Modulhandbuch

Compilation of Modules

Master Engineering Science: Defence Systems

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Numerical Mathematics	Numerical Mathematics	4	Prof. Dr. Markus Bause	C in ESDS	74
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Protection Technologies, Security and Situational Awareness II: Surveillance	Protection Technologies, Security and Situational Awareness II: Surveillance	4	Prof. Dr.-Ing. Christian Kreischer	DST in ESDS	86
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				01.01.2024: WPF in M.Sc. Mech SSP AMW	
Statistical Thermodynamics	Statistical Thermodynamics	4	Prof. Dr.-Ing. Karsten Meier	CMD in ESDS	94
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Modul Active Sonar ET-43-AS

Active Sonar
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

PD Dr.-Ing. Thomas Fickenscher
Lehrbeauftragter: PhD Blair Bonnett

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Qualifikationsziel / Module Objectives and Competencies

Students will

- obtain a basic understanding of the principles of sonar imaging
- learn how to apply those principles for the design of underwater imaging systems
- develop competences in the use of acoustical imaging for mine hunting
- get practical experience in image processing supported by data-driven navigation

Inhalte / Content

1) Sound propagation through water
2) Transducer theory and arrays
3) Target properties
4) Basic image processing
5) Sidescan sonar
6) Synthetic aperture sonar
7) Navigation, trajectory errors and corrections
8) Interferometry (bathymetry)
9) Change detection

Modulbestandteile / Composition of Module

Module Part	Type Lecture L Execises E Laboratory Lab	Contact Hours per Week	AT/WT/ST
Sonar	L	2	AT
Sonar	E/Lab	1	AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture and especially exercises organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Fundamentals of elecxtromagnetics

Verwendbarkeit des Moduls / Usability of Module

WPF in M.Sc. INI + INT

EO in ESDS

Arbeitsaufwand / Work Load

	Weeks	Hours/Week	Hours Total
Lecture	12	2	24
Exercises	12	1	12
Preparation and follow-up	12	4	48
Preparation for Exam			36
Total			120

Prüfung und Benotung / Evaluation

Das Modul wird mit einer Klausur (120 Minuten) oder einer mündlichen Prüfung oder einer Projektarbeit beendet.

Dauer in Trimestern / Duration of Module

One Trimester (AT)

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Lawrence J. Ziomek: An Introduction to Sonar Systems Engineering, CRC Press, 2016
Set of slides available on platform ILIAS.

Sonstiges / Miscellaneous

Modul Advanced Numerical Mathematics AdvNumMath

Advanced Numerical Mathematics
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Markus Bause
Prof. Dr. Thomas Carraro

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carraro@hsu-hh.de +49 40 6541 3540

Qualifikationsziel / Module Objectives and Competencies

Participants learn to develop, implement and validate algorithms for the solution of boundary and initial-boundary value problems of partial differential equations that are often used to model engineering problems and phenomena in natural sciences. Hence, they obtain a key qualification to apply and develop simulation methods for technological processes. In particular, the participants acquire the capability to analyze the efficiency and accuracy of finite element simulations that are frequently applied in industrial development processes. As a side effect, they further deepen their knowledge of basic numerical methods as gained in the module on numerical mathematics.

Inhalte / Content

I. Finite element method for elliptic boundary value problems
a. Boundary value problems for elliptic differential equations
b. Weak form
c. Galerkin method
d. Stiffness, mass, and damping matrices
e. Construction of basis functions
f. Incorporation of boundary conditions
g. Variational crimes and accuracy issues
h. Practical issues
II. Iterative solver for large sparse systems
a. Convergence of iterative methods
b. Spectral radius of matrices
c. Jacobi and Gauss-Seidel iteration
d. Successive over-relaxation
e. Conjugate gradient method
f. Preconditioning

III. Discretization of parabolic problems
a. The heat equation
b. Spatially semi-discretized system
c. Time discretization by finite difference methods
d. Variational time discretization
IV. Discretization of hyperbolic problems
a. The wave equation
b. Spatially semi-discretized system
c. Time discretization by finite difference methods
d. Variational time discretization
V. Applications
VI. Implementation and usage of mathematical software

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT	Contact Hours per Week	AT/WT/ST

	Exercises E Lecture L Laboratory Lab		
Advanced Numerical Mathematics	L	2	ST
Advanced Numerical Mathematics	E/Lab	2	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Skills learned in Mathematics

Verwendbarkeit des Moduls / Usability of Module

HPC in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises/Lab	12	2	24
Preparation and follow-up	12	5	60
Preparation for exam			12
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 2

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

1. P. Knabner, L. Angermann, Numerical Methods for Elliptic and Parabolic Partial Differential Equations, Springer Berlin, 2003

2. C. Grossmann, H.G. Roos, M. Stynes, Numerical Treatment of Partial Differential Equations, Springer Berlin, 2007

3. A. Quarteroni, A. Valli, Numerical Approximation of Partial Differential Equations, Springer, 1994

Further course materials are provided by the lecturer.

Modul Advanced Technical Optics AdvTechOpt

Advanced Technical Optics
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Oleg Pronin

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oleg.pronin@hsu-hh.de / +49 40 6541 2756

Qualifikationsziel / Module Objectives and Competencies

Students will
• obtain a basic understanding how modern light detection and ranging systems work, what are the main modalities of
remote sensing
• obtain a basic knowledge about optical aberrations and will be able to design a simple microscope or telescope
• get an understanding of modern optical microscopy techniques and applications in soft and hard matter analysis

Inhalte / Content

1) Modern light detection and ranging systems (LIDARs) and remote sensing systems.
2) Advanced sensors and receivers.
3) Aberrations
4) Modern optical microscopy, imaging techniques and applications.

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Technical Optics	L	2	ST
Technical Optics	E/Lab	1	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Fundamentals of Electromagnetics

Verwendbarkeit des Moduls / Usability of Module

EO in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total

Lectures	12	2	24
Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

1 Trimester

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

E. Hecht: Optics, Addison-Wesley; Michael Bass, Virendra N. Mahajan - Handbook of Optics

Modul Aircraft Construction ES22AirCon

Aircraft Construction
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Rolf Lammering
Dr.-Ing. Markus Fischer

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Qualifikationsziel / Module Objectives and Competencies

Students are introduced to the fundamentals of flight physics, aircraft design and aircraft evaluation. They will learn design objectives, essential design criteria and design parameters that are prerequisites for aircraft design (fixed wing, civil or military use). In addition, they will learn to recognize basic interrelationships and modes of operation of essential aviation systems and major assemblies.

Inhalte / Content

Historical development of fixed-wing aircraft (civil and military use, underlying goals and design philosophies).

Principles of flight physics (aerodynamics, flight mechanics; masses, weights, and loads)

Flight performance (mission profiles, mission performance, flight envelope, point performance)

Aircraft configuration, airframe, aircraft systems, propulsion systems, integration aspects, structural and materials considerations

This fundamentals-oriented module is designed to provide students with basic knowledge and methods and tools of general aircraft design

Modulbestandteile / Composition of Module

Subject title	Type	Contact hours per week	CP		AT/WT/ST
Aircraft Construction	V	2	4	Compulsory Optional Subject	ST
Aircraft Construction	Ü	1	Compulsory Optional Subject	ST	

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture simultaneously for all students

Voraussetzungen für die Teilnahme / Requirements

Knowledge of mathematics (Bachelor level)

Basic knowledge in physics advantageous

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

	weeks	hours/week (HT/FT)	total hours	CP
lectures	12	2	24	
exercises	12	1	12	
preparation and wrap-up of the course	12	4,5	54	
exam preparation			30	
			120	4

**) optional: lecture with integrated lecture hall exercise

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

1 Trimester

Teilnehmer(innen)zahl / Number of Participants

max. 20

Anmeldeformalitäten / Registration

none

Literatur / Bibliographical References and Course Material

Literature references as well as exercise materials will be given during the lecture (by topic section).

Modul Ammunition and Weapon Technology AmWeapTech

Ammunition and Weapon Technology
Leistungspunkte / Credit Points: 8

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Martin Meywerk
Dr. T. Schmidt

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Qualifikationsziel / Module Objectives and Competencies

This module can be offered from spring term 2020

Inhalte / Content

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
	L	2	ST/AT
	E	1	ST/AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Knowledge of technical basics in mechanics, mechanical engineering, electrical engineering, electronics, of mathematics, materials technology in accordance with the mechanical engineering study program (BA)

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS (offered from ST 2020)

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours

			Total
Lectures	2x12	2	48
Exercises	2x12	1	24
Preparation and follow-up	2x12	5	120
Preparation for exam			48
Total			**240**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

Trimester 2, 3

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Notes will be distributed during the lecture; Recommended reading at the beginning of the lecture.

Modul Ballistics 1 Ballist1

Ballistics 1
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Studiendekan Engineering Science

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

carraro@hsu-hh.de
040/6541-3540

Qualifikationsziel / Module Objectives and Competencies

- Fundamentals of ballistics: internal ballistics, transitional ballistics, basics of external ballistics
- Ballistic calculations based on simplified models and tables
- Introduction to typical ballistics software
- Ability to educate soldiers; fundamental course ”Ballistics”

Inhalte / Content

- Internal ballistics: pyro statics and pyro dynamics
- Transitional ballistics: gas pressure aftereffect, static and dynamic gun barrel deformation, effects on hit probability
- External ballistics I: classic orbital models, numerical and table based calculations
- practical exercise under test site/ laboratory conditions, practical metrology

Modulbestandteile / Composition of Module

Lecture-Titel	LV-Art	TWS	Compulsory (C) or elective (E)	HT/WT/FT
Ballistics 1	L	2	E	FT
Ballistics 1	E	1	E	FT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Auditorium based lecture and exercise:

- Digital presentation with computer and projector
- Explanations and discussions on the board

Exercise:

- Autonomous work of the students
- Programming exercise in the computer pool
- Practical exercise in test sites , shooting ranges or military training area
- In general intense communication between students and tutors

Voraussetzungen für die Teilnahme / Requirements

none

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.
The intended examination type will be announced no later than the first lecture of the course.

Dauer in Trimestern / Duration of Module

1 Trimester

Teilnehmer(innen)zahl / Number of Participants

In general unlimited, possible limitation due to capabilities of computer rooms or practical exercises.

