Joint Degree Master Program in Biomedical Engineering

Joint Course Catalogue

Status: January 30, 2024
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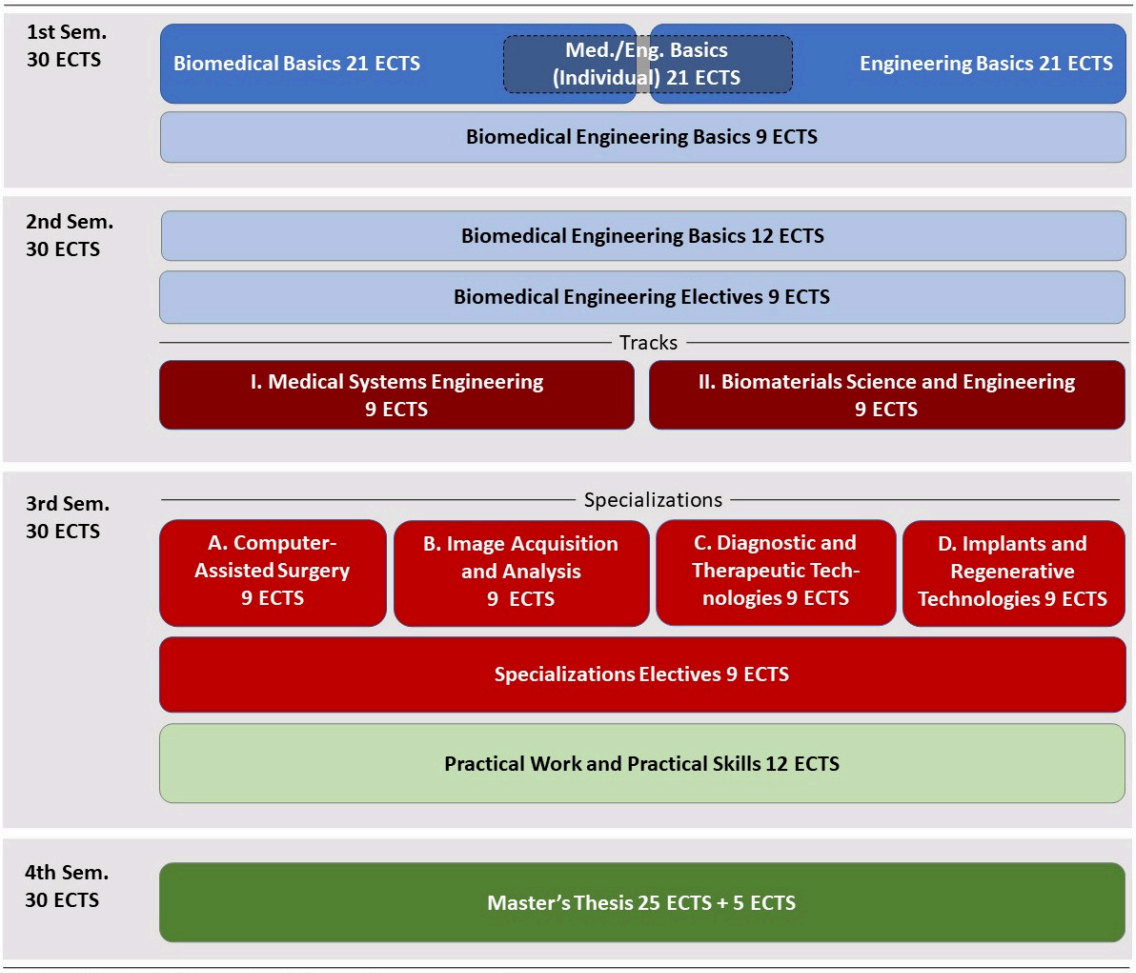
Official course catalogue of the joint degree master program in biomedical engineering. For more details and course registration see https://biomedicalengineering.ch/.

Program Structure



* Not all combinations of modules can be guaranteed

Table of Contents

C06 / M-SBME-MSc C06

Hardware Programming of Medical Sensors

Module	Biomedical Basics
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Autumn semester
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, max. 1 repetition allowed (no re-registration to the course possible)
Assessment Details	Graded exercises or group works (20%), written exam at course end (80%)
Workload	3 ECTS
Lecturer(s)	Reto Wildhaber <reto.wildhaber@fhnw.ch> (Coordinator) Simon Lemoigne nn Nn Frédéric Waldmann
Course contents	Theory (28 contact lessons) - Microcontroller structures and introduction to C programming - Sensors with analoge and digital sensor interfaces - Analog-to-digital conversion and technologies - Memory management on microcontrollers (MCs) - Digital data flow on MCs and interrupt safety. - Data containers and structures on MCs. - Basic signal processing algorithms - Alternative hardware structures and low-power technologies: MC, FPGA, ASICs. Exercises (14 contact or online lessons) - Weekly or biweekly exercise / Q&A / Lab sessions
Bibliography (Mandatory / Optional)	t.b.d.
Entry Requirements	Basics in programming and electronics / micro controllers
Learning Outcome and Competences	After completing the module, students will be able to… • evaluate a hardware platform for given application • connect a sensor to a microcontroller system • implement digital data acquisition using microcontrollers • perform optimal analog-digital conversion
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	September 07, 2023

C07 / 69465-01

Physiology & Anatomy: Digestive, Endocrine and Urinary System

Module	Biomedical Basics
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Lecture with internship weekly
Assessment Regulations	Type: main lecture exam Repeatability: no repetition Evaluation Scale: 1-6 0,1
Assessment Details	Examen Multiple Choice Exam
Workload	3 ECTS
Lecturer(s)	
Course contents	Endocrine System Pathophysiology of the Endocrine System Gastroenterology (Eat and grow) Kidney and Urinary System Pathophysiology of the Kidney and Urinary System Gastrointestinal System
Bibliography (Mandatory / Optional)	SILVERTHORN, D. U. (2019). Human physiology: an integrated approach. Atlas of Human Anatomy (Netter Basic Science), Seventh Edition, Elsevier Publishers
Entry Requirements	Students in Biomedical Engineering others upon request to master-dbe@unibas.ch only!
Learning Outcome and Competences	
Comments	next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280155
Last Updated	July 10, 2023

C08 / 69466-01

Physiology & Anatomy: Locomotor System and Skin

Module	Biomedical Basics
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Lecture with internship weekly
Assessment Regulations	Type: main lecture exam Repeatability: no repetition Evaluation Scale: 1-6 0,1
Assessment Details	Examen, Multiple Choice Prüfung
Workload	3 ECTS
Lecturer(s)	
Course contents	Physiology and Anatomy of the Musculoskeletal System Pathophysiology of the Musculoskeletal System Dermatology (Skin – barrier between inside and outside)
Bibliography (Mandatory / Optional)	SILVERTHORN, D. U. (2019). Human physiology: an integrated approach Atlas of Human Anatomy (Netter Basic Science), Seventh Edition, Elsevier Publishers
Entry Requirements	Students in Biomedical Engineering others upon request to master-dbe@unibas.ch only!
Learning Outcome and Competences	
Comments	next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280156
Last Updated	July 10, 2023

C09 / 69462-01

Physiology & Anatomy: Head and Spinal Cord

Module	Biomedical Basics
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Lecture with internship weekly
Assessment Regulations	Type: main lecture exam Repeatability: no repetition Evaluation Scale: 1-6 0,1
Assessment Details	Examen, Multiple Choice Exam
Workload	3 ECTS
Lecturer(s)	
Course contents	Neurology (Central command) - Anatomy and Cell Physiology and Neural System - Pathophysiology of the Neural System - Anatomy and Physiology of the Sense Organ (visual, auditory system and smell/taste) - Pathophysiology of the Sense Organs
Bibliography (Mandatory / Optional)	Atlas of Human Anatomy (Netter Basic Science), Seventh Edition, Elsevier Publishers SILVERTHORN, D. U. (2019). Human physiology: an integrated approach
Entry Requirements	Students in Biomedical Engineering others upon request to master-dbe@unibas.ch only!
Learning Outcome and Competences	
Comments	next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280157
Last Updated	July 10, 2023

C10 / 69464-01

Physiology & Anatomy: Cardiovascular and Respiratory System

Module	Biomedical Basics
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Lecture with internship weekly
Assessment Regulations	Type: main lecture exam Repeatability: no repetition Evaluation Scale: 1-6 0,1
Assessment Details	Examen Multiple Choice Exam
Workload	3 ECTS
Lecturer(s)	
Course contents	Anatomy of and physiology of the respiratory system (Breathing is everything) Anatomy and physiology of the cardiovascular system (Circulation) Anatomy of and physiology of hematology/ immunology (Blood – more than red) Pathophysiology of the cardiovascular system, the respiratory system, the immune system
Bibliography (Mandatory / Optional)	SILVERTHORN, D. U. (2019). Human physiology: an integrated approach Atlas of Human Anatomy (Netter Basic Science), Seventh Edition, Elsevier Publishers
Entry Requirements	Students in Biomedical Engineering others upon request to master-dbe@unibas.ch only!
Learning Outcome and Competences	
Comments	next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280154
Last Updated	July 10, 2023

