	Basics of Communication Technologies or equivalent

Lerninhalte:

- Stochastic description of Mobile Radio Channels
- Time/Frequency Diversity Techniques
- Multi-Carrier-Systems (Filterbank Modulated, OFDM)
- Code-Division-Multiple Access (e.g. DS-CDMA)

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

Lernergebnisse / Kompetenzen:

After this course, the students will be able to

- understand the fundamentals of mobile communication channels (Doppler-Spread, Delay-Spread, Angular-Spread, Frequency and time selectivity) as well as channel models (Rice/Rayleigh fading);
- explain the concept of communication diversity and related techniques;
- understand the principles of mapping information onto F/T-grids, to explain the ambiguity function, inter-carrier and inter-symbol-interference, to design multi-carrier-systems like OFDM, FBMC);
- understand the principle of separating signals in the code domain, to explain the design of (composite) spreading sequences, and to design CDMA receivers used in modern communication systems.

Workloadberechnung:

The module comprises a lecture, exercises and laboratory exercises of 4 credit hours:

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

Total working hours: 180h

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof.Dr.-Ing. Armin Dekorsy
Häufigkeit:	**Dauer:**
SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
SoSe 20	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
6 / 180 Stunden	4 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Klausur	Prüfungsleistung

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	01-15-03-WCom(a)-V Wireless Communications
Häufigkeit: SoSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch	**Dozent(en):** Dekorsy, Armin, Prof.Dr.-Ing.
Lehrform(en): Vorlesung Übung	**Zugeordnete Modulprüfung:** Modulprüfung

Modul 09-M52-03-01: Philosophy of Cosmology, Space and Space Travel

Philosophy of Cosmology, Space and Space Travel
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Electives Space-ST	None

Lerninhalte:
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?

Lernergebnisse / Kompetenzen:
• 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.

Workloadberechnung:
3 CP, 90 h

- presence (Lecture): 28 h (2 h x 14 weeks)

- (i) a short statement/report on the topic of each presentation and (ii) a presentation: 62 h

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr. rer. nat. Claus Lämmerzahl Prof. Dr. Dr. Norman Sieroka
Häufigkeit:	**Dauer:**
WiSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
-	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Kombinationsprüfung	
Prüfungsform: Kombinationsprüfung	(i) a short statement/report on the topic of each presentation and (ii) a presentation

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	09-M52-03-01 Philosophy of Cosmology, Space and Space Travel
Häufigkeit: WiSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch	**Dozent(en):**
Lehrform(en): Seminar	**Zugeordnete Modulprüfung:**

Modul SpTe: Space Telescopes
MPO 2020

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Electives Space-ST	Basic optics

Lerninhalte:

Introduction of completed and planned space telescope missions, payloads and instruments

Possible space telescopes to be discussed are (i) Hubble Space Telescope, (ii) James Webb Space Telescope, (iii) Telescopes searching for Exo-planets such as Kepler or PLATO (iv) X-Ray telescopes such as Chandra, XMMNewton and Athena (v) Gamma-Ray Telescopes such as Fermi and INTEGRAL (vi) CMB observatories such as Planck (vii) LISA for the observation of gravitational waves

The aim is to discuss for each Space Telescope

- the science objectives of the mission,
- the mission scenario and operational aspects,
- the design of the telescope and requirements driving the design,
- the instruments and the underlying technologies.

References:

- Max Born, Emil Wolf: Principles of Optics

Lernergebnisse / Kompetenzen:

- Understand the basic aspects of science cases for several space telescopes
- Learn about mission scenarios for completed, ongoing and planned space telescopes operating in various regions of the electromagnetic spectrum
- Learn about operation principles and technological aspects of space telescope payloads

Workloadberechnung:

- 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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr. rer. nat. Claus Lämmerzahl Dr. Sven Herrmann
Häufigkeit:	**Dauer:**
WiSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
SoSe 20	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	Written or oral eamination

Modul 01-29-03 Eng E: Engineering Ethics

Engineering Ethics
MPO v. 05.04.2017

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Electives Space-ST	keine

Lerninhalte:

- 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

Lernergebnisse / Kompetenzen:

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.