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

- Lecture notes with additional references
- Cranz, Carl Julius: Handbook of ballistics; translated from the second German edition; London, H.M. Stat. Off. 1921
  - Vol. 1. Cranz, C. and Becker, D. Exterior ballistics, being a theoretical examination of the motion of the projectile from the muzzle to the target
  - Vol. 2. pt. 1-2. Interior ballistics. The motion of the projectile through the barrel and attendant phenomena
  - Vol. 3. pt. 1-2. Experimental ballistics or theory of methods of measurement, observation and recording in ballistics. 2d ed. (1927)
- Brynk, A. ; Interior Ballistics, Vol. 1: Properties of Powders and Their Action in Closed Chambers and in Cannon (Reprint); Forgotten Books 2018
- McCoy, Robert L. : Modern Exterior Ballistics the Launch and Flight Dynamics of Symmetric Projectiles; Schiffer Pub Ltd; 2009
- Carlucci, Donald E.; Jacobson , Sidney S.; Ballistics: Theory and Design of Guns and Ammunition; CRC Press; 2018

Modul Ballistics 2 Ballist2

Ballistics 2
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Studiendekan Engineering Science

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carraro@hsu-hh.de
040/6541-3540

Qualifikationsziel / Module Objectives and Competencies

- Fundamentals of ballistics: advanced external ballistics, terminal ballistics
- Introduction to dynamics simulation software
- Orbital and impact calculations based on analytical and numerical models
- Ability to educate soldiers; extension of fundamental course ”Ballistics”

Inhalte / Content

- External ballistics II: atmosphere models, weather reports, fault calculation, STANAG 4355
- Rocket ballistics: drives, guided and unguided rockets, motion equations, target tracking
- Terminal ballistics: punch through metal and concrete, intrusion into earth
- Unconventional weapons: hypervelocity accelerators, electro-thermal / chemical guns, electromagnetic guns, railguns
- Hit probability
- Introduction to ballistics and dynamics simulation software, practical class in the computer pool
- practical shooting exercise under test site/ laboratory conditions,
- practical metrology

Modulbestandteile / Composition of Module

Lecture-Titel	LV-Art	TWS	Compulsory (C) or elective (E)	HT/WT/FT
Ballistics 2	L	2	E	HT
Balistics 2	E	1	E	HT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Auditorium based lecture and exercise:

- Digital presentation with computer and projector
- Explanations and discussions on the board

Exercise:

- Autonomous work of the students
- Programming exercise in the computer pool
- Practical exercises in test sites shooting ranges or military training area
- In general intense communication between students and tutors

Voraussetzungen für die Teilnahme / Requirements

none

Verwendbarkeit des Moduls / Usability of Module

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral. The intended examination type will be announced no later than the first lecture of the course.

Dauer in Trimestern / Duration of Module

1 Trimester

Teilnehmer(innen)zahl / Number of Participants

In general unlimited, possible limit due to capabilities of computer rooms or practical exercises.

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

- Lecture notes with additional references
- Cranz, Carl Julius: Handbook of ballistics; translated from the second German edition; London, H.M. Stat. Off. 1921
  - Vol. 1. Cranz, C. and Becker, D. Exterior ballistics, being a theoretical examination of the motion of the projectile from the muzzle to the target
  - Vol. 3. pt. 1-2. Experimental ballistics or theory of methods of measurement, observation and recording in ballistics. 2d ed. (1927)
- McCoy, Robert L. : Modern Exterior Ballistics the Launch and Flight Dynamics of Symmetric Projectiles; Schiffer Pub Ltd; 2009
- Rosenberg, Zvi ; Dekel, Erez : Terminal Ballistics, Springer; 2012

Modul Biomechanics of Military Related Effects ES21Biom

Biomechanics of Military Related Effects
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

OTL Dr. Steffen Grobert
Prof. Dr. S. Peldschus (Ludwigs-Maximilians-Universität München)
Prof. Dr.-Ing Bernd Niemeyer

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Qualifikationsziel / Module Objectives and Competencies

- Knowledge and ability to reproduce fundamental mechanics of the human body
- Understanding of short-term dynamic injury mechanics
- Knowledge of state-of-the-art injury risk analysis methods
- Understanding the causation of military related trauma
- Knowledge on basic principles of protection and injury mitigation
- Ability to plan studies/analyses on the effectiveness of protection systems and weapon systems
- Ability to recognise major risks in soldier training and mission

Inhalte / Content

1. Fundamentals of Trauma Biomechanics

- Mechanics, Biology, Medicine (role of interdisciplinarity)
- Injury criterias (application and limitations)
- Test procedures and dummys (basics)
- Accident reconstructions (methodic)
- Experimental investigations (basics)
- Simulation (finite element models, injury risk analyses)
- Injuries and injurie mechanisms (entities, life threatening injuries)

2. Military Related Effects

- Fundamentals of wound ballistics
- Fundamentals of blast effects (materials, human tissue)
- Short-term dynamic blunt and penetrating trauma (pathophysiological aspects and clinical implications)
- Blast trauma (pathophysiological aspects and clinical implications)
- International test procedures for ballistic protective equipment
- Experimental investigations on ballistics and blast (basics)
- Occupational safety in training and on mission (blast)
- International state of research

Modulbestandteile / Composition of Module

LV-Titel	LV-Art	TWS	HT/FT/WT
Biomechanics of Military Related Effects	L	2	WT
Biomechanics of Military Related Effects	E	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Auditorium based lectures (powerpoint)

Verwendbarkeit des Moduls / Usability of Module

EPS in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

	Wochen	Std./Woche	Std. insgesamt
Lecture	12	2	24
Exercise	12	1	12
Home works	12	2	24
Preparation and follow-up	12	3	36
Preparation for the exam			24
Total:			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

One trimester (trimester 1)

Teilnehmer(innen)zahl / Number of Participants

Unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Set of slides will be handed to the participants.

Modul CBRN CBRN
CBRN
Leistungspunkte / Credit Points: 8

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing Bernd Niemeyer

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Qualifikationsziel / Module Objectives and Competencies

Participants are able to understand:
- the basics on chemistry, biology, as well as radiation,
- protection, detection, and decontamination of CBRN events,
- risk assessment, and risk management,
- Treaties, and agreements between countries and also international organizations.

With this fundamental information, they basically can contribute to counteract CBRN threats.

Inhalte / Content

A) Chemistry

Based on the Chemistry knowledge of the BA studies, we teach the fundamentals of Chemical warfare agents.

B) Biology

1) Biochemistry (amino acids, proteins)
2) Cells (structures, compartments, surface)
3) Microorganisms and viruses
4) Biological warfare agents

C) Radiation

1) Origin and types of radiation
2) Effects of radiation
3) Radio nuclear attacks

D) Threat of CBRN weapons

1) Protection measures (against C-, B-, R-, N-threats)
2) Detection methods (of C-, B-, R-, N-risks)
3) Decontamination procedures methods (after C-, B-, R-, N-attacks)

E) Risk assessment and risk management

F) Actual treaties and agreements between countries, and their association

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
CBRN	L	2	ST/AT
CBRN	E	1	ST/AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture with exercises in small groups accompanied including some guided basic laboratory practical exercises. Video images complete teaching tool-box.

The lecture can be offered as a block-lecture.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	-

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	2x12	2	48
Preparation and follow-up	2x12	2	48
Exercises	2x12	1	24
Exercises preparation and follow-up	2x12	2,5	60
Preparation for exam			60
Total			**240**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

Trimester 2,3

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Richardt, B. Hülseweh, B. Niemeyer, F. Sabath (eds.); *CBRN Protection, Managing the Threat of Chemical, Biological, Radioactive and Nuclear Weapons,* VCH-Wiley, Weinheim, FRG,

Modul Computational Design of Surfaces and Interfaces CompDes

Computational Design of Surfaces and Interfaces
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Thomas Klassen
Prof. Dr. Denis Kramer

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

klassen@hsu-hh.de +49 40 6541 3617

Qualifikationsziel / Module Objectives and Competencies

Participants will gain skills in modelling surfaces and interfaces to elucidate basic processes occurring in functional engineering materials.

Inhalte / Content

Introduction to modelling of surfaces and interfaces
Major simulation approaches for surface and interface related phenomena (MD, Phase-Fields)
Implementation of electronic and atomistic phenomena (e.g. DFT)
Elemental transport processes (diffusion, migration, convection)
Chemical and electrochemical interactions (basics)
Physical vs. functional properties
Modelling shear across interfaces
Complexity issues

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Computational Design of Surfaces and Interfaces	L	2	WT
Computational Design of Surfaces and Interfaces	E/Lab	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Skills learned in Mathematics

Verwendbarkeit des Moduls / Usability of Module

CMD in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 4

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Script with slides and screen shots

Modul Computational Electromagnetics CompElecma

Computational Electromagnetics
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Marcus Stiemer

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

m.stiemer@hsu-hh.de +49 40 6541 2769

Qualifikationsziel / Module Objectives and Competencies

The students learn to develop and implement numerical simulation methods to solve electromagnetic field problems by their own hands. Further, they will be educated to solve practically relevant problems in electrical engineering with the help of numerical simulations.

Inhalte / Content

The course focuses on the implementation of different mathematical models of the electromagnetic field theory within the context of efficient numerical discretization methods such as, e.g., the boundary element method or the finite element method. Practical exercises will guide the students to finding solutions by numerical simulation. A selection of several subjects from the following list will be discussed:
- Numerical determination of the electrical scalar potential for planar, axisymmetric, or three-dimensional structures,
- Visualization of computed electromagnetic fields, derivation of related physical quantities,
- Treatment of nonlinear material behaviour,
- Computation of eigenmodes in wave guides,
- Simulation of relaxation problems for capacitive fields,
- Computation of static magnetic fields,
- Implementation of the eddy current equation, numerical solution of induction problems
- Thermo-electromagnetic coupling
- Mechanically electrically coupled problems
- Simulation of the propagation of electromagnetic waves
- Simulation methods in antenna theory

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Computational Electromagnetics	L	2	AT
Computational Electromagnetics	E/Lab	2	AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Skills learned in Mathematics

Verwendbarkeit des Moduls / Usability of Module

HPC in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises/Lab	12	2	24
Preparation and follow-up	12	4	48
Preparation for exam			24
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 3

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Bibliographical references and course materials are provided by the instructor.