C11 / 52054-01

Biology of Tissue Regeneration

Module	Biomedical Basics
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester
Format	Lecture weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	Presentation of a topic related to Tissue Regeneration Multiple Choice Exam Attendance of 10/14 lectures minimum is mandatory
Workload	3 ECTS
Lecturer(s)	Karoliina Pelttari <karoliina.pelttari@unibas.ch> (Coordinator) Arnaud Scherberich
Course contents	1. Structure and organization of a cell: the fundamental unit of life (Olga Krupkova) 2. Cell division and protein synthesis (Adrien Moya) 3. Cell-cell- and cell-matrix interactions (Arnaud Scherberich) 4. Tissue organization and morphogenesis (Karoliina Pelttari) 5. Stem cells (Nunzia di Maggio) 6. Endogenous tissue regeneration: wound healing (Olga Krupkova) 7. Angiogenesis and vasculogenesis for tissue regeneration (Andrea Banfi) 8. Cartilage tissue (Andrea Barbero) 9. Bone tissue/organ (Arnaud Scherberich) 10. Nerve tissue (Elisabeth Kappos) 11. Cardiac tissue (Anna Marsano) 12. Principles of regenerative medicine and their applications (Ivan Martin) 13. Series presentation by students (I) 14. Series presentation by students (II)
Bibliography (Mandatory / Optional)	
Entry Requirements	
Learning Outcome and Competences	students will gain fundamental knowledge on cell biology and on the molecular and cellular mechanisms responsible for the development and regeneration of different types of tissues/organs. Additionally, students will receive information on selected rapidly emerging multidisciplinary fields of regenerative medicine
Comments	
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280153
Last Updated	July 10, 2023

C12 / 69467-01

Bioengineering Basics I

Module	Biomedical Basics
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester
Format	Lecture weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	Student’s presentation & Multiple choice exam (50/50 weight)
Workload	3 ECTS
Lecturer(s)	Pablo Sinues <pablo.sinues@unibas.ch> (Coordinator) Oliver Braissant nn Nn Iris Schulz
Course contents	1. Biochemistry Refresher: Water, Acids, Bases, and Buffers ¦ Cell building blocks 2. Microbiology basics I: Bacteria, Fungi and Viruses 3. Microbiology basics II: Sterility and decontamination ¦ Antimicrobial substances and targets 4. Basic genetics: DNA structure and function 5. Advanced genetics: Principles of genetic mutation, and associated human diseases ¦ Gene technology 6. Metabolism I: Basics thermodynamic ¦ G and energy metabolism 7. Metabolism II: Anabolism & catabolism 8. -OMICS I: Genomics (GWAS) ¦ Epigenomics (EWAS) ¦ Transciptomics (RNAseq) 9. -OMICS II: Proteomics ¦ Metabolomics 10. Biofluids 11. Biomarkers 12. Method validation ¦ Quality control ¦ Reference intervals
Bibliography (Mandatory / Optional)	Alberts, B., Hopkin, K., Johnson, A., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2019). Essential cell biology (Fifth edition, international students edition ed.). W. W. Norton & Company Ha, C.-E., & Bhagavan, N. V. (2011). Essentials of Medical Biochemistry: With Clinical Cases. Elsevier Science.
Entry Requirements	
Learning Outcome and Competences	After completing the module, students will be able to: • Comprehend essential notions necessary for a training in biology-related engineering fields. • Describe the basic components and functions found in cells • Translate information from genetic code • Describe essential metabolic pathways • Verify statements about specific cellular mechanisms
Comments	
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280240
Last Updated	July 10, 2023

C01 / M-SBME-MSc C01

Atomic View to Materials

Module	Engineering Basics
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Autumn semester
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, max. 1 repetition allowed (no re-registration to the course possible)
Assessment Details	- Individual oral examination, 30 min.
Workload	3 ECTS
Lecturer(s)	Michael de Wild <michael.dewild@fhnw.ch> (Coordinator) Klaus Mayer Bert Müller
Course contents	Periodic table of elements; Bravais lattices (Müller, 2) - Tutorial 01 (Question 1: Chemical elements within the human body; Question 2: Description of crystalline lattices) Chemical and physical bonds in condensed matter (Müller, 2) - Tutorial 02 (Question 1: Ionic crystal with covalent character—magnesium oxide; Question 2: Explaining properties of metals, semiconductors, and insulators) Polymeric solid states (Müller, 2) - Tutorial 03 (Question 1: Properties of polyether ether ketone (PEEK) and polyethylene (PE); Question 2: Crystalline structures in polymers) Microstructure, surfaces and interfaces (de Wild, 2) - Tutorial 04 (Question 1: Photoelectric effect; Question 2: Calculation of grain size) Preparation of surfaces for implants (de Wild, 2) - Tutorial 05 (Question 1: Surface roughness measurements; Question 2: Hydrophobicity of surfaces) Crystal defects in medically relevant materials (Müller, 2) - Tutorial 06 (Question 1: Zero-dimensional defects; Question 2: One-dimensional defects) Simple crystal structures of elements and compounds (Müller, 2) - Tutorial 07 (Question 1: Titania structures; Question 2: Optical and electron microscopy) Electrical and optical properties; Optical and electron microscopy (de Wild, 2) - Tutorial 08 (Question 1: Monte Carlo Simulation Energy Dispersive Spectroscopy (EDX); Question 2: calculation of absorption coefficient) Computed tomography for tissue and implant characterization (Müller, 2) - Tutorial 09 (Question 1: Conventional X-ray sources; Question 2: Interactions of X-rays with matter) Crystal and thin-film growth including online monitoring (Müller, 2) - Tutorial 10 (Question 1: Hierarchy of activated processes; Question 2: Molecular beam deposition) Materials in dentistry, microstructures, phases, biodegradation (de Wild, 2) - Tutorial 11 (Question 1: De- and re-mineralization of enamel; Question 2: XRD phase identification) Small-angle X-ray scattering for materials and tissue characterization (Müller, 2) - Tutorial 12 (Question 1: Tooth structure in health and disease; Question 2: Lipid bilayer thickness measurement) Experiments, error estimation/Statistics: Spectrometer, Pohl oscillator (Mayer, 2) - Tutorial 13 (Question 1: Resonances; Question 2: Error analysis) Labtour and Q&A session: Demonstrations of surface and bulk characterization methods and systems for additive manufacturing (de Wild, 2) - Tutorial 14 (Question 1: Measuring crystal shape; Question 2: Ostwald ripening)
Bibliography (Mandatory / Optional)	- W.D. Callister, D.G. Rethwisch, Materials Science and Engineering: SI Version (English), Wiley-VCH Verlag GmbH & Co KgaA, 2016. - G. Carter, D. Paul, Materials Science and Engineering, ASM International, Materials Park, OH,

2010. ISBN 978-0-87170-399-6.
- Interactive simulations (https://phet.colorado.edu/en/simulations/category/new)

Entry Requirements

Defined entry level
- Bachelor degree with medical or engineering background

Learning Outcome and Competences

The students will understand the atomic and molecular structure of solid states and soft materials. Based on this knowledge, the students will be able to draw conclusions about material properties on the macroscopic scale to select and tailor their characteristics for medical applications including the broad variety of medical implants made from metals, ceramics, polymers, composites, etc. The microscopic, crystallographic and spectroscopic characterization of materials down to the atomic level will be discussed, as this is the main prerequisite for innovations and improvements. Finally, the biocompatibility of implant materials will be explored.

After completing the module, students will be able to…
- understand the arrangement of element within the periodic table
- explain potential arrangements of atoms in crystal lattices
- describe bonding of atoms in molecules and condensed matter
- understand microscopy of materials and tissues
- present the importance of the microstructure for quality control.
- explicit reciprocal-space techniques for materials characterization
- understand structure-function relationship of materials
- engineer materials for medical applications.