Workloadberechnung:

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: 28 h (2 h x 14 weeks)
- Preparation of report and exam: 34 h

Total working hours: 90 h

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Prof. Dr. Dagmar Borchers MA Björn Haferkamp
Häufigkeit:	**Dauer:**
SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
WiSe 17/18	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	2 Stunden

Modulprüfungen

Prüfungstyp: Studienleistung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	Protokoll

Prüfungstyp: Prüfungsleistung	
Prüfungsform: Mündlich	Oral Examination

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	01-29-03-EnE-V Lecture Engineering Ethics
Häufigkeit: SoSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch	**Dozent(en):**
Lehrform(en):	**Zugeordnete Modulprüfung:** Prüfungsleistung Studienleistung

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

On-Board Data Handling
MPO 05.04.2017

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Electives Space-ST	keine

Lerninhalte:

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.

Lernergebnisse / Kompetenzen:

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.

Workloadberechnung:

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

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	Dr. Frank Dannemann
Häufigkeit:	**Dauer:**
SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
WiSe 17/18	-

ECTS-Punkte / Arbeitsaufwand:	**SWS:**
3 / 90 Stunden	3 Stunden

Modulprüfungen

Prüfungstyp: Modulprüfung	
Prüfungsform: Bekanntgabe zu Beginn des Semesters	Oral examination

Lehrveranstaltungen des Moduls

Lehrveranstaltung:	04-M30-CEM-SFI-1 On-Board Data Handling
Häufigkeit: WiSe	**Gibt es parallele Veranstaltungen?** nein
Sprache: Englisch	**Dozent(en):** Dannemann, Frank, Dr.
Lehrform(en):	**Zugeordnete Modulprüfung:**

Modul 01-29-03 PrSpa: Project
MPO 2020

Modulzuordnung:	Empfohlene inhaltliche Voraussetzungen:
• Project & Master's Thesis Space-ST	keine

Lerninhalte:
The content is related to the respective area of research of the individual project. The project is an independent, autonomous, though supervised piece of scientific work. The project is carried out at the laboratories of the Institute of Environmental Physics / Electrical Engineering / Alfred-Wegener-Institute or at a cooperating institute or entity under individual instruction. The scientific investigations necessary for a research project are followed by the preparation of a written report. The topic of the project should - as a rule - be related to the topic of the subsequent Master's Research (Master Thesis).

Lernergebnisse / Kompetenzen:
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.

Workloadberechnung:
360 working hours

Unterrichtsprache(n):	Modulverantwortliche[r]:
Englisch	Prof. Dr. John P. Burrows Lecturers of Department 1 Physics/Electrical Engineering
Häufigkeit: WiSe, SoSe	**Dauer:** 1 Semester
Modul gültig seit: WiSe 20/21	**Modul gültig bis:** -
ECTS-Punkte / Arbeitsaufwand: 12 / 360 Stunden	**SWS:** -

Modulprüfungen

Prüfungstyp: Kombinationsprüfung	
Prüfungsform: Projektbericht	Written report and oral presentation thereof

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

Master's Thesis

MPO 05.04.2017

Modulzuordnung:	**Empfohlene inhaltliche Voraussetzungen:**
• Project & Master's Thesis Space-ST	Passing of all the mandatory exams of the module sections “Compulsory”, “Compulsory Elective” and the module “project”.

Lerninhalte:

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,
- conduct a critical evaluation, assessment and discussion of own scientific results,
- summarize and present scientific results in a thesis and in a colloquium.

Lernergebnisse / Kompetenzen:

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

Workloadberechnung:

Working hours: 900 h

Unterrichtsprache(n):	**Modulverantwortliche[r]:**
Englisch	N.N. Lectureres of Department 1 Physics/Electrical Engineering
Häufigkeit:	**Dauer:**
WiSe, SoSe	1 Semester
Modul gültig seit:	**Modul gültig bis:**
WiSe 17/18	-
ECTS-Punkte / Arbeitsaufwand:	**SWS:**
30 / 900 Stunden	-

Modulprüfungen

Prüfungstyp: Masterarbeit	
Prüfungsform: Abschlussarbeit	Written dissertation

Prüfungstyp: Kolloquium	
Prüfungsform: Kolloquium	Kolloquium