Modul Computational Fluid Dynamics CompFluDyn

Computational Fluid Dynamics
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing, Michael Breuer

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

breuer@hsu-hh.de +49 40 6541 2724

Qualifikationsziel / Module Objectives and Competencies

Participants of the course on Computational Fluid Dynamics (CFD) will:

- get an introduction into CFD, its motivation and objectives
- learn step by step the different steps required to solve a fluid mechanical problem based on CFD
- gain a deep understanding of basic discretization methods in space and time
- learn important basic properties on finite approximations used in commercial and in-house CFD codes
- understand how large systems of equations are efficiently solved in CFD applications
- understand how the Navier-Stokes equations for incompressible fluids are solved
- get an introduction into high-performance computing techniques (vectorization and parallelization) and their applications in CFD
- solve fluid mechanical problems based on CFD codes

Inhalte / Content

1. Introduction and motivation for Computational Fluid Dynamics (CFD)
2. Finite-difference method (classical and compact schemes)
3. Finite-volume method (principle, approximation of volume and surface integrals, approximation of fluxes)
4. Time discretization methods
5. Properties of finite approximations: Consistency, stability, convergence)
6. Solution methods for linear systems of equations (direct and iterative solvers)
7. Solution methodologies for the Navier-Stokes equations of incompressible fluids
8. Numerical grids and their properties
9. High-performance computing techniques: vectorization and parallelization

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Computational Fluid Dynamics	L	2	ST
Computational Fluid Dynamics	E/Lab	1	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

The lecture is supported by additional hands-on exercises, in which the students have to write small programs on their own in order to apply the solution schemes in practice. Furthermore, commercial and in-

house CFD codes are applied to practical applications. The idea is to get a deep understanding how CFD codes work and which issues are important to achieve reliable results out of the CFD predictions.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Skills learned in Mathematics

Verwendbarkeit des Moduls / Usability of Module

HPC in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

One Trimester

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

- Detailed lecture notes are available in German:
  M. Breuer, Numerische Strömungsmechanik, Vorlesungsskript, Professur für Strömungsmechanik, HSU Hamburg.
- Ferziger, J.H., Peric, M., Computational Methods for Fluid Dynamics, ISBN 978-3-540-42074-3, Springer Berlin Heidelberg New York, 2002. German Version on Springer-Link: link.springer.com/

- A list of further appropriate books will be provided on the Ilias platform under https://ilias.hsu-hh.de (> Professur für Strömungsmechanik > Computational Fluid Dynamics)
- Furthermore, additional material (slides and exercises) will also be made available on Ilias.

Modul Computer-Aided Simulation in Ballistics ES22CASB

Computer-Aided Simulation in Ballistics
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Kramer,
Dr. Marina Seidl,
Dr. Roman Wölbing

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d.kramer@hsu-hh.de
marina.seidl@isl.eu
roman.woelbing@isl.eu

Qualifikationsziel / Module Objectives and Competencies

- to build an understanding of numerical simulation methods for internal, transitional, external and terminal ballistics
- to learn the underlying mathematics and physics
- to understand the general capabilities, limitations and computational costs of the models
- to familiarize with the concepts by practical exercise

Inhalte / Content

- discretization methods
- fluid dynamics based on the finite volume approach
- reactive flows for internal and transitional ballistics
- fluid structure interaction for external ballistics
- element and particle based methods for terminal ballistics
- projectile-target contact for low, medium, high and hyper velocity impact

Modulbestandteile / Composition of Module

LV-Titel	LV-Art	TWS	HT/FT/WT
Computer-Aided Simulation in Ballistics	L	2	FT
Computer-Aided Simulation in Ballistics	E	1	FT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

- auditorium based lecture (powerpoint)
- exercises individual or in small groups (depending on availability of computers)

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

	Wochen	Std./Woche	Std. insgesamt

Lecture	12	2	24
Exercise	12	1	12
Home works	12	2	24
Preparation and follow-up	12	2,5	30
Preparation for the exam			30
Total:			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

one trimester (trimester 2)

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

- lecture notes with additional references
- Toro, Eleuterio F.: Riemann Solvers and Numerical Methods for Fluid Dynamics; 3rd ed., Berlin, Springer (2006)
- Meyers M. A., Dynamic behaviour of materials, Canada, Wiley (1994)
- Rosenberg Z. and Dekel E., Terminal Ballistics, 3rd ed. Springer (2020)

Modul Continuum Mechanics ContMech

Continuum Mechanics
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Rolf Lammering

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

rolf.lammering@hsu-hh.de + 49 40 6541 2734

Qualifikationsziel / Module Objectives and Competencies

On completion of this course, the participants are able to use the methods of continuum mechanics as a basis for computational analysis of mechanical structures. They know different types of material behavior and the methods of constitutive description. Finally, they know how to classify complex mechanical problems and to select adjusted solution strategies.

Inhalte / Content

- Kinematics
- Stress
- Balance principles
- Constitutive theory
- Linearization
- Variational principles

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Continuum Mechanics	L	2	WT
Continuum Mechanics	E/Lab	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Skills learned in Mathematics

Verwendbarkeit des Moduls / Usability of Module

CMD in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24

Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 1

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

- G. A. Holzapfel, Nonlinear Solid Mechanics. Wiley, 2001.
- L.E. Malvern, Introduction to the Mechanics of a Continuous Medium. Englewood Cliffs, 1969.
- K. D. Hjelmstad, Fundamentals of Structural Mechanics, Springer, 2005.

Modul Corrosion and Corrosion Protection CorrProt

Corrosion and Corrosion Protection
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Th. Böllinghaus

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Thomas.Boellinghaus@bam.de +49 30 8104 1020

Qualifikationsziel / Module Objectives and Competencies

At present, economic losses affiliated to damages and failures related to corrosion amount to about five percent of the GDP in almost all highly industrialized countries. Meanwhile, several countries have established programs for corrosion protection, not only for technical infrastructure preservation. Such programs particularly account to military forces aimed to maintain highest possible operational readiness. The US-DoD currently represents the leading governmental organization in the field with its Corrosion Protection Program (CPC) that succeeded in decreasing the totally more than 20 billion US-$ economic losses caused by corrosion by about 10 %. Only in the German Navy, the corrosion related costs are quantified to more than 70 Mio €. At such background, it is an inherent wish of the German federal armed forces and other governmental authorities to intensify the corrosion and corrosion protection education, especially within the frame of the engineering sciences at HSU.
Precisely at this point the module Corrosion and Corrosion Protection makes a start. To cover above mentioned needs, the current optional lecture at the Faculty for Mechanical Engineering with 1 TWS has thus been extended to a complete mandatory elective module 2V/1Ü with 3 TWS. Counteracting increasingly abandoned teaching and research in corrosion, this course might increase the attractiveness and visibility of the HSU for students also beyond the needs of the German Federal Armed Forces. As another benefit for students, the module just classically provides a high synergy between teaching with already established and further extended corrosion research at HSU in clearly application-oriented fields, like the oil and gas industry as well as marine technologies. Most recent spectacular and very sudden failure cases of technical infrastructure caused by corrosion cracking are addressed to elucidate the safety-relevant aspects of corrosion prevention. By such examples, the relevance of specific knowledge about corrosion phenomena to many other engineering disciplines beyond defense technology will be made obvious for the students. This also accounts to modern industrial branches like renewable energy systems exposed to harsh environments, like in geothermal power, offshore wind turbines and solar energy. In view of future needs, the corrosion resistance of additive manufactured components versus conventionally produced or tailored components will be addressed. Since corrosion resistance and protection become increasingly important for the early design stages, the module will also be open to MSc students in Product Development and Logistics.

The students will

- realize the economic and military importance of corrosion and its prevention with respect to sustainability, operational readiness and safety of technical products
- understand the interdisciplinarity of the subject with respect to the various engineering disciplines, various industrial branches and the product life cycle
- get acquainted to the most important basics of electro-chemical and chemical corrosion
- be able to identify corrosion systems and their influencing factors
- be able to distinguish the various phenomena and types of corrosion
- understand the interaction between passivity and local corrosion of materials, in particular with respect to additive and weld manufacturing
- get deeper insight into the transition from local corrosion to corrosion cracking and their effects on the life time of technical products
- get used to the application of basic corrosion tests
- be able to draw basic relations between the corrosion of metals versus other classes of materials
- get known to the various corrosion protection measures.

Inhalte / Content

The module covers well established lecturing in the field of Corrosion and Corrosion Protection in conjunction with additional subjects related to military applications and exposure of technical products to harsh environments. The lectures are at least partly aligned to other international lectures, like at the academies of the US forces. The content is focused on the Corrosion and Corrosion Protection of metals with a special emphasis on steels. Relations to other classes of materials and their corrosion and degradation behavior will be covered where needed and possible.
The various lectures (12 x 2 TWS) comprise:

- Terms and definitions, economic and military importance of corrosion and its avoidance
- Electro-chemical and chemical basics of corrosion for engineers: Thermodynamics, kinetics, Faraday´s Law, Nernst Equation, Pourbaix diagrams, Tafel slopes
- Overview of various corrosion phenomena and relation to the various types of corrosion
- General corrosion: Atmosphere, soil, water
- Passivity and passive layer destruction
- Selective and galvanic corrosion
- Pitting and crevice corrosion
- Types of corrosion cracking: Corrosion coupled to mechanical load
- Corrosion associated with hydrogen absorption
- Transition from local corrosion to corrosion cracking
- Tribo- and erosion corrosion
- High temperature corrosion
- Product life cycle in corrosive environments I: Corrosion related design and long term behavior of technical components in aggressive media
- Product life cycle in corrosive environments II: Production, effects of additive versus conventional production, tailoring
- Corrosion protection: Surface treatment, anorganic and organic coatings, metallic and non-metallic coatings, active electro-chemical corrosion protection, cathodic protection, treatment of media
- Analytical and numerical procedures for modelling and simulation of corrosion effects and for long term behavior and exposure of technical components to corrosive environments

The respective practices (12 x 1 TWS) are devoted to the various corrosion test procedures and to corrosion protection.

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Corrosion and Corrosion protection	L	2	ST
Corrosion and Corrosion protection	E	1	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Frontal lectures as well as laboratory practice. Partially, the lectures might be presented by invited external experts with long term practice in the field. The ppt presentations might contain videos and animations.
If the number of participants exceeds a certain limit, the practices will be organized in parallel sessions.
The lectures and practices will offer opportunities for own contributions by the students. Opportunities for excursions will be provided, as for instance to the >Marineunterstützungskommando<.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Basic knowledge, as for instance from the BSc studies,

		in materials engineering, production technologies or design is helpful, but is not a mandatory requirement.