Comments

- Lectures
- Power-point presentations as pdf-files
- Parts of textbooks
- Relevant journal articles
- Interactive simulations
- Lab tour and Q&A session
- Group work, experiment evaluation and interpretation
- Tutorial questions and example solutions

2 lectures per week à 45 Min, whole semester 14 weeks
(1st and last event 2 lecturers: intro/overview/requirements, resp. summary/important points for exam/Q&A-session)

Course Enrolment

https://esp.hls.fhnw.ch

Further Details

FHNW Inside-> "Mein Studium"

Last Updated

September 07, 2023

C02 / M-SBME-MSc C02

Programming Basics with MATLAB

Module	Engineering Basics
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Autumn semester
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, unlimited repeatable
Assessment Details	• Final e-assessment, individual (100%)
Workload	3 ECTS
Lecturer(s)	Oliver Mülken <oliver.muelken@fhnw.ch> (Coordinator) Joris Pascal Pablo Sinues
Course contents	
Bibliography (Mandatory / Optional)	• https://ch.mathworks.com/help/matlab/index.html?s_tid=hc_panel • MATLAB for biomedical engineers and scientists; A. P. King and P. Aljabar, Elsevier Science, 2022
Entry Requirements	Technical: • Own laptop • Latest MATLAB version installed. The FHNW provides MATLAB including licence. Download the supported version form https://www.fhnw.ch/plattformen/ict/softwaredownload/ Intellectual: • Basic understanding of Algebra, https://www.khanacademy.org/math/get-ready-for-algebra-i https://www.khanacademy.org/math/algebra • Basic understanding of Analysis, https://www.khanacademy.org/math/get-ready-for-precalculus • Basic knowledge of dealing with computer applications
Learning Outcome and Competences	After completing the module, students will be able to… • operate the basics of the MATLAB interface. • recognize and define different objects such as vectors and matrices. • explain and perform simple computations with defined objects. • import data sets into MATLAB. • manipulate imported data sets. • Implement plotting of imported data sets and fitting functions to the data. • analyse data using filters such as moving averages. • write code for simple MATLAB functions. • understand how different loops structures are used in MATLAB. • write code for simple MATLAB scripts. • apply MATLAB to applications in Biomedical Engineering.
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	January 26, 2024

C03 / M-SBME-MSc C03

Electrical Engineering and Electronics Basics

Module	Engineering Basics
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Autumn semester
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, max. 1 repetition allowed (no re-registration to the course possible)
Assessment Details	Written exam at course end (100%)
Workload	3 ECTS
Lecturer(s)	Reto Wildhaber <reto.wildhaber@fhnw.ch> (Coordinator)
Course contents	Theory (28 contact lessons) - Resistive Network Analysis - AC Network Analysis - Transient Analysis - Frequency Response and System Concept - Semiconductors and Diodes - Transistor Fundamentals - Operational Amplifiers Exercises (14 contact or online lessons) - weekly or biweekly exercise or Q&A sessions
Bibliography (Mandatory / Optional)	Course book: Giorgio Rizzoni, James A. Kearns, "Principles and applications of electrical engineering", 978-00-7352-9592
Entry Requirements	Basics in physics, mathematics
Learning Outcome and Competences	After completing the module, students will be able to… - analyze linear RLC-networks - draw a passive linear filter - understand the concepts of semiconductors such as diodes - analize a basic circuit including transistors - analize a basic circuit including operational amplifiers
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	September 07, 2023

C04 / 52055-01

Mathematics in Biomedical Engineering I

Module	Engineering Basics
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester
Format	Lecture with practical courses weekly
Assessment Regulations	Type: main lecture exam Repeatability: no repetition Evaluation Scale: 1-6 0,1
Assessment Details	Examen - 50% of homework exercises points. - 50 % Written exam;
Workload	6 ECTS
Lecturer(s)	Edgar Delgado-Eckert <edgar.delgado-eckert@unibas.ch> (Coordinator) Georg Schulz
Course contents	Ordinary differential equations and linear algebra.
Bibliography (Mandatory / Optional)	James Stewart "Calculus", International Metric Edition, 8th Edition. David Poole "Linear Algebra : A Modern Introduction", 4th Edition.
Entry Requirements	Maths skills of a Swiss Matura-level
Learning Outcome and Competences	- Solve first order and second order ordinary differential equations. - Learn the basic concepts of linear algebra and vector spaces. - Apply the theory of vector spaces to analyzing data, e.g., principal component analysis (PCA).
Comments	Digital media via "Cengage's WebAssign" (https://www.webassign.net/wa-auth/login) next offer HS 2023
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280201
Last Updated	July 10, 2023

C16 / 69471-01

Mechanics I: Statics

Module	Engineering Basics
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester
Format	Lecture with practical courses weekly
Assessment Regulations	Type: main lecture exam Repeatability: no repetition Evaluation Scale: 1-6 0,1
Assessment Details	Examen
Workload	3 ECTS
Lecturer(s)	Georg Rauter <georg.rauter@unibas.ch> (Coordinator) Nicolas Gerig
Course contents	Vector calculus, basics of statics, equilibrium, degrees of freedo/statical determindness, general approach for solving equilibrium problems, girders, rope statics (infinitesimal calculus, concepts for optimization), distributed forces, center of mass/gravity/volume, statics of beams friction, principle of virtual work Matlab will be introduced as a basic calculation and plotting tool
Bibliography (Mandatory / Optional)	
Entry Requirements	
Learning Outcome and Competences	
Comments	
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280202
Last Updated	July 10, 2023

C17 / 69472-01

Programming Basics with Python

Module	Engineering Basics
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester
Format	Lecture with practical courses weekly
Assessment Regulations	Type: continuous assessment Repeatability: as often as necessary Evaluation Scale: Pass / Fail
Assessment Details	continous assessment 200 of 240 points in weekly exercises quiz
Workload	3 ECTS
Lecturer(s)	Philippe Cattin <philippe.cattin@unibas.ch> (Coordinator) nn Nn
Course contents	The goal of the lecture is to prepare students to work with Python and various other tools. We will provide an overview of different useful tools, including Visual Studio, GitHub, and working with the console. Additionally, we will offer a crash course on important features and libraries of Python, such as classes, modules, numpy, pandas, and scikit-learn. We will also explore faster computation using PyTorch on the GPU and briefly discuss AI-assisted programming
Bibliography (Mandatory / Optional)	
Entry Requirements	• Some programming experience is recommended • A laptop is required for this course
Learning Outcome and Competences	1. Understand Python fundamentals and gain proficiency in the language. 2. Learn essential tools for Python development, e.g., Visual Studio, GitHub, and consoles. 3. Explore important Python features and libraries, e.g., classes, modules, numpy, pandas, and scikit-learn. 4. Utilize PyTorch on the GPU for faster computations. 5. Discuss AI-assisted programming and its applications. 6. Apply Python and relevant tools in real-world scenarios. 7. Foster a foundation for further learning in Python and related technologies
Comments	
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280203
Last Updated	July 10, 2023

C13 / M-SBME-MSc C13

Materials Science and Biomaterials

Module	Biomedical Engineering Basics
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Autumn semester
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, max. 1 repetition allowed (no re-registration to the course possible)
Assessment Details	Written exam, 90 minutes
Workload	3 ECTS
Lecturer(s)	Bert Müller <bert.mueller@unibas.ch> (Coordinator) Michael de Wild Madduri Srinivas

Course contents

Introduction into biomaterials science and engineering: Hierarchy of structures: Human-organ-tissue-cells-biomolecules-atoms; Titanium-based dental implant as example for tissue-materials interface (Müller/de Wild, 2)
- Tutorial 01 (Question 1: Estimating the number of atoms within a human tooth; Question 2: Contact-angle measurements)

Atomic/molecular structure of condensed matter (Müller, 2)
- Tutorial 02 (Question 1: Physical description of crystalline lattices; Question 2: Explaining materials properties by atomic interactions)

Polymeric solid states including their binding (Müller, 2)
- Tutorial 03 (Question 1: Prerequisites for the formation of polymer crystals; Question 2: Bond-property relations)

Polymers for medical implants including hydrogels (Madduri, 2)
- Tutorial 04 (Question 1: Procedure, a medical doctor carries out applying PMMA as bone cement; Question 2: Determination of glass transition temperature)

Materials-tissue interface; Standards in biocompatibility testing (de Wild, 2)
- Tutorial 05 (Question 1: Definition of biocompatibility and other relevant terms; Question 2: Interactions between implant and surrounding tissues)

Description of crystal defects (Müller, 2)
- Tutorial 06 (Question 1: Role of entropy in crystal defect formation (vacancies); Question 2: Interactions of dislocations using Burgers vectors)

Characterization of materials – bulk and surfaces (de Wild, 2)
- Tutorial 07 (Question 1: Debye-Scherrer method (powder diffraction); Question 2: Electron spectroscopy for chemical analysis (ESCA))

Natural and synthetic ceramics for implants and regenerative medicine; mechanical properties (de Wild, 2)
- Tutorial 08 (Question 1: Calcium phosphate phases; Question 2: Preparation steps of ceramic products)

Metal-based implants with focus on NiTi (de Wild, 2)
- Tutorial 09 (Question 1: Stress shielding; Question 2: Shape memory-based medical implants)

Formation of solid-state materials (Müller, 2)
- Tutorial 10 (Question 1: Liquid-solid transition; Question 2: Concept of critical nucleus -surface and bulk)

Materials and technologies in oral health (Müller/Sigron, 2)
- Tutorial 11 (Question 1: Oral scanners and their accuracy; Question 2: Spatially resolved small-angle X-ray scattering to characterize nano-anatomy)

Artificial sphincters, Stimuli-responsive liposomes (Müller, 2)
- Tutorial 12 (Question 1: Mechanical properties of human soft tissues; Question 2: The Fahraeus-Lindqvist effect and the human blood vessel system)

Sterilization methods, Mechanical testing of implants, fractography (de Wild, 2)

- Tutorial 13 (Question 1: Sterilization methods; Question 2: Stress-strain correlation to Vickers measurements)

Materials selection in implant design; Employing materials science for improving human health: Example brain-computer interface; Q&A session (Müller/de Wild, 2)
- Tutorial 14 (Question 1: Materials and component selection for a hip joint; Question 2: Challenges in brain imaging)

Bibliography (Mandatory / Optional)

- Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons: "Biomaterials Science: An Introduction to Materials in Medicine", 2nd edition, Elsevier Academic Press.
- W.D. Callister, D.G. Rethwisch, Materials Science and Engineering: SI Version (English), Wiley-VCH Verlag GmbH & Co KgaA, 2016.
- G. Carter, D. Paul, Materials Science and Engineering, ASM International, Materials Park, OH, 2010. ISBN 978-0-87170-399-6.
- Interactive simulations (https://phet.colorado.edu/en/simulations/category/new)

Entry Requirements

Defined entry level
- Scientific background in medicine, chemistry, physics or analytical chemistry.
- Basic lectures on chemistry and physics are a prerequisite to follow this course.