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

1 Trimester

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

The contents of the lectures will be provided as ppt which be provided via the lectures. Further literature will be introduced during the lectures, as for instance
ASM-Handbook: Corrrosion,
Kaesche: Corrosion of Metals,
Uhlig: Corrosion Handbook etc.

Modul Design and Assessment of Protective Structures ES23DAPS

Design and Assessment of Protective Structures
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Max Gündel

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

max.guendel@hsu-hh.de 040 6541-3960

Qualifikationsziel / Module Objectives and Competencies

Students, who have successfully completed the course, are able to design and to assess indecently structural members and buildings structures subjected to high dynamic actions like blast waves and impact loads. This includes knowledge about methods of risk analysis, modes of actions and the structural response of elements under these loads. In addition, students learn basics about blasting of civil and building structures in combat and for deconstruction.

Inhalte / Content

- risk analysis
- types and effects of blast loadings (detonation, deflagration, nuclear, internal, external, contact detonation)
- types and effects of impact loadings (bullets, missiles, vehicles, aircrafts)
- material behaviour under high dynamic loading (strain rate effects, ductility, concrete, steel, masonry)
- member design against high dynamic loadings (walls, floors, columns, interaction between elements)
- structural concepts for exceptional loadings (robustness, alternate load path, key element method)
- blasting of structures (blasting in combat, blast demolition of civil structures)
- requirements from authorities for construction in Germany and foreign countries (civil and military standards)

Modulbestandteile / Composition of Module

LV-Titel	LV-Art	TWS	HT/FT/WT
Design and Assessment of Protective Structures	L	2	AT
Design and Assessment of Protective Structures	E	1	AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

The content of the course is imparted by lectures, exercises (presented by lecturer and solved indecently under supervision) and homework. Lectures are provided for all students at the same time; exercises are provided in small groups.

Verwendbarkeit des Moduls / Usability of Module

EPS in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

	Wochen	Std./Woche	Std. insgesamt
Lecture	12	2	24
Exercise	12	1	12

Home works	12	2	24
Preparation and follow-up	12	2,5	30
Preparation for the exam			30
Total:			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

One trimester (trimester 3)

Teilnehmer(innen)zahl / Number of Participants

Unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Literature will be distributed at the beginning of the course.

Modul Electrochemical Power Sources for Military Applications ElecPowS

Electrochemical Power Sources for Military Applications
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Dr. Carsten Cremer, Fraunhofer ICT

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

carsten.cremers@ict.fraunhofer.de + 49 721 4640 665

Qualifikationsziel / Module Objectives and Competencies

The participants

- will be introduced into the working principles of the different electrochemical power sources like primary and secondary batteries, flow-batteries and fuel cells
- will also learn about the sensitivity of the different types of power sources to environmental factors like temperature, shock and vibration or altitude
- shall also become familiar with risks posed by the different type of power sources
- shall also be introduced into the design of power conversion and storages systems based on or using electrochemical power sources
- shall be informed about fcators influencing the operation under operation conditions
- shall be introduced into the concept of hybridization allowing for improved system performance by combining different type of power sources
- shall become acquainted with the logistic impacts caused by different types of electrical power supply solutions. Also the use of renewable energy options shall be introduced.

Inhalte / Content

- Basic principles of Electrochemistry
- Different types of electrochemical power sources
- Environmental influence factors (operation at low and high temperatures, influence of vibration and shock, influence of low ambient pressure due to high altitudes, influence of air pollutants
- Risk assesment of different type of power sources
- Design of storage system, ways of coupling of several batteries, thermal and mecahnical consideration with respect to system safety and fast recharging
- Design of generation systems: selection of the right type of power sources, fuel considerations
- Hybdrisation: Optimising size weight and capacity of a system by combining different types of power sources
- Logistic burden, transportation of batteries (uncharged, charged damaged), batterie recharging infrastructure, non-logistic fuel issues for use with fuel cells
- Potential role of renewable energies

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Electrochemical Power Sources	L	2	ST
Electrochemical Power Sources	E	1	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture with exercises in small groups

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
Electrochemical Power Sources	-	Basics of Chemistry and Physics

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture	12	2	24
Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48
Exam praparation			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

Trimester 2

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Handouts will be made available for download once the lecture starts

Exercise sheets will be distibuted on-site.

Modul Failure Analysis and Maintenance FailAnalys

Failure Analysis and Maintenance
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Th. Böllinghaus, Bundesanstalt für Materialforschung und -prüfung

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

Thomas.Boellinghaus@bam.de +49 30 8104 1020

Qualifikationsziel / Module Objectives and Competencies

a) In the first part of the module, the students should get acquainted with the procedures and the application of failures analyses for technical systems and their components, with specific consideration of defense and military applications. Since failures analysis implies the whole product life cycle, students should also recognize the importance of the earlier parts of the life cycle, like the design period, as well as the later parts, like, repair, recycling or replacement. The students will get acquainted and will know about the importance of defects and imperfections introduced during production and the consequences for the service life of components. With a view on effective failure prevention, the students will get known to the special importance of materials selection. The students will learn that modern failure analysis is not only oriented at the materials behavior and properties, but is based on the interaction of the three factors material, load and structural design. The students will realize that such interaction is of immanent importance with respect to failure analysis and avoidance in the production phase as well as during service life of technical systems and their components.
The basic terminology in failure analysis should be understood, as well as customer orientation during failure anamnesis and the target-oriented analysis of failure origins and root failure causes. The students should realize the direct relations of failure analyses in various industrial sectors to evaluations of the operational readiness of military systems. A comprehensive catalogue of examples should enable the students to draw such comparisons and to detect such parallels. The students should learn how to establish immediate support as well as long-term failure avoidance strategies. The concepts of tear-down-analysis should be realized and considered, in particular with respect to the advantages to detect hidden failures at still operating equipment. The advantages for long-term usage of military equipment and respective early detection should also be realized.

b) In the second part of the module, special emphasis will be laid on the various degradation types of materials and related failures of components. In addition to wear, special emphasis is laid on corrosion failures and their prevention. The students should get acquainted and will be enabled to recognize the different corrosion types, the mechanisms will be partly elucidated and it will be shown how they are applied to the different types of metallic materials, i. e. low and high alloyed steels as well as light metals alloys. Similarly, some basics for chemical corrosion will be provided. Special emphasis will be laid on recognizing and preventing corrosion cracking mechanisms and the respective phenomenology. By providing a comprehensive catalogue of examples, the students will be enabled to recognize and assign the various failure types correctly in practice and to assess their impact on the component behavior during service life. As a special example for designing mainly failure resistant components, corrosion protection measures and the options to design components subjected corrosive environments will be presented, under particular consideration of welded components. The students will be enabled to apply test procedures correctly and, based on this, to draw tentative conclusions on the respective component service behavior.

Inhalte / Content

The various lectures (12 x 2 TWS) comprise:

- Terminology and basics on failure analysis
- Risk assessment
- Interaction of material, structural design and loading
- Influence of production processes on the service life of components,
- Classification of technical failures
- Procedures for failure analysis at technical components (VDI-Guideline 3822 etc.): Anamnesis, description, investigation, failure root cause detection, documentation,

- Fractography
- Failures associated with static and dynamic mechanical loads
- Failures at coupled loads: Mechanical, thermal, corrosive, wear-related etc.
- Component and system-oriented materials testing
- Development of conclusive test sequences
- Application of analytical and numerical models for failure analysis, prevention and maintenance
- Transfer of real loads to laboratory testing and vice versa
- Component integrated failure avoidance: Monitoring, risk-based inspection, maintenance, overhaul, repair and maintenance levels
- Retrospective failure prevention: Tear-down-analyses, materials testing, re-design of technical components, comprehensive catalogue of examples

The various practical lectures (12 x 1 TWS) will be devoted to specific test procedures, potentials for analytical and numerical failure simulations and to practicing of specific failure investigations.

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Failure Analysis and Maintenance	L	2	WT
Failure Analysis and Maintenance	E/Lab	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Frontal lectures as well as laboratory practice, partially, the lectures might be presented by external experts.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
Failure Analysis and Maintenance	-	Basic knowledge, as for instance from the materials engineering, corrosion, mechanics and other lectures.

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture	12	2	24
Laboratory practise	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

1 Trimester

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

The contents of the lectures will be provided as ppt on the home-page for downloading,
ASM-Handbook: Failure Analysis,
Wolpi: Understanding how Components Fail,
ASM Handbook of Case Histories in Failure Analysis
Czichos: Technical Diagnostics,
VDI-Guideline 3822,
ASM-Handbook: Corrrosion,
Kaesche: Corrosion of Metals,
Uhlig: Corrosion Handbook

Modul Fundamentals of Energetic Materials ES22FEM

Fundamentals of Energetic Materials
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Bernd Niemeyer
Dr.-Ing. Daniel Krentel
PhD Thomas Rozsypal

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

Niemeyer@hsu-hh.de, -3500
Tomas.Rozsypal@unob.cz
Daniel.Krentel@bam.de

Qualifikationsziel / Module Objectives and Competencies

According the chemistry of explosives, after completing the course, students will be able to explain the general terms associated with the chemistry of explosives. They will know the differences and examples of pyrotechnics and explosives. Students will understand their chemical behaviour and the basics of production of selected representatives. They will have the knowledge of the laws of physical chemistry needed to understand the subject. Students will have an overview of the methods used for the detection and identification of explosives and will understand their principles.

Furthermore, the students know the fundamentals of development and manufacture of explosives, propellants and pyrotechnics, and the thermochemical behaviour, as well as they can reproduce these topics. Additionally they understand the environmental decomposition of explosives, and the analytical methods for their detection.

Related to the physical fundamentals of explosives, the students know and will be able to apply the fundamentals of short-term dynamics, gas dynamics, blast wave propagation, characteristics of explosions, as well as the basic principles of short-term dynamics measurement technology. They will be able to plan and conduct basic short-term dynamics experiments and apply and evaluate basic calculation methods for explosions and blast.

Inhalte / Content

Chemistry:

- Basic terms as well as chemical properties of explosives, and their manufacturing
- Pyrotechnics versus explosives,
- Classification of explosive materials
- Fundamentals of organic and physical chemistry related to explosives chemistry
- Methods of bulk and trace explosives detection
- Methods of explosives identification and determination
- CBRN EOD

Physics:

- Fundamentals of short-term and gas dynamics, physics of explosions and their effects
- Phenomena, processes and models during detonation propagation inside and outside of explosives
- Blast wave propagation, as well as characteristics of shock reflection
- Experimental set-ups for blast generation, and measurement techniques for explosions and short-term dynamics applications
- Post-processing and analysis of experimental and numerical data
- Numerical simulation of explosions (methods and constraints)

Modulbestandteile / Composition of Module

LV-Titel	LV-Art	TWS	AT/WT/ST

Fundamentals of Energetic Materials	L	2	ST
Fundamentals of Energetic Materials	E	1	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Auditorium based lectures (powerpoint); exercises will be hold individually or in small groups; webinars/ online lectures, team exercises are occasionally utilized

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

	Wochen	Std./Woche	Std. insgesamt
Lecture	12	2	24
Exercise	12	1	12
Home works	12	2	24
Preparation and follow-up	12	2,5	30
Preparation for the exam			30
Total:			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

One trimester (trimester 2)

Teilnehmer(innen)zahl / Number of Participants

Unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

J. Akhavan: The Chemistry of Explosives. 3rd Ed. 2015. Royal Society of Chemistry;
M. A. Liberman: Introduction to Physics and Chemistry of Combustion: Explosion, Flame, Detonation. 2018. Springer.
J.B. Ledgard: The Preparatory Manual of Explosives. 2007.
B.M. Ham, A. Maham: Analytical Chemistry: A Chemist & Laboratory Technician´s Toolkit. 2016. Wiley
Ch.E. Needham: Blast Waves. 2018. Springer;
I. Sochet: Blast Effects. 2018. Springer;
K. Ramamurthi: Modeling Explosions and Blast Waves. 2021. Springer;
V. Babu: Fundamentals of Gas Dynamics. 2021. Springer

Modul Hardware Architecture of HPC Systems HardArcHPC

Hardware Architecture of HPC Systems
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Philipp Neumann

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

philipp.neumann@hsu-hh.de, 040-6541-2723

Qualifikationsziel / Module Objectives and Competencies

The goal is for participants to learn the layout and functionality of computing hardware in an HPC system on all hierarchical levels. Beginning from an instruction set, the architecture of an individual core is explored. Modern chips have multiple cores and multiple chips make up a node, which are in turn connected through an interconnect network. Design choices on all levels lead to a broad diversity of possible system architectures. Common architectures are evaluated, their suitability for different computing tasks analysed and possible future developments discussed.

Inhalte / Content

- Instruction set architecture
- Microarchitecture
- Multicore chips
- Interconnect networks
- Memory hierarchy
- Evaluation of HPC systems
- HPC architectures and their history

Modulbestandteile / Composition of Module

Module Part	**Type** Computer Training CT Exercises E Lecture L Laboratory Lab	**Contact Hours per Week**	**AT/WT/ST**
Hardware Architecture of HPC Systems	L	2	ST from 2023: WT
Hardware Architecture of HPC Systems	E/Lab	2	ST from 2023: WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	**formal**	**content**
	-	-

Verwendbarkeit des Moduls / Usability of Module

HPC in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises/Lab	12	2	24
Preparation and follow-up	12	3	36
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 2

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Course materials will be provided in the online modules. A list of books and further reading will be announced in the lecture.

Modul High-Power Electromagnetics and Laser Systems HPElec

High-Power Electromagnetics and Laser Systems
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Stefan Dickmann
Dr. Martin Schaarschmidt (LA)
Dr.-Ing. Markus Jung (LA)

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Qualifikationsziel / Module Objectives and Competencies

High-Power Electromagnetics (HPEM):
To develop a broad understanding of the fundamentals of High-Power-Electromagnetics, awareness of its threats and respective countermeasures.

High-Energy Laser Effectors and their Applications (HELE):
To provide insight into the operation principles of High-Energy Laser Effectors. Students know about the fundamental physics of HELE and its most important parameters:
Laser source, beam guidance, athmospheric transmission and light to matter interaction.
Students will be enabled to describe the parameters of the components and their influence on the overall system performance.

Inhalte / Content

HPEM:

- Fundamentals
- High power Microwave and Ultrawideband Sources
- HPEM Propagation
- HPEM Interaction with Systems
- Hardening

HELE:

- Purpose of HEL effectors
- Athmospheric Influence on Laser Propagation
- HEL weapon systems
- HEL Demonstrators
- Effects of HEL-Effectors on Targets
- Safety Aspects of HEL Effectors

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
High-Power Electromagnetics	L	2	WT

High-Energy Laser Effectors and their Applications	L	2	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Fundamentals of Electromagnetics

Verwendbarkeit des Moduls / Usability of Module

EO in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures HPEM	6	4	24
Lectures HELE	6	4	24
Preparation and follow-up	12	4	48
Preparation for exam			24
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 4

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

HPEM

- C.D. Taylor, D.V. Giri: High-Power Microwave Systems and Effects, *Taylor & Francis*
- D.V. Giri: High-Power Electromagnetic Radiators- Nonlethal Weapons and other Applications, *Harvard University Press*
- J. Benfod, J.A. Swegle, E. Schamiloglu: High power Mocrowaves, 2nd edition, *Taylor & Francis*
- K.S.H. Lee, ed.: EMP Interaction: Principles, Techniques and Reference Data, Springer

HELE

Copies of slides used in the lectures will be given to the students.

Modul HPC Techniques and Software Development HPCTech

HPC Techniques and Software Development
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Philipp Neumann

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philipp.neumann@hsu-hh.de, 040-6541-2723

Qualifikationsziel / Module Objectives and Competencies

The goal is for the participants to learn principles of software development for efficient and robust deployment on HPC systems.
Algorithmic aspects and implementation examples, typically in view of numerical simulation, are given to explain and lay out the interwovenness of hardware capability, HPC-aware algorithms and actual source code.
At the same time, various implementations are discussed or carried out which underpin how efficient software is written for different hardware levels, including vectorization at core-level, threading within a node and message passing via MPI on entire HPC systems.
Besides learning to generate efficient code, students are explained profiling tools so that they are able to analyze and improve code performance.

Inhalte / Content

- Compile time optimization
- Algorithmic building blocks for code optimization (blocking, loop unrolling, avoiding branches, loop fusion)
- Vectorization
- Threading with OpenMP
- Message passing with MPI
- Data locality
- Performance profiling

Modulbestandteile / Composition of Module

Module Part	**Type** Computer Training CT Exercises E Lecture L Laboratory Lab	**Contact Hours per Week**	**AT/WT/ST**
HPC techniques and software development	L	2	AT from 2023: ST
HPC techniques and software development	E/Lab	2	AT from 2023: ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	**formal**	**content**
	-	Skills learned in Mathematics

Verwendbarkeit des Moduls / Usability of Module

HPC in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP ADM+ M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises/Lab	12	2	24
Preparation and follow-up	12	3	36
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 3

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Course materials will be provided in the online modules. A list of books and further reading will be announced in the lecture.

Modul Improvised Explosive Devices Disposal ImpExplDD

Improvised Explosive Devices Disposal
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Bernd Niemeyer
Thomas Jäger, Bundeskriminalamt

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Thomas.Jaeger@bka.bund.de +49 30 5361 26747

Qualifikationsziel / Module Objectives and Competencies

Participants understand basics of explosives and how to inoffensive them. They are able apply their knowledge to new and unknown situations and analyze critical situations. They are capable to generate case specific solutions and finally valuate them and also the procedure after an (successful) operation. Participants realize the basics on IED (explosives and their chemistry, technologies of IED), recognize them, and are able to dispose them. Legal and organizational linkage on international level enables the participants for international operation and cooperation.

Inhalte / Content

- Organizational and legal introduction
  a) Structure of security authorities
  b) Legal bases of fighting bomb attacking
  c) International linkage and cooperation of explosive mitigation
- Chemistry of explosives
  a) Pyrotechnics versus different kinds of explosives
  b) Chemistry of explosives
  c) Analysis of the different explosives
  d) Functions and fields of application of various explosives
  e) Legal basis of handling explosives
- Explosive devices
  a) Set-up of Improvised explosive devices disposal (IEDD)
  b) Ways of fast recognition of IEDD
  c) First measures and structurized procedure of explosive mitigation
  d) Technologies of mitigation
  e) Means for guidance and countermeasures

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Improvised Explosive Devices Disposal	L	2	ST
Improvised Explosive Devices Disposal	E	1	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture with exercises in small groups accompanied by video images and example pieces. Roll-plays show typical situations as well as provide options for flexible counteracting.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
IEDD	-	Basics of chemistry

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture	12	2	24
Exercises	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module conludes with a final examination, either written (120 min) or oral.

Dauer in Trimestern / Duration of Module

Trimester 2

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Handouts are presented at the beginning of the lecture.

Modul Infrared Technologies and Applications InfrTech

Infrared Technologies and Applications
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Oleg Pronin

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

oleg.pronin@hsu-hh.de +49 40 6541 2756

Qualifikationsziel / Module Objectives and Competencies

Students will undestand the basic physics of infrared technology. They will get a deep insight in detecting and imaging applications. They learn to design optical systems and know their capabiliites and limits.

Inhalte / Content

- Black- and gray-body radiation
- Radiation contrast and sensitivity
- Infrared signatures
- Atmospheric propagation
- Design of optical systems
- Infrared materials
- Infrared detectors, FLIR systems, focal plane arrays
- Hyperspectral imaging
- Search and track systems

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Infrared Technologies and Applications	L	2	WT
Infrared Technologies and Applications	E/Lab	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Fundamentals of Electromagnetics

Verwendbarkeit des Moduls / Usability of Module

EO in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours

			Total
Lectures	12	2	24
Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 4

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Biliographical references and course materials are provided by the lecturer.

Modul Laboratory Project LabProj

Laboratory Project
Leistungspunkte / Credit Points: 9

Modulverantwortlicher / Contact Person

Profs EE / Profs ME

Qualifikationsziel / Module Objectives and Competencies

In this module, the students develop and prove their ability to solve a given problem in the field of engineering science as applied in defence systems (electrical and computer engineering, information science, mechanical engineering, chemical engineering) using scientific methods within a limited time. The knowledge and methods acquired in the preceding modules are to be applied and further developed. The level of difficulty goes beyond the level of difficulty of the Bachelor Thesis.

Professional and key skills are to be strengthened by

- team work, because the Master Thesis usually contributes to a superordinate project and requires to cooperate with other persons, e.g. lab employees and student research assistants
- presentations on intermediate and final results
- written and oral verbal skills in English
- methodic project work, using definition, adaption and accomplishment of a milestone plan
- reading English and German technical literature

Inhalte / Content

formal	content
-	Skills acquired in the bachelor programme and study modules attended between trimester 1 and trimester 3.