Learning Outcome and Competences

The students will understand the atomic and molecular structure of solid states and soft materials. Based on this knowledge, the students will be able to draw conclusions about material properties on the macroscopic scale to select and tailor their characteristics for biomedical applications including the broad variety of medical implants made from metals, ceramics, polymers, composites, etc. The biological, mechanical, chemical, spectroscopic and tribologic characterization of materials down to the atomic level will be discussed, as this is the main prerequisite for innovations and improvements. State-of-the-art technologies and methodologies for the analysis of materials will be discussed. This lecture series also covers selected fabrication procedures for a variety of implants, including a discussion of phase transformations and thermally activated processes. The biocompatibility of implant materials will be explored. Biocompatibility does not only depend on the chemical composition but also on the surface morphology and critically on the specific host tissue.

After completing the module, students will be able to…
- give an overview of the broad spectra of metallic, polymeric and ceramic biomaterials from the perspective of materials science from the macroscopic to the nanoscopic scale
- explain uses and selection criteria for biomaterials
- express how to exploit the structure-function relationship of materials
- explain different state-of-the-art technologies and methodologies for the analysis of materials
- understand fabrication of biomaterials for medical implants
- understand the concept of biocompatibility
- classify biomaterials according to the response of the biological system.
- justify the importance of physical-chemical analyses for determining biocompatibility.

Comments

Course Enrolment

https://esp.hls.fhnw.ch

Further Details

FHNW Inside-> "Mein Studium"

Last Updated

September 07, 2023

C14 / 69469-01

Introduction to LTI-Systems and Control

Module	Biomedical Engineering Basics
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester
Format	Lecture with practical courses weekly
Assessment Regulations	Type: main lecture exam Repeatability: no repetition Evaluation Scale: 1-6 0,1
Assessment Details	Examen written 2.5h
Workload	3 ECTS
Lecturer(s)	Georg Rauter <georg.rauter@unibas.ch> (Coordinator) Nicolas Gerig
Course contents	LTI-systems, Frequency response, Analytical control synthesis, Nyquist and bode plots, Transition Matrix, State transform, controlability, observability, transition from transfer functions to state space models (normals forms), state control (pole placement, stabilizability, stabilization of arbitrary working points), State observer, Kalman filter Group project for stabilizing an inverted pendulum using TwinCAT3 & Matlab Simulink Matlab/Simulink will be used as a basic calculation, simulation, and visualization tool
Bibliography (Mandatory / Optional)	
Entry Requirements	
Learning Outcome and Competences	
Comments	
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280237
Last Updated	July 10, 2023

C15 / M-SBME-MSc C15

Medical Imaging and Medical Image Processing

Module	Biomedical Engineering Basics
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Autumn semester
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, max. 1 repetition allowed (no re-registration to the course possible)
Assessment Details	• Student presentations, groups of 2-3 (20 %) • Closed book examination at the end of the semester (80 %)
Workload	3 ECTS
Lecturer(s)	Antje Knopf <antje.knopf@fhnw.ch> (Coordinator)
Course contents	1. Image Formation (Overview imaging modalities, Overview image reconstruction) 2. Basics 3. Image Processing in the Clinic (Image Processing Chain, Data Formats) 4. Image Enhancement in the spatial domain I (Noise, Smoothing) 5. Image Enhancement in the spatial domain II (Template matching, Edges) 6. Image Enhancement in the frequency domain 7. Morphological image processing 8. Image Segmentation 9. Feature extraction (4D images, Optical Flow, Visualization, Surface rendering, Volume rendering, Introduction Image Processing with AI) 11. 4D images 12. Visualization Volume rendering
Bibliography (Mandatory / Optional)	Dougherty, G. (2009). Digital Image Processing for Medical Applications. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511609657
Entry Requirements	Bachelor level of analysis, linear algebra, statistics, basic Matlab and/or Python programming skills
Learning Outcome and Competences	After completing the course, students will be able to • apply image processing methods to basics image analysis problems • understand the typical image processing chains on clinical applications • knowing some advanced image processing methods
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	September 07, 2023

C20 / M-SBME-MSc C20

Sensor and Signal Processing

Module	Biomedical Engineering Basics
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Spring semester
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	
Assessment Details	Assessment of the group work throughout the semester & report in form of a short scientific paper (100%), groups of 2 to 4. Group work with individual assessment (the own contribution to the group results is evaluated)
Workload	3 ECTS
Lecturer(s)	Joris Pascal <joris.pascal@fhnw.ch> (Coordinator)
Course contents	System requirements specifications for the development of a sensor system for biomedical applications (Joris Pascal, 10 lessons) • Definition of the system requirements specifications Integrated sensors technologies (Joris Pascal, 11 lessons) • Introduction to electromagnetism • State of the art in high precision miniaturized magnetic sensors technologies • Performance assessment of different sensors for their application in biomedical engineering Signal processing techniques (Joris Pascal, 11 lessons) • Analog signal processing techniques for sensors offset and noise reduction • Digital signal processing (digital filters, FFT analysis) • Real time localization algorithm of embedded magnetic sensors Workshops in laboratory (Joris Pascal, 10 lessons) • Design and test of hardware and software with a prototype
Bibliography (Mandatory / Optional)	Relevant scientific papers will be provided to illustrate the state of the art
Entry Requirements	Bachelor level in analysis, linear algebra, electronics and signal processing. Preferably but not mandatory, students have attended to the following lectures during the first semester: C04 Mathematics for Biomedical Engineering C02 Programming Basics with MATLAB C03 Electrical Engineering and Electronics Basics C06 Hardware Programming of Medical Sensors
Learning Outcome and Competences	After completing the module, students will be able to: • understand the requirements for the development of embedded sensors and signal processing for medical devices (e.g. accuracy, long term stability, MRI compatibility) • develop a concept design (a high level description) for the implementation of sensor systems and signal processing for medical devices • select electronic components (e.g. integrated sensors, electronic front end, digital signal processing unit) • define and implement signal processing algorithm on embedded systems
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	November 21, 2023

C21 / 70402-01

Mechanics II: Dynamics

Module	Biomedical Engineering Basics
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Spring semester
Format	Lecture with practical courses weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	record of achievement
Workload	3 ECTS
Lecturer(s)	Georg Rauter <georg.rauter@unibas.ch> (Coordinator) Nicolas Gerig
Course contents	Concepts of different coordinate sytems and change of coordinate systems (Jacobian), kinematics of rigid bodies, basics of kinetics (impulse), kinetics of rigid bodies (inertia tensor, change of reference, dynamic Euler equations), kinetics of the center of mass, energy concepts (work, power, potential), oscillations (equilibrium conditions, linearization of the euqation of motion, free-/damped-/enforced oscillations of mass, spring, damper systems) Matlab and Maple will be used as basic calculation and simulation tools
Bibliography (Mandatory / Optional)	
Entry Requirements	Basics in Statics or C16
Learning Outcome and Competences	
Comments	
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280145
Last Updated	July 10, 2023

C26 / M-SBME-MSc C26

Medical Device Development

Module	Biomedical Engineering Basics
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, unlimited repeatable
Assessment Details	Case study: written report (75%) and presentation (video recording) (25%)
Workload	3 ECTS
Lecturer(s)	David Hradetzky <david.hradetzky@fhnw.ch> (Coordinator) Thorsten Göttsche Simone Hemm
Course contents	• Identification of stakeholders • Coding / De-coding diagnosis, procedures and reimbursement • Development process for medical devices in compliance with medical standards e.g. EN ISO 13485 • Application of European regulation (MDR) and national laws (MeDO) on medical devices • Conformity assessment procedure, identification and role of involved parties (Notified Bodies) • Application of risk management procedure for medical devices according EN ISO 14971 • Fundamentals in clinical evaluation according EN ISO 14155 • Harmonized standards • Guidance documents (as MEDDEV, NB-MED, MDCG, NBOG, CS) • Post market activities
Bibliography (Mandatory / Optional)	Regulation (EU) 2017/745 on medical devices (MDR) EN ISO 13485 EN ISO 14971 EN ISO 14155 (all documents will be available throughout the course)
Entry Requirements	-
Learning Outcome and Competences	After completing the module, students .. ... will be familiar with the regulations applied for medical device throughout Europe ... will be able to plan, design and run a project for medical device development according to European standards and complying with the Medical Device Regulation ... will be familiar with applying selected risk management procedure according DIN ISO 14971
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	January 23, 2024