Verwendbarkeit des Moduls / Usability of Module

C in ESDS

Arbeitsaufwand / Work Load

270 hours

Prüfung und Benotung / Evaluation

According to the examination regulations for "Projektarbeit"

Dauer in Trimestern / Duration of Module

1 Trimester

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Modul Laser Technology LaserTech

Laser Technology
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. rer. nat. Detlef Kip

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

kip@hsu-hh.de +49 40 6541 2457

Qualifikationsziel / Module Objectives and Competencies

To develop a broad understanding of the fundamentals of laser systems. Students will learn how to use different laser types for various applications.

Inhalte / Content

<p style="margin-bottom: 0.07cm; line-height: 110%;">- Fundamentals of optics - Gaussian beams - Resonator optics - Photons and atoms - Lasers and laser amplifiers - Laser systems

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Laser Technology	L	2	WT
Laser Technology	E/Lab	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Fundamentals of Electromagnetics

Verwendbarkeit des Moduls / Usability of Module

EO in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48

Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 1

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Literature will be announced in the first lecture.

Modul Machine Learning ES24ML

Machine Learning
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Oliver Niggemann

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

oliver.niggemann@hsu-hh.de, 040 / 6541-2722

Qualifikationsziel / Module Objectives and Competencies

Goal of the lecture is to teach the fundamentals of machine learning. Students have knowledge about data acquisition, data quality and data visualization. They know how to analyze data manually and how to exploratively draw conclusions from the data. Students can differentiate between statistical solutions and machine learning solutions and they can classify problems into categories such as supervised and unsupervised machine learning. They have basic knowledge about statistics and can apply this to typical problems such as classification and regression. Students know typical machine learning approaches and have a deeper understanding of neural networks.

Main applications are technical systems, i.e. students know how the analyze sensor and actuator signals and how to use machine learning algorithms for system monitoring and optimization. They can use typical environments such as Python for such solutions.

Inhalte / Content

Classification of machine learning problems, supervised learning, unsupervised learning, reinforcement learning, classification, regression, metrics for machine learning and statistics, AUC (Area Under The Curve) ROC (Receiver Operating Characteristics), F-Measure

Statistical models for information fusion and data analysis, stochastic processes, a-posteriori probability computation, maximum-likelihood, supervised gaussian models, unsupervised gaussian models, maximum-likelihood, variational inference

Machine learning approaches for data analysis, neural networks, perceptrons, autoencoders, restricted boltzmann machines, deep neural networks, learning algorithms for neural networks

Applications for machine learning in the context of cyber-physical systems, tools for machine learning such as Python

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Machine Learning	L	2	WT

Machine Learning	E	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture in the lecture hall: Tablet PC-based projection and interactive explanation of lecture slides, possibly blackboard

Exercise: Working with programming languages, possibly blackboard, in addition, each student has a PC available to program independently. Additional teaching / learning offers will be announced by the respective teacher at the beginning of the event.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Skills acquired in Mathematics

Verwendbarkeit des Moduls / Usability of Module

HPC in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP ADM+ M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture	12	2	24
Exercises	12	1	12
Preparation and followup	12	5	60
Preparation for exam			24
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

One Trimester

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Scripts, lecture slides, exercises and programming examples are provided electronically.

Literature:

Kevin P. Murphy: Machine Learning: A Probabilistic Perspective, MIT Press.

Modul Master-Thesis MastThes

Master Thesis

Leistungspunkte / Credit Points: 30

Modul Material Handling and Warehouse Technology MatHand

Material Handling and Warehouse Technology
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Rainer Bruns
Dr.-Ing. Stephan Ulrich

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

m_bru@hsu-hh.de +49 40 6541 2855/2287
stephan.ulrich@hsu-hh.de +49 40 6541 2495

Qualifikationsziel / Module Objectives and Competencies

It will provide an overview of the conveyor and storage technology that can be used for the design of material handling systems.
The students learn the operating conditions, the advantages and disadvantages of the different technical systems, including economic aspects.
Overall, the students should be qualified to select, dimension and design appropriate machinery components and subsystems of logistics systems.

Inhalte / Content

Terms, characteristics and structuring of the material flow technology

Delivery of goods, loading equipment and cargo securing
- bulk goods
- piece goods
- paletts, boxes and container

Material handling technology
- cranes
- ndustrial trucks
- automatic guided vehicles
- hoisting devices
- belt conveyor
- screw conveyor
- vibration conveyor
- roller conveyor

Warehouse technology
- storage racks
- storage and retrieval systems
- automatic sortation
- order-picking systems

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Logistics	L	2	WT
Logistics	E	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture and exercise together for all participants.

Voraussetzungen für die Teilnahme / Requirements

Module Par t	**formal**	**content**
	-	basic knowledege of mathematics and mechanics

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

Module Part	**Weeks**	**Hours/Week**	**Hours Total**
Lecture	12	2	24
Exercises	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

Trimester 3

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

- Script with additional references
- J.A. Tompkins, J.D. Smith The Warehouse Management Handbook, Mc Graw Hill

Modul Materials Modelling MatMod

Materials Modelling
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Thomas Klassen
Prof. Dr. Denis Kramer

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

klassen@hsu-hh.de +49 40 6541 3617

Qualifikationsziel / Module Objectives and Competencies

Participants will learn computational modelling ontology, different simulation and modelling techniques, and approaches to link effects on different scales.

Inhalte / Content

- Basic introduction to modelling and simulation on different scales;
- Continuum methods, Finite element simulations;
- Discrete approaches; electronic, atomistic, microscale, mesoscale;
- Multiphysics simulations;
- Scale bridging and linking: defining critical parameters
- Problems in variable definitions and transfer between different methods (data issues)
- Post-processing
- Interpretation of results and pitfalls

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Materials Modelling	L	2	ST from 2023: WT
Materials Modelling		1	ST from 2023: WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Skills learned in Mathematics

Verwendbarkeit des Moduls / Usability of Module

CMD in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 2

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Script with slides and screen shots

Modul Modelling Advanced Processing Technologies ModAdv

Modelling Advanced Processing Technologies
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Thomas Klassen
Prof. Dr. Denis Kramer

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

klassen@hsu-hh.de +49 40 6541 3617

Qualifikationsziel / Module Objectives and Competencies

Participants will acquire skills for process simulation of advanced manufacturing, and understand the link between process parameters and component properties

Inhalte / Content

- Introduction to process characteristics of laser processing and additive manufacturing technologies
- Modelling laser processing and direct energy deposition processes (e.g. laser cladding)
- Modelling powder based processes (e.g. SLM)
- Setting up simulations (incl. meshing strategies)
- Variation of parameters and discussion of sensitivities
- Development of microstructures and stresses for different geometries and process conditions
- Extraction of critical interdependencies to strategically tailor process conditions

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Modelling Advanced Processing Technologies	L	2	AT
Modelling Advanced Processing Technologies	E/Lab	1	AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Skills learned in Mathematics

Verwendbarkeit des Moduls / Usability of Module

CMD in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours

			Total
Lectures	12	2	24
Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 3

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Script with slides and screen shots

Modul Naval Shipbuilding NavShip

Naval Shipbuilding
Leistungspunkte / Credit Points: 8

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Martin Meywerk
Dr.-Ing. H. D. Ehrenberg, Atlas Elektronik

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

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hans-dieter.ehrenberg@atlaselektronik +49 421 4571124

Qualifikationsziel / Module Objectives and Competencies

- Fundamentals in ship engineering
- Fundamentals about various vessel types, design, construction and operation of naval ships,
- especially corvettes, frigates, OPV's, support vessels.

Inhalte / Content

- A brief outline of the history of naval ships
- Fundamentals of Marine Technology
- Difference of naval ships vs. Merchant ships, short outline of types of vessels
- Buoyancy and stability
- Naval architecture, smooth water, waves
- Materials
- Ship Design: main dimensions, lines, resistance, maneuvering,
- Driving power, capacity, weight calculation, admeasurement
- Ship Design: Space, Topside Arrangement
- Propulsion machinery
- Marine electrical engineering, automation
- Ship operation equipment
- Active and passive survivability, signatures
- Role and use - scenarios of surface vessels
- Sensors and effectors OW / UW
- Fundamentals of application systems for specific roles
- Look into the future of Navy - Surface Vessels

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Naval Shipbuilding	L	2	ST/AT
Naval Shipbuilding	E	1	ST/AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture: in the auditorium with PC (and projector), overhead transparencies and panel
Exercise: Students develop drafts of naval vessels based on predefined scenarios and functional requirements, students present their solutions in teams
Excursion(s) : to companies in the naval shipbuilding and equipment of naval vessels according to the availability.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Knowledge of technical basics in mechanics, mechanical engineering, electrical engineering, electronics, of mathematics, materials technology in accordance with the mechanical engineering study program (BA)

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	2x12	2	48
Exercises	2x12	1	24
Preparation and follow-up	2x12	5	120
Preparation for exam			48
Total			**240**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

Trimester 2,3

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Notes will be distributed during the lecture; Recommended reading at the beginning of the lecture.

Modul Numerical Mathematics NumMath

Numerical Mathematics
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Markus Bause

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

bause@hsu-hh.de +49 40 6541 2721

Qualifikationsziel / Module Objectives and Competencies

Participants learn to use basic numerical techniques for solving mathematical problems originating from engineering applications and natural sciences. They are qualified to identify the proper numerical method, implement the scheme and interpret and evaluate the computed solution within the context of the application.

Inhalte / Content

1) Linear and nonlinear systems of equations
   a. LR and Cholesky factorization
   b. QR decomposition
   c. Newton's method
2) Interpolation and quadrature
   a. Newton interpolation
   b. Spline interpolation
   c. Newton-Cotes formulas
   d. Gauss quadrature rule
3) Ordinary differential equations
   a. Single step methods, Runge-Kutta methods
   b. Multistep methods
   c. Finite element method for two-point boundary value problems
4) Applications
5) Implementation and usage of mathematical software

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Numerical Mathematics	L	2	WT
Numerical Mathematics	E	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture and especially exercises are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
Numerical Mathematics	-	Elementary Calculus and Linear Algebra

Verwendbarkeit des Moduls / Usability of Module

C in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture	12	2	24
Exercises	12	1	12
Preparation and follow-up	12	5	60
Preparation for exam			24
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final written exam (90 minutes).

Dauer in Trimestern / Duration of Module

Trimester 1 (see FSPO)

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Bibliographical references and course materials are provided by the instructor.

Modul Operating Systems and Secure Computer Networks OpSys

Operating Systems and Secure Computer Networks
Leistungspunkte / Credit Points: 8

Modulverantwortlicher / Contact Person

Prof. Dr. phil. nat. habil. Bernd Klauer

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

bernd.klauer@hsu-hh.de +49 40 6541 3380

Qualifikationsziel / Module Objectives and Competencies

To develop a broad understanding of the fundamentals of layer based Network modeling. Knowing common protocols and basics of distributed simulation. Being able to apply the OSI model to a network use - case and have a basic understanding of the topic of cyber security.

Inhalte / Content

Part 1: Operating Systems

1) Classification
2) Components
3) User Interfaces
4) The Kernel
5) Scheduling, Paradigms and Methods
6) Hardware Interaction
7) Application Interaction
8) Device Administration
9) Memory Hierarchy
10) Memory Management
11) User Administration

Part 2: Secure Computer Networks

1) Fundamentals
2) Distributed Systems
3) Communication Systems
4) OSI-Layer Model
   Introduction to the seven layer OSI-network model.
5) Common Protocols
   Ethernet, WLAN, IP, TCP, UDP, HTTP
6) Military Protocols (Link 16)
   Link 16 from physical layer, data link layer and application layer perspective.
7) Distributed Simulation
   Using Computer Networks for distributed Simulation/Multiplayer Gaming.
8) Cyber Security
   Using the OSI-Model to detect cyber security risks and to take measures.

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Operating Systems	L	2	AT
Operating Systems	E/CT	2	AT

Secure Computer Networks	L	2	WT
Secure Computer Networks	E/CT	2	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

The teaching language is either German or English. The course material is written in English.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
Part 1	-	Basic skills in C-Programming
Part 2	-	-

Verwendbarkeit des Moduls / Usability of Module

C in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	2*12	2	48
Exercises/CT	2*12	2	48
Preparation and follow-up	2*12	5	120
Preparation for exam			24
Total			**240**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 3, 4

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

- Tanenbaum, Andrew S. & Wetherall, David J.,"Computer Networks"
- Vacca, John R., "Cyber Security and IT Infrastructure Protection"

Modul Parallel Computing for Multiscale and Multiphysics Problems ParaComp

Parallel Computing for Multiscale and Multiphysics Problems
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Philipp Neumann

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

philipp.neumann@hsu-hh.de, 040-6541-2723

Qualifikationsziel / Module Objectives and Competencies

The goal is for participants to learn fundamental modelling techniques and how to fuse computational models, describing different phenomena at different scales, into multi-scale and multi-physics models. First, an overview of modelling techniques in science and engineering is given, starting from the concept of a system and focussing on the different abstractions used. Based on system boundaries, possible combinations of models across scales and across modelled phenomena are analysed. Benefits and potential drawbacks of multi-scale and multi-physics models are discussed. Finally, approaches for developing parallel simulation codes for these complex models are introduced.

Inhalte / Content

- Modelling techniques in science and engineering
- Multi-scale and multi-physics simulations
- Coupling methods
- Adaptive simulations
- Concurrency and computational load distribution for coupled systems

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Parallel Computing for multi-scale and multi-physics problems	L	2	WT from 2023: AT
Parallel Computing for multi-scale and multi-physics problems	E/Lab	1	WT from 2023: AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
Parallel Computing for multi-scale and multi-physics problems	-	Skills learned in Mathematics

Verwendbarkeit des Moduls / Usability of Module

HPC in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 4

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Course materials will be provided in the online modules. A list of books and further reading will be announced in the lecture.

Modul Protection for Constructions I ES21Prot I

Protection for Constructions I
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Dr. rer. nat. A. Jung

Qualifikationsziel / Module Objectives and Competencies

The students should
- gain basic knowledge of material behaviour under dynamic loading and dynamic material characterisation.
- learn about and be able to identify different threat situations,
- learn the effect of different threats (blast, fire, etc.) on infrastructures
- learn about and apply protection concepts for different infrastructures

Inhalte / Content

- Historical outline for the protection of buildings and infrastructure
- Materials under dynamic loading (strain rate dependence of metals, polymers, ceramics and composites, methods for dynamic material characterisation)
- Identification of different threat situations/weapons and their effects (blast/explosions, car bomb, backpack bomb, grenades, fire, vehicles, etc)
- Basics of threat and risk analysis
- Defining and designing 3D protection zones
- Basics of active and passive protection concepts

Modulbestandteile / Composition of Module

LV-Titel	LV-Art	TWS	AT/WT/ST
Protection for Constructions I	L	2	WT
Protection for Constructions I	E	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Auditorium based lectures (powerpoint)

Verwendbarkeit des Moduls / Usability of Module

EPS in ESDS

Arbeitsaufwand / Work Load

	Wochen	Std./Woche	Std. insgesamt
Lecture	12	2	24
Exercise	12	1	12
Preparation and follow-up	12	2	24
Exercise preparation and follow-up	12	2,5	30
Preparation for the exam			30
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

One trimester (trimester 1)

Teilnehmer(innen)zahl / Number of Participants

Unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Blast Protection of Buildungs, ASCE/SEI 59-11, American Chemical Society of Civil, 2011, ISBN 978-0-7844-1188-9.
E. Yandzio, M. Gough; Protection of Buildings against Explosions; SCI Publication 244, The Steel Construction Institute, Berkshire, GB, 1999 ISBN 1-85942-089-3.
K.V. Frokov, G.B. Baecher (eds.); Proceeding of the NATO Advanced Research Workshop on Protection of Civilian Infrastructure from Acts of Terrorism, Series C: Environmental Security, Vol. 12, Moscow, Russia, 2004, Springer, Dodrecht, The Netherlands, 2006.

Modul Protection for Constructions II ES22ProtII

Protection for Constructions II
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Dr. rer. nat. A. Jung

Qualifikationsziel / Module Objectives and Competencies

The students should
- be able to identify the critical areas of infrastructures/buildings,
- be familiar with specific protection concepts for different threat situations and be able to apply them,
- be able to carry out simple simulations for blast loading.

Inhalte / Content

- Explosion protection facades incl. retrofitting
- Explosion protection walls incl. retrofitting
- Methods for experimental characterisation
- Methods and implementation of simulation for buildings under blast loading
- Concepts for earthquake protection
- Examples of constructive protection measures

Modulbestandteile / Composition of Module

LV-Titel	LV-Art	TWS	AT/WT/ST
Protection for Constructions II	L	2	ST
Protection for Constructions II	E	1	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Auditorium based lectures (powerpoint)

Verwendbarkeit des Moduls / Usability of Module

EPS in ESDS

Arbeitsaufwand / Work Load

	Wochen	Std./Woche	Std. insgesamt
Lecture	12	2	24
Exercise	12	1	12
Preparation and follow-up	12	2	24
Exercise preparation and follow-up	12	2,5	30
Preparation for the exam			30
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

One trimester (trimester 2)

Teilnehmer(innen)zahl / Number of Participants

Unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Primer for Design of Commercial Buildings to Mitigate Terrorist Attacks, Providing Protection to People and Buildings, Federal Emergency Management Agency (FEMA), No., 427, 2003.
N. Uddin; Blast Protection of Civil Infrastructures and Vehicles using Composites, CRC Press, Woodhead Publishing, Great Abington Cambridge, GB, 2010.
R.I. Atlas (ed.); 21st Century Security and CPTED: Designing for Critical Infrastructure Protection and Crime Prevention, Taylor & Francis, Boca Raton, FL, USA, 2008, ISBN 978-1-4200-6807-8.

Modul Protection Technologies, Security and Situational Awareness I: Protection ProtTech I

Protection Technologies, Security and Situational Awareness I: Protection
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Christian Kreischer

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

christian.kreischer@hsu-hh.de

+49 40 6541 2060

Qualifikationsziel / Module Objectives and Competencies

Students will

- learn to characterise perils for humans and equipment in military operations
- understand the scientific background of technical protective measures
- develop competences in the engineering of protecting systems
- obtain skills to assess active and passive protective technologies

Inhalte / Content

Examples from the following selection are discussed to train the students to achieve the above defined competences:

1) Protection against explosives & ballistic threats
2) Specific metrological tools
3) Material parameters extraction, static and dynamic loadings
4) Material response on dynamic impact
5) Definition and understanding of different protection levels
6) Add-on armour for specific threats
7) Ageing effects and their influence on protection performance
8) Modelling of blast propagation, estimation of effects at different distances
9) Modelling of thermal phenomena of the interaction between radiation and matter

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	Compulsory (C) or elective (E)	AT/WT/ST
Protection Technologies	L	2	E	WT
Protection Technologies	E	1	E	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially exercises organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Formally none. Recommended: Fundamentals of materials science, mechanics, and electromagnetics.

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture	12	2	24
Exercises	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

One trimester (WT)

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Set of slides will be handed to the participants.

Sonstiges / Miscellaneous

The module is taught by Dr. Bernd Fischer (bernd.fischer@isl.eu, +33 3 8969 5070).

Modul Protection Technologies, Security and Situational Awareness II: Surveillance ProtTechII

Protection Technologies, Security and Situational Awareness II: Surveillance
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Christian Kreischer

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

christian.kreischer@hsu-hh.de

+49 40 6541 2060

Qualifikationsziel / Module Objectives and Competencies

Students will

- understand the scientific and technological background of surveillance and situational awareness
- develop competences in the engineering of sensors and supervising systems
- learn how to integrate sensor based protective technologies in military systems
- understand how relevant information can be gained from acquired data
- obtain skills to assess surveillance technologies

Inhalte / Content

Examples from the following selection are discussed to train the students to achieve the above defined competences:

1) Acoustic and optical tracking and identification of Unmanned Aerial Vehicles (UAVs)
2) Improvement of optical and acoustic technologies for protection
3) Detection of improvised explosive devices
4) Novel spectroscopy tools for detection of explosives and chemical threats
5) Image-based navigation for surveillance and logistics
6) New Generation Earplugs with enhanced communication features
7) Bio-inspired multiple-sensor systems
8) Algorithms for the autonomous learning of sensing systems

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	Compulsory (C) or elective (E)	AT/WT/ST
Surveillance	L	2	E	ST
Surveillance	E	1	E	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture will be given at the University of Adelaide in the context of a cooperation/exchange program

Lecture could also be made available via remote teaching technologies (videostream, etc.).