C56 / 70411-01

Statistics for Biomedical Engineering

Module	Biomedical Engineering Basics
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Lecture with practical courses weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	• Presentation at the end of the course of a relevant paper covering statistical methods learned during the lectures (30%) • Exam (70%)
Workload	3 ECTS
Lecturer(s)	Pablo Sinues <pablo.sinues@unibas.ch> (Coordinator) Klaus Mayer
Course contents	The course will involve practical statistics and data-analysis techniques relevant in the biomedical engineering field, with a focus on solving biomedical problems. The course will introduce or repeat basic concepts of statistics but will emphasize on the use and application of statistics and understanding data analysis and representation rather than on understanding the mathematical background of statistics. The course will be set up around relevant and realistic datasets. Students will learn how to understand the fundamental concepts of descriptive and inferential statistics, analyze data and choose an appropriate hypothesis test to answer a given question, compute numerical statistical measures and perform hypothesis tests ‘by hand’, and visualize data and perform statistical analysis. They will learn and explore DOE techniques in a hands-on experiment and learn how to use error analysis to correctly determine (in-)accuracies, essential to the interpretation of any experiment.
Bibliography (Mandatory / Optional)	
Entry Requirements	Programming in MATLAB at the level of course “Programming Basics with MATLAB” (C02) Programming in Python at the level of course “Programming Basics with Python” (69472/C17)
Learning Outcome and Competences	After completing the module, students will be able to… • Visualize data using MATLAB and Python. • Summarize data via descriptive statistics. • Use Inferential Statistics. • Perform power and sample size calculations. • Use linear regression and correlation analysis. • Use linear mixed models and ANOVA analysis • Perform a DOE • Perform error analysis
Comments	
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=0
Last Updated	January 26, 2024

C05 / 53772-01

Mathematics in Biomedical Engineering II

Module	Biomedical Engineering Electives
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Spring semester
Format	Lecture with practical courses weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	-50% of homework exercises points. - 50%Written exam.
Workload	3 ECTS
Lecturer(s)	Edgar Delgado-Eckert <edgar.delgado-eckert@unibas.ch> (Coordinator) Georg Schulz
Course contents	Fourier Series, Fourier Transforms, and Laplace transforms and their applications to solving differential equations and image analysis. Systems of coupled linear first-order differential equations. Numerical methods for solving ordinary differential equations. Brief introduction to partial differential equations relevant in applied physics and engineering.
Bibliography (Mandatory / Optional)	Zill - Differential Equations with Boundary-Value Problems, International Metric Edition, 9th edition.
Entry Requirements	Ordinary differential equations and linear algebra (syllabus content of Mathematics for Biomedical Engineering I course, C04/52055).
Learning Outcome and Competences	- Representing functions as weighted infinite sums or integrals of suitable basic functions, such as trigonometric functions (Fourier series and Fourier transforms). - Laplace transforms: Learn how the operations of differentiation and integration can be mapped into algebraic operations, thus converting the task of solving an ordinary linear differential equation into the simpler task of solving an algebraic equation over the complex numbers. Applications to control theory (i.e. transfer functions). - Solve systems of coupled linear first-order differential equations. - Learn the algorithms behind numerical solvers of ordinary differential equations. - Get acquainted with partial differential equations relevant in applied physics and engineering.
Comments	Digital media via "Cengage's WebAssign" (https://www.webassign.net/wa-auth/login)
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280134
Last Updated	July 10, 2023

C22 / M-SBME-MSc C22

Optimization Methods

Module	Biomedical Engineering Electives
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, unlimited repeatable
Assessment Details	project work
Workload	3 ECTS
Lecturer(s)	Erik Schkommodau <erik.schkommodau@fhnw.ch> (Coordinator) Uri Nahum
Course contents	The major topics covered in the module are: • identification of problems solvable with optimization methods • abstraction and modelling of task description • coding of optimization tasks • getting overview about linear, non-linear, deterministic and stochastic optimization methods including necessary mathematical methods • implementation of examples from various fields with Matlab
Bibliography (Mandatory / Optional)	- Practical Methods of Optimization Paperback, by R. Fletcher, 2009 - Applied Dynamic Programming (Princeton Legacy Library), by Richard E. Bellman (Author), Stuart E Dreyfus, 2015 - Numerical Recipes: The Art of Scientific Computing, by William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, 3rd Edition
Entry Requirements	Bachelor level of analysis, linear algebra, statistics; Matlab programming skills There is an online tutorial available for students without Matlab skills
Learning Outcome and Competences	After completing the module, students will be able to: • explain and validate different optimization methods • apply them appropriately to problems in their field (e.g. medical measurement data).
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	November 21, 2023

C24 / 28420-01

Principles in Medical Imaging

Module	Biomedical Engineering Electives
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Lecture weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	Multiple Choice Exam
Workload	3 ECTS
Lecturer(s)	Philippe Cattin <philippe.cattin@unibas.ch> (Coordinator) Oliver Bieri Antje Knopf Francesco Santini
Course contents	This course presents the fundamental principles of medical imaging techniques such as magnetic resonance imaging (MRI), X-ray, computed tomography (CT), ultrasound (US), positron emission tomography (PET), and single photon emission computed tomography (SPECT). For each of these imaging modalities its physical principle, the mathematical methods for image generation and reconstruction, its anatomical and physiological information content and its limitations are discussed.
Bibliography (Mandatory / Optional)	"The Physics of Diagnostic Imaging". David J. Dowsett, Peter A. Kenny, R. Eugene Johnston, Chapman & Hall Medical. "The Essential Physics of Medical Imaging". Jerrold T. Bushberg, J.Anthony Seibert, Edwin M. Leidholdt Jr., John M. Boone, Williams & Wilkins.
Entry Requirements	C15, Medical Imaging and Medical Image Processing
Learning Outcome and Competences	The objective of this lecture is to introduce the basic physical principles of the imaging systems used in the medical field. The necessary background to understand the imaging devices will be taught.
Comments	
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280080
Last Updated	July 10, 2023

C25 / tbd

Angewandte Nano-Wissenschaftssethik

Module	Biomedical Engineering Electives
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Spring semester
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	
Assessment Details	
Workload	3 ECTS
Lecturer(s)	Roberto Andorno <roberto.andorno@unibas.ch> (Coordinator)
Course contents	
Bibliography (Mandatory / Optional)	
Entry Requirements	
Learning Outcome and Competences	
Comments	
Course Enrolment	
Further Details	
Last Updated	July 10, 2023

C27 / 70404-01

Bioengineering Basics II

Module	Biomedical Engineering Electives
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Lecture weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	Student’s presentation & Multiple choice exam (50/50 weight)
Workload	3 ECTS
Lecturer(s)	Pablo Sinues <pablo.sinues@unibas.ch> (Coordinator) Oliver Braissant nn Nn Götz Schlotterbeck
Course contents	Overview to the analytical techniques and instrumentation used clinical chemistry laboratories in hospitals
Bibliography (Mandatory / Optional)	
Entry Requirements	C12 Bioengineering I or a bachelor with a background with content of Bioengineering I
Learning Outcome and Competences	After completing the module, students will be able to understand the basic principles of: • Spectrophotometry • Chromatography and electrophoresis • Electrochemistry • Mass spectrometry • Nuclear magnetic resonance technology and clinical applications • Immunoassays ¦ Nucleic acid analysis ¦ PCR • Laboratory automation • Point-of-care testing • Clinical microbiology • Microcalorimetry and thermal analysis • Cell and microbial cultures
Comments	
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280147
Last Updated	September 25, 2023

C28 / 54876-01

Applied Engineering in the Hospital and Current Trends

Module	Biomedical Engineering Electives
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Spring semester
Format	Lecture weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	Presence: 80% (11/ 14 sessions) to be admitted to the exam. MCP- exam:
Workload	3 ECTS
Lecturer(s)	Niklaus Friederich <niklaus-f.friederich@unibas.ch> (Coordinator) nn Nn
Course contents	Cardiac Electrophysiology Scoliosis -Therapy Neuro-angiological interventions Thoracic Imaging Neuro Imaging DaVinci Surgery Neurosurgery- Navigation Breath Analysis AI in the Hospital Artificial Heart 3 D Print
Bibliography (Mandatory / Optional)	
Entry Requirements	Basics of human Anatomy similar to C60; limited number of students only, priority will be given to students the Master in Biomedical Engineering.
Learning Outcome and Competences	
Comments	
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280136
Last Updated	July 10, 2023

C29 / 48186-01

Lasers and Optics in Medicine

Module	Biomedical Engineering Electives
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Lecture weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	Attendance 5%, Practical Work 30%, Quiz 20% and Final oral Exam 45%
Workload	3 ECTS
Lecturer(s)	Ferda Canbaz <ferda.canbaz@unibas.ch> (Coordinator) nn Nn
Course contents	Introduction: Nature of light, fundamentals of light-matter interactions, photobiology, photophysics, photochemistry, laser and light sources. Light-Tissue Interactions: Photochemical interaction, biostimulation, photo-thermal effects, photoablation, plasma-induced ablation, photo-acoustic effects, photon transport Spectroscopy: Absorption, diffuse reflectance, fluorescence, Raman and tissue spectroscopy Bioimaging Principles and Techniques: Introduction to optical microscopy, principle of image formation, amplitude and phase microscopy, polarization, fluorescence and confocal microscopy, optical diffraction tomography and new microscopic techniques. 3D Bioimaging: Optical coherence tomography, polarimetry, diffuse optical tomography, photothermal imaging, photoacoustic imaging and optical biopsy.
Bibliography (Mandatory / Optional)	Recommended Reading: Prasad, P.N., “Introduction to Biophotonics”, (Wiley-VCH), 2003 Boudoux, C., "Fundamentals of Biomedical Optics, Niemz, H. M., "Laser-Tissue Interactions" Splinter, R., Hooper, B. A., "An introduction to Biomedical Optics"
Entry Requirements	Physics: electromagnetic theory and quantum mechanics basics, optics, electricity, and mechanics knowledge; Math: Fourier transform Limited student numbers (24), priority given to student in Biomedical Engineering
Learning Outcome and Competences	Students will learn the characteristics of light and lasers, laser-tissue interaction mechanisms, imaging conditions, and basics of 2D and 3D imaging modalities. With practical exercises, students will operate lasers and collect OCT images.
Comments	
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280137
Last Updated	July 10, 2023

C30 / M-SBME-MSc C30

Drug Delivery and Combination Products

Module	Biomedical Engineering Electives
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, unlimited repeatable
Assessment Details	written examination (50%), project work (25%), group work (25%)
Workload	3 ECTS
Lecturer(s)	David Hradetzky <david.hradetzky@fhnw.ch> (Coordinator) Reza Abedian Stephan Affolter Oliver Germershaus Jutta Hotz

Course contents

Introduction (Hradetzky, 1 lessons)
Drug delivery basics (Germershaus, 1, Abedian, 3)
• Basics in drug delivery, uptake of drugs, mode of action, side effects
• Biologics, nano medicine, oligonucleotide, gene therapy

Drug development (Abedian, 4)
• Clinical development
• Roadmap for drugs vs. medical devices

Regulations (Affolter, 6)
• Pharma regulatory lifecycle, Pharma GMP
• Combination products regulatory lifecycle in EU and US
• QMS requirements for combination products

Examples from the industry:

Coated and impregnated devices (Hotz, 8)
• VI and associated devices: history, requirements, kinetics, verification & validation, lab and clinical testing, pre-clinical and clinical studies, challenges and pitfalls

Devices for self-administration (Affolter, 2, Abedian 3)
• history, requirements, trends, kinetics, diagnostics, verification & validation, lab and clinical testing, human factor / usability studies, pre-clinical and clinical studies, challenges and pitfalls
• Software as a medical device / connected combined products

Bibliography (Mandatory / Optional)	
Entry Requirements	Anatomy and Physiology
Learning Outcome and Competences	After completing the module, students will be able to… … understand drug development process, stages and timelines … understand specific requirements of certain molecule types in interactions with delivery devices … develop a sound judgment on the most suitable delivery devices, considering design requirements, needs of certain drug substance and therapeutic areas as well as the target patient groups.
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	January 23, 2024

C31 / 53822-01

Advanced Methods in Medical Image Analysis

Module	Biomedical Engineering Electives
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Lecture weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	written exam
Workload	3 ECTS
Lecturer(s)	Philippe Cattin <philippe.cattin@unibas.ch> (Coordinator)
Course contents	This course provides an introduction to deep learning and how this cutting-edge technology can be applied to medical image analysis. The course covers the following topics • Fundamentals of deep learning • Numerical optimization (for training machine learning models) • Multilayer perceptrons • Convolutional Neural Networks (CNNs) and their medical applications • Segmentation with CNNs • Autoencoders • Generative models • Deep learning models for sequential data.
Bibliography (Mandatory / Optional)	
Entry Requirements	C15; Medical Imaging and Medical Image Processing; Python Knowledge or C17
Learning Outcome and Competences	• Understand the basics of deep learning and how it can be applied to medical image analysis • Understand numerical optimization algorithms used to train deep learning models • Understand the architecture and training of multilayer perceptrons and CNNs • Medical applications of MLPs and CNNs for classification, regression, segmentation, and anomaly detection tasks • Know different generative models and their medical applications • Know appropriate models for sequential data analysis
Comments	
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280238
Last Updated	September 07, 2023

C32 / M-SBME-MSc C32

Project Management and Intellectual Property

Module	Biomedical Engineering Electives
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, unlimited repeatable
Assessment Details	project work (2/3 project management 1/2 intellectual property)
Workload	3 ECTS
Lecturer(s)	David Hradetzky <david.hradetzky@fhnw.ch> (Coordinator) Markus Renz

Course contents

Project Management (21 lessons)

- Introduction
- Planning
- Execution
- Closure
- PM in BME: Medical Device Development, Healthcare IT, Research (case studies)
  Advanced PM topics: Project Portfolio Management, Agile Project Management, Leadership in Project Management, Strategic Project Management, International Project Management, Capstone Project
- Professional Development and Ethics: Ethics in Project Management, Professional Development for Project Managers, Project Management Certification

Intellectual Property (7)

- Overview
- Legislation: Copyright, Patent, Trademark, Traded Secret

Bibliography (Mandatory / Optional)

Entry Requirements

Learning Outcome and Competences

Learning outcomes
• Project Planning: Develop proficiency in creating comprehensive project plans, including defining scope, schedules, budgets, and risk assessments.
• Team Leadership: Acquire leadership skills to effectively manage and lead multidisciplinary teams
• Risk Management: Demonstrate the ability to identify, assess, and manage risks associated with complex projects.
• Communication Skills: Enhance communication skills for project stakeholders, including effective reporting, presentation, and documentation practices.
• Understand IP Basics: Develop a foundational understanding of intellectual property laws, including patents, trademarks, and copyrights.
• IP Strategy: Gain insights into formulating effective intellectual property strategies for protecting and managing innovations throughout their life cycle.
• Patent Analysis: Acquire skills in conducting patent analyses, including searching, reading, and interpreting patents.

Competences
• Effective Collaboration: Collaborate efficiently with diverse stakeholders, integrating engineering expertise with project management principles to achieve project goals.
• Resource Optimization: Optimize resources, both human and material, to ensure the successful completion of projects within time and budget constraints.

	• Adaptability: Develop adaptability and flexibility in responding to challenges and changes, applying agile project management principles when appropriate. • Strategic Decision-Making: Make informed decisions regarding the protection and commercialization of intellectual property. • IP Portfolio Management: Effectively manage and strategize intellectual property portfolios, considering business goals and market dynamics. • Ethical Considerations: Demonstrate an understanding of ethical considerations related to project decision-making and intellectual property.
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	January 23, 2024

C34 / M-SBME-MSc C34

Model-Based Signal Processing and Medical Diagnostics

Module	I. Medical Systems Engineering
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, unlimited repeatable
Assessment Details	Exercises or group works during the semester (20%) and written exam at semester end (80%).
Workload	3 ECTS
Lecturer(s)	Reto Wildhaber <reto.wildhaber@fhnw.ch> (Coordinator)

Course contents

Bioelectrical Signals and Physical Measurements in Diagnostics:
- Pathophysiology of selected cardiovascular, respiratory, and neuromuscular diseases.
- Diagnostic methods based on bioelectrical signals such as: ECG (Electrocardiography), icECG (Intracoronary Electrocardiography), esoECG (Esophageal Electrocardiography), and others.
- Diagnostic methods based on physical measurements such as: blood pressure, blood flow, blood gas, and air flow signals.

Fundamentals on Model-Based Signal Analysis:
- Introduction to linear filters
- Introduction to model-based signal analysis
- Working in a least-squares framework
- From sample to feature spaces
- Feature space manipulations
- Pattern detection, localization, and discrimination; recursive pattern matching
- Parameter estimation in feature space
- Distance measures and signal clustering/classification in feature space

Exercises and Practical Applications:
- Analysis of physiologic and pathologic ECG signals (examples):
  - Extraction of heart rate and heart rate variability
  - P-, T-, and QRS-wave detection and discrimination
  - Identification of wave onsets and durations
  - Detection of arrhythmia, clustering of heart beat morphologies
  - Analysis of invasive blood pressure signal recordings:
- Robust extraction of features in noisy signals such as minimum and maximum, notches, slopes, etc.

Bibliography (Mandatory / Optional)

Course material:
- Lecture script & (some) slides, selected book chapters.