Voraussetzungen für die Teilnahme / Requirements

Formally none. Recommended: Fundamentals of materials science, mechanics, and electromagnetics.

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture	12	2	24
Exercises	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

1 Trimester

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Set of slides will be handed to the participants.

Sonstiges / Miscellaneous

The module is taught by Dr. Bernd Fischer (bernd.fischer@isl.eu, +33 3 8969 5070).

Modul Pulsed Power and Applications PulsPower

Pulsed Power and Applications
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Stiemer

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

marcus.stiemer@hsu-hh.de

+49 40 6541 2769

Qualifikationsziel / Module Objectives and Competencies

Students will

- learn that pulsed power is a specific domain of electromagnetics being of interest for armed forces
- understand the scientific background of pulsed power
- develop competences in the engineering of pulsed power technology
- obtain skills to assess applications of pulsed power

Inhalte / Content

The following program is used to train the students to achieve the above defined competences:

1) Introduction: Basic Concept and Applications of Pulsed Power Systems
2) Pulsed High Magnetic Fields
3) Basic considerations
4) Generators, Metrology, Circuitry, Devices and Components
5) Applications: Electromagnetic Launch, Magnetic Forming, others
6) Pulsed High Electric Fields
7) Basic Considerations
8) Generators, Metrology, Circuitry, Devices and Components
9) Applications: High Power Microwaves, Electroporation, others.

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	Compulsory (C) or elective (E)	AT/WT/ST
Pulsed Power and Applications	L	2	E	WT
Pulsed Power and Applications	E	1	E	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially exercises organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Formally none. Recommended: Fundamentals of transient electromagnetics.

Verwendbarkeit des Moduls / Usability of Module

EO in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture	12	2	24
Exercises	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

One trimester (WT)

Teilnehmer(innen)zahl / Number of Participants

Unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Set of slides will be handed to the participants.

Sonstiges / Miscellaneous

The module is taught by Dr. Markus Schneider (markus.schneider@isl.eu, +33 3 8969 5198).

Modul Simulating High Strain Deformation SimHSD

Simulating High Strain Deformation
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Thomas Klassen
Prof. Dr. Denis Kramer

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

klassen@hsu-hh.de +49 40 6541 3617

Qualifikationsziel / Module Objectives and Competencies

Participants will learn how to handle extreme mechanical strains in finite element simulations, including mesh requirements and they gain experience in handling stability issues of solvers.

Inhalte / Content

- Introduction to Eulerian and Lagrangian approaches in finite element simulations
- Mesh design for extreme deformation, i.e. high strain rate and high strain
- Examples of particle impact on surfaces, discussion of problems and challenges
- Examples and discussions of simulation artefacts
- Measures and strategies for optimization and stabilization of FEM simulations (solvers)

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Simulatiing High Strain Rate Deformation	L	2	AT from 2023: ST
Simulatiing High Strain Rate Deformation	E/Lab	1	AT from 2023: ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Skills learned in Mathematics

Verwendbarkeit des Moduls / Usability of Module

CMD in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 2

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Script with slides and screen shots

Modul Special Applications of HPC in Defence Technology SpecAppHPC

Special Applications of HPC in Defence Technology
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Philipp Neumann

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

philipp.neumann@hsu-hh.de, 040-6541-2723

Qualifikationsziel / Module Objectives and Competencies

The goal is for participants to learn how to develop actual software for HPC applications relevant for defense technology.
This invokes particularly algorithmic and implementational work.
To solve an actual problem setting (e.g. from computational fluid dynamics, molecular dynamics, data analysis), a simulation software is written and/or extended by the students that will be able to assess this specific HPC application.

Inhalte / Content

- Presentation of actual HPC application
- Basics and principles on the numerical simulation approach for the HPC application
- Software design for the HPC application
- Algorithmic and code optimization for the HPC application

Examples include the incorporation of efficient simulation methodology (finite differences, time stepping scheme), parallelizing the software with OpenMP or MPI, or tuning other parts of the code.

Modulbestandteile / Composition of Module

Module Part	**Type** Computer Training CT Exercises E Lecture L Laboratory Lab	**Contact Hours per Week**	**AT/WT/STSpe**
Special Applications of HPC in Defence Technology	L	2	WT from 2023: AT
Special Applications of HPC in Defence Technology	E/Lab	4	WT from 2023: AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	**formal**	**content**
	-	Skills learned in Mathematics

Verwendbarkeit des Moduls / Usability of Module

HPC in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Part 1: Lectures	12	2	24
Part 1: Exercises/Lab	12	4	48
Part 1: Preparation and follow-up	12	2	24
Part 1: Preparation for exam			24
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 4

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Course materials will be provided in the online modules. A list of books and further reading will be announced in the lecture.

Modul Statistical Thermodynamics StatTherm

Statistical Thermodynamics
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Karsten Meier

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

meierk@hsu-hh.de +49 40 6541 2735

Qualifikationsziel / Module Objectives and Competencies

Objectives

On completion of this module students should have developed and be able to demonstrate a thorough understanding of the fundamentals of statistical thermodynamics and molecular simulations. They should be able to apply the theoretical methods of statistical thermodynamics and molecular simulation techniques to predict phase equilibria, thermodynamic properties, and transport properties of pure fluids and mixtures.

Learning outcomes
At the end of the module students should:
• know the fundamentals of statistical thermodynamics
• be able to calculate ideal gas heat capacities
• be familiar with the numerical techniques of molecular dynamics and Monte Carlo simulations and be able to apply them to the calculation of phase equilibria and thermodynamic properties
• be able to calculate transport properties such as viscosity, thermal conductivity and diffusion coefficients by kinetic theory and in molecular dynamics simulations
Skills outcomes
- Ability to understand underlying physics associated with statistical thermodynamics
- Transferable skills in linking fundamental theories to macroscopic properties of fluids
- Organization and analysis of computer simulations
- Advanced programming skills
- Critical reasoning.

Inhalte / Content

1. Fundamentals of statistical thermodynamics
2. Heat capacity of ideal gases
3. Intermolecular forces and virial equation of state
4. Molecular dynamics and Monte Carlo simulations
5. Molecular simulation of phase equilibria and thermodynamic properties
6. Calculation of transport properties by kinetic theory
7. Molecular simulation of transport properties in the time-correlation function formalism and by non-equilibrium techniques

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Statistical Thermodynamics	L	2	AT
Statistical Thermodynamics	E/Lab	1	AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Skills learned in Mathematics

Verwendbarkeit des Moduls / Usability of Module

CMD in ESDS

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final oral or written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 3

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

- R. Becker, Theory of heat, 2nd ed., Springer, Berlin, 1967
- P. Atkins, J. de Paula, J. Keeler, Physical Chemistry, 11th ed., Oxford University Press, 2017.
- M.P. Allen, D.J. Tildesley, Computer simulation of liquids, Oxford University Press, 1987

Modul Systems Engineering for Land Vehicles SysEngLV

Systems Engineering for Land Vehicles
Leistungspunkte / Credit Points: 8

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Martin Meywerk
Dr.-Ing. Axel Scheibel
Dipl.-Ing. Hanno Ackerhans

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hanno.ackerhans@kmweg.de

Qualifikationsziel / Module Objectives and Competencies

- Fundametals about the role of systems technology in the various life-cycle stages.
- Conceptional fundamentals and technical as well as non-technical design criteria and parameters fort he operation of land vehicles.
- Interdependencies and synergies of different design options

Inhalte / Content

- Definition of the term "systems engineering".
- Past milestones in the development of country systems.
- Exemplary analysis of the system layout of various existent weapons systems.
- Demand analysis and derivation of functional demands.
- Conceptual design of a balanced overall system.
- Primary criteria for system design.
- Technical and non-technical interpretation conflicts.
- Ensuring modularity, flexibility and growth potential in the concept phase.
- Transfer of basic concepts developed for different systems to maximize system performance.
- Demand management and controlling.

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Systems Engineering for Land Vehicles	L	2	ST/AT
Systems Engineering for Land Vehicles	E	1	ST/AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture : in the auditorium with PC (and projector), panel
Exercise: Joint development of concepts and solutions to exercises and individual presentation of students homework for a scenario adapted optimized system design
Excursion(s): to respective companies are scheduled.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content

	-	Knowledge of mathematics, mechanics, electrical engineering, information technology in accordance with the engineering science study program (BA)

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	2x12	2	48
Exercises	2x12	1	24
Preparation and follow-up	2x12	5	120
Preparation for exam			48
Total			**240**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

Trimester 2,3

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Further reading list will be announced in the lecture.

Modul Terramechanics and Off-Road Vehicle Engineering TerrOffRVE

Terramechanics and Off-Road Vehicle Engineering
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Martin Meywerk

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martin.meywerk@hsu-hh.de +49 40 6541 2728

Qualifikationsziel / Module Objectives and Competencies

The students can apply in-depth experimental analysis of deformable soils and how to evaluate trafficability of deformable soils with experiments as well as with modelling and simulation techniques using advanced methods (MBS, FEM) referring to NG-NRMM (Next Generation NATO Reference Mobility Model). They know different powertrains for off-road trucks and tracked vehicles as well as their characteristics. They understand the need of differentials locks (longitudinal and lateral) and rough terrain as well as the relationship to different kinds of suspensions. They know the principle design components of offroad vehicles.

Inhalte / Content

- Experimental methods for the investigation of the mechanical behaviour of soils
- Experimental methods for the trafficabiliy of tracked vehicle
- Experimental methods for the trafficabiliy of wheeled vehicle
- Design components of offroad vehicles: tyres, tracks, suspensions (springs and dampers), powertrains, transmissions
- Relationship between different components and trafficability
- Modelling and simulation for wheeled and tracked vehicles: MBS and FEM models

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
	L	2	AT
	E	1	AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Flipped classroom: Students watch short videos with online quizzes on their own; in the in-class wrap-up points are
clarified, the solution of the quizzes are explained and the lecturer summarizes the content; in the in-class exercises the
students put into practice what they have learned.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Mathematics, Engineering Mechanics

Verwendbarkeit des Moduls / Usability of Module

DST in ESDS

ab Studienbeginn 01.01.2024: WPF in M.Sc. Mech SSP AMW

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

1 Trimester

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Meywerk, M.: Vehicle Dynamics, Wiley, 2015
Wong, J.Y.: Terrain Behaviour, Off-Road Vehicle Performance and Design