Course references (optional):
- R. A. Wildhaber et al., Signal Detection and Discrimination for Medical Devices Using Windowed State Space Filters, Biomedical Engineering (BioMed 2017), DOI: 10.2316IP.20J7.852-020
- Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006 (Only selected chapters)
- J. Enderle, J. Bronzino, Biomedical Engineering, 3rd Edition, Elsevier, 2012 (Only selected chapters)
- R. A. Wildhaber et al., Windowed State-Space Filters for Signal Detection and Separation, IEEE Transactions on Signal Processing (Volume: 66, Issue: 14, July 15, 2018)

Entry Requirements

- Basic background in linear algebra and probability theory.
- Basic programming skills in Python (or Matlab).
- A background in human physiology.

Learning Outcome and Competences

After completing the module, students will be able to…
- understand bioelectric signals and how they are induced.
- know some example diseases of the cardiovascular and pulmonary system and the purposes of

	diagnostic measurements and devices. - understand diagnostic tools that rely on bio(electrical) signals or dynamic pressure or flow measurements. - assess the quality of observed signals and is aware of most relevant signal artefacts. - understands the concepts of linear and non-linear filters. - understanding the concepts of time-domain and frequency-domain filtering - understands the concepts of model-based signal processing in a least-squares error framework. - understands complex model designs. - knows methods to detect known signal templates, such as ECG waves of particular shape, in a noisy and interfered signal. - knows methods to deal with superimposed signals (e.g., bioelectrical signals superimposed by some baseline artefacts). - knows methods to extract features from a biological signal. - knows how to take advantage of multi-channel signals.
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	January 24, 2024

C35 / 48882-01

Applied Control

Module	I. Medical Systems Engineering
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Lecture with practical courses weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	Form: 2 homework assignments, group work, oral exam The students will have to hand in homework for the lectures until the end of the semester. 80% of the homework should be evaluated positive. In addition, the students have to complete practical work on a robotic system using Matlab/Simulink and TwinCAT3 during the semester (can be accomplished in small groups). The combination of Matlab/Simulink and TwinCAT3 is taught in a preeceeding block course one week before the beginning of every semester (55664-01 - Block course) and is therefore a requirement for attending this course. The homework and practical work will be discussed individually during an oral exam at the end of the semester.
Workload	3 ECTS
Lecturer(s)	Georg Rauter <georg.rauter@unibas.ch> (Coordinator) Nicolas Gerig
Course contents	The lecture is split into a lecture part, where students learn theoretical aspects on control and a practical part where they apply their knowledge on a real robotic system. The lecture will build upon basics in continuous linear time-invariant systems (LTI-systems, taught in 26937-01_Data Processing and Control). Starting with time discrete systems, the students will learn transforming time continuous systems to time discrete ones, see how to design simple controllers (PID), will employ Bode plots for control design according to certain requirements (cutoff frequency, phase margin, remaining error), test stability of systems using the Nyquist criterium. Furthermore, the students will learn about state transform and the invariance of transfer functions on state transform. The state transform consecutively used to bring control systems to first and second standard form to derive observability and controlability criteria. In a final theoretical part of the lecture, the students will learn about state control based on controller-canonical form, stabilization around an arbitrary operating point, observers, and finally Kalman filter. In the practical part of the lecture, the students will work in groups on an inverted pendulum setup using Matlab/Simulink and TwinCAT3. The task will be to design controllers to swing the pendulum up in a first case and to keep it upright in a second case. The students should design at least 2 different controllers to maintain the pendulum upright despite of disturbances and compare their controllers' performance.
Bibliography (Mandatory / Optional)	Control Systems 1 (IRT at TU-Graz, Austria) https://www.tugraz.at/institute/irt/lehre/ergaenzende-informationen/control-systems-1/ Control Systems 2 (IRT at TU-Graz, Austria) https://www.tugraz.at/institute/irt/lehre/ergaenzende-informationen/control-systems-2/ Hans Peter Geering, Regelungstechnik: Mathematische Grundlagen, Entwurfsmethoden, Beispiele, Springer Hans Peter Geering, Optimal Control with Engineering Applications, Springer

The following literature exceeds the content of the lecture, but is recommended for the interested reader for his/her future lectures or work in the field of control:

FiOrdOs http://fiordos.ethz.ch/dokuwiki/doku.php

T. Murakami, F. Yu, and K. Ohnishi, “Torque sensorless control in multidegree-of-freedom manipulator,” IEEE Transactions on Industrial Electronics, vol. 40, no. 2, pp. 259–265, 1993.

A. Kato and K. Ohnishi, “Robust force sensorless control in motion control system,” 9th IEEE International Workshop on Advanced Motion Control, 2006., pp. 165–170, 2006.

J. C. Hsu, A. U. Mayer, Modern Control Principles and Applications, McGraw Hill, New York, 1968

M. Athans, P. L. Falb, Optimal Control, McGraw Hill, New York, 1966

M. Papageorgiou, Optimierung, Oldenbourg Verlag, München, 1991

O. Föllinger, Optimierung dynamischer Systeme - eine Einführung für Ingenieure, R. Oldenbourg Verlag, München, 1985

Dimitri P. Bertsekas, Dynamic Programming and Optimal Control, Athena Scientific

Entry Requirements	Students should have prior knowledge on basic control theory: required course (or equivalents): 69469 - Introduction to LTI-Systems and Control 55664-01 - Blockkurs: Hands-on Introduction to Medical Robotics Hardware
Learning Outcome and Competences	The goal is to make students aware of a variety of different control principles for linear time-invariant systems (LTI-systems), their advantages and disadvantages. The knowledge is supported by practical examples tested in Matlab/Simulink and TwinCAT3 on a real robot (inverted pendulum)
Comments	
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280138
Last Updated	July 10, 2023

C36 / M-SBME-MSc C36

Modelling and Simulation

Module	I. Medical Systems Engineering
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, unlimited repeatable
Assessment Details	- Case studies - Presentation
Workload	3 ECTS
Lecturer(s)	Daniel Seiler <daniel.seiler@fhnw.ch> (Coordinator) nn Nn
Course contents	Approach: Simulation in product development, simulation tools. Finite element modelling: Abstraction, element properties, meshing, boundary conditions, loads and material models. Calculation: solution algorithms, convergence. Result evaluation: interpretation, verification and validation. Application areas: structural mechanics, fluid flow, heat transfer, chemical reactions, electrodynamics, acoustics.
Bibliography (Mandatory / Optional)	tbd
Entry Requirements	Basic in physics, mathematics
Learning Outcome and Competences	- know the mathematical basics of the finite element method (FEM) - understand the relevant sub-steps such as abstraction of reality - know the technical limitations of FE programmes - can create FE models, carry out the calculation and evaluate them - can interpret and verify the FEM results
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	September 07, 2023

C37 / M-SBME-MSc C37

Biofabrication and Biohybrid Systems

Module	II. Biomaterials Science and Engineering
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, unlimited repeatable
Assessment Details	Project work delivered by the end of the module: written report (60%) oral presentation (40%)
Workload	3 ECTS
Lecturer(s)	Maurizio Gullo <maurizio.gullo@fhnw.ch> (Coordinator)
Course contents	Theory (26 lessons in presence) Water as a biomaterial, Hydrogels, Cell material interaction, Cell injury. ECM andbiomimicry, Engineering with biological material, Fabrication methods – Macro/Bioprinting, Inks, Biological building blocks, Vascularstructures, Complex multicellular tissues Fabrication methods – Micro/Single cell, Polymer microfabrication methods, Sigle cell manipulationmethods, Engineering with single cells Applications: Cochlea implants, Retina implants, Deep brain stimulation implants, Prostaticreplacement tissue, Cardiac supporting tissue, Skin tissue, tooth implants, biohybrid micro robots,biohybrid limbs Exercises (6 lessons in presence) Weekly or by weekly sessions to repeat and assess the knowledge transfer Project work (10 lessons online) Group work on a specific topic with report and presentation as output
Bibliography (Mandatory / Optional)	tbd
Entry Requirements	Basic physics and chemistry
Learning Outcome and Competences	After competition of the module the students will … Understand the different biological building blocks in bio fabrication Understand cell material interaction Understand hydrogel chemistry and ECM mimicry Understand cell/tissue repair processes at the micro scale Choose material and processes involved in biohybrid systems Know about sate of the art bio fabrication methods
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	January 30, 2024

C38 / 70410-01

Characterizing Materials in Medicine: Nanoscience

Module	II. Biomaterials Science and Engineering
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Lecture with practical courses weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	Reports on experiments, rapid-fire presentation plus discussion
Workload	3 ECTS
Lecturer(s)	Bert Müller <bert.mueller@unibas.ch> (Coordinator) nn Nn
Course contents	Introduction to the nano-structural characterization of human tissues and medically relevant materials Electron microscopy and energy dispersive X-ray spectroscopy – experiments, Contact-angle measurements, Small-angle X-ray scattering experiments: Nanoparticles and proteins in solution, Small-angle X-ray scattering experiments: Polymers and lipid bilayers, (Spatially resolved) small-angle X-ray scattering experiments for tissue imaging and materials characterization, Student presentations and scientific discussions on nano-structural characterization of medically relevant materials
Bibliography (Mandatory / Optional)	
Entry Requirements	(C13) Materials in Medicine and Biomaterials, Basics in Mathematics similar knowledge to 52055-01 (C04), Recommanded to register to: C05/53772-01 and C21/70402-01, Nice to have: C16/ 69471 Basics in Mechanics: Statics und C56/70411-01 Basics in Statistics Limited student numbers, priority given to student in Biomedical Engineering
Learning Outcome and Competences	The students will become familiar with state-of-the art instrumentation for the characterization of medically relevant materials down to the molecular scale. Under supervision, they will carry out selected experiments and analyze their results. The related reports of the experiments not only support the performance review (grading) but, more important, they should enable the students to efficiently start with the envisioned Master thesis projects.
Comments	
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=0
Last Updated	January 26, 2024

C39 / 54000-01

Materials in Medicine: Tissue Regeneration

Module	II. Biomaterials Science and Engineering
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Spring semester (start: Spring semester 24)
Format	Lecture with practical courses weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	continuous assessment Presentation on a selected topic, laboratory performance, laboratory report
Workload	3 ECTS
Lecturer(s)	Madduri Srinivas <srinivas.madduri@unibas.ch> (Coordinator) Michael de Wild Bert Müller
Course contents	Introduction to bioengineering and tissue characterization Tailoring biomaterials and their tissue interface for regenerative medicine, Polymeric and cellular drug delivery for tissue regeneration, Bioengineering of tissues and entire organs, Tissue bioengineering: Pre-clinical and clinical research, From human tissues to bio-inspired implants, tissue-materials interactions, Physical methods and their combination, Student presentations and scientific discussions on materials in medicine for tissue regeneration
Bibliography (Mandatory / Optional)	
Entry Requirements	Basics in materials science (C13)
Learning Outcome and Competences	The students will learn how to scientifically discuss, design and apply the interdisciplinary subject of tissue engineering and regenerative medicine exploiting state-of-the art literature. Based on a sound introduction and supervision, - within a workshop style - the students will treat with pre-selected journal articles to become familiar with a critical literature overview and multi-disciplinary knowledge for the envisioned Master thesis project and for future translational medical activities. The students will aquire presentation skills, and team spirit by learning and doing the active group presentations during the entire semester.
Comments	Limited number of students Priorities: Students of the Master in Biomedical Engineering Strong recommendation to combine this course with Characterizing Materials in Medicine: Nanoscience, 70410-01
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280140
Last Updated	July 10, 2023

C44 / 53826-01

Computer-Assisted Surgery

Module	A. Computer-Assisted Surgery
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Lecture weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	30 min oral exam
Workload	3 ECTS
Lecturer(s)	Philippe Cattin <philippe.cattin@unibas.ch> (Coordinator)
Course contents	In this course, students will learn about the most recent advances in the use of computers to aid in planning and executing surgeries. Focus will be on the general concepts of Computer-Assisted Surgery (CAS) systems.
Bibliography (Mandatory / Optional)	
Entry Requirements	C15, Python knowledge similar to C17
Learning Outcome and Competences	
Comments	next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280177
Last Updated	July 10, 2023

C45 / M-SBME-MSc C45

Fundamentals in Robotics

Module	A. Computer-Assisted Surgery
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, unlimited repeatable
Assessment Details	
Workload	3 ECTS
Lecturer(s)	Erik Schkommodau <erik.schkommodau@fhnw.ch> (Coordinator)
Course contents	- mathematical tools describing mechanical systems (coordinate transformations, Jacobi Matrix, Bezier splines, quaternion) forward and backward transformation of serial robotic system - Denavit-Hartenberg notation - path generation - dynamic descriptions Practical exercise (6 lessons) - safety considerations - introduction to Stäubli programming language (offline and online programming of Stäubli TX60)
Bibliography *(Mandatory / Optional)*	Books - Craig, J.: Introduction to Robotics. Mechanics and Control. Reading (Mass.): AddisonWesley, 2005 - Canudasde Wit, C.; Siciliano, B.; Bastin, G. (Eds.): Theory of Robot Control. London: Springer-Verlag, 1996 - Sciavicco, L.; Siciliano, B.: Modelingand Control of Robot Manipulators. New York: McGraw Hill, 1996 - Spong; M.W.; Vidyasagar, M.: Robot Dynamicsand Control. New York: John Wiley, 1989 Journals: • The International Journal of Robotics Research • IEEE Journal of Robotics and Automation • IEEE Transactionson Mechatronics
Entry Requirements	• bachelor level of engineering/informatics • basic programming skills in MATLAB
Learning Outcome and Competences	After completing the module, students will be able to… • understand kinematics of robots • apply mathematical tools to describe behaviour of mechanical systems using matlab • program an industrial robot • understand limits of robotical systems • know standard procedures of robots
Comments	The date of the practical exercise will be announced at the beginning of the lecture.
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	September 07, 2023

C47 / 70409-01

Medical Robotics

Module	A. Computer-Assisted Surgery
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Lecture with practical courses weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	
Workload	3 ECTS
Lecturer(s)	Nicolas Gerig <nicolas.gerig@unibas.ch> (Coordinator) Georg Rauter
Course contents	Course contents Lecture (Nicolas Gerig, 26 (13x2) lessons) • presentation/discussion of a medical robot example from the market or research each week. • classifications of different devices fields of medical robots • actuation and control principles • digital and cascaded control • control paradigms • multi-objective control realizations • principles and application of sensory fusion Exercises (Nicolas Gerig or assistant(s), 13 lessons) • mathematical, programming, or control tuning assignments in e.g. MATLAB / Simulink to consolidate frontal teaching from lectures. Potential Group Projects (Nicolas Gerig and/or Phd students, ~13 update meetings) • practical group work (2-3 students) on a related challenging topic (e.g. multi-objective control, sensory fusion) with robotic demonstrator or haptic user interfaces at the BIROMED-Lab.
Bibliography (Mandatory / Optional)	
Entry Requirements	• bachelor level of engineering/informatics • basic programming skills in MATLAB and the ability to adapt to other programming languages. • basic knowledge on control system modelling (C14 “Introduction to LTI Systems and Control) • basic knowledge of digital signal acquisition and filtering (C20 “Sensors and Signal Processing”) • experience on applying closed-loop feedback control (C35 “Applied Control”) • basic knowledge on serial robot kinematics or concurrent enrolment in C45 “Fundamentals in robotics
Learning Outcome and Competences	After completing the module, students will be able to… • classify different types of medical robots (surgical robots, robotic prosthetics/orthoses, assistive devices, rehabilitation training devices, medical simulators). • remember covered examples from industry and research. • understand the functionality of covered medical robots. • remember different actuation principles and their benefits/limitations. • understand limitations of digital control. • design control charts reflecting cascaded feedback control loops. • compare different control paradigms (such as Position vs. Force control, Impedance vs. Admittance control, dynamics-based vs. kinematic control). • implement simple feedback controllers and tune their parameters. • evaluate different forms of user-robot interaction. • understand challenges of multi-objective control. • implement state estimation based on sensory fusion from multiple sensors with different update rates

	and delays
Comments	next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280159
Last Updated	July 10, 2023

C48 / 27584-01

Digital Dentistry

Module	B. Image Acquisition and Analysis
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Lecture weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	Exam type: Written answers of the tutorial questions and reports on experiments.
Workload	3 ECTS
Lecturer(s)	Bert Müller <bert.mueller@unibas.ch> (Coordinator) Simone Hemm
Course contents	Introduction to oral health from the clinical and engineering/research points of view, Fundamentals of hard X-ray imaging: Micro- and nanostructure of human crowns in health and disease, Ex vivo characterization of a human crown with a caries lesion: Excise at micro computed tomography system (SkyScan 1275), Mechanical removal of the caries-affected hard tissue, Ex vivo characterization of a human crown after removal of the caries lesions: Excise at micro computed tomography system, Preparation of dental fillings ex vivo using preselected materials, Ex vivo characterization of a human crown with dental filling: Excise at micro computed tomography system, Intraoral scanners: Function and accuracy, Intraoral scanners: Correct handling and training, Current and future aligner treatments, Devices to train the tongue muscles: Principles, medical applications and beyond, Studying the efficacy of bone graft materials and mineralization in jaw bone and teeth, Segmentation and data registration for the quantitative evaluation of the dental fillings,
Bibliography (Mandatory / Optional)	
Entry Requirements	C31 (Advanced Methods in Medical Image Analysis) and C13 (Materials Science and Biomaterials)
Learning Outcome and Competences	The students will become familiar with the dentistry-related human anatomy and restoration treatments. They will acquire knowledge on state-of-the-art dental materials and technologies applied in well-equipped dental offices and learn how to quantitatively characterize crowns and dental materials using a microtomography system and an intraoral scanner. The students will learn to efficiently communicate with dentists and medical doctors. Finally scientific and commercial activities will be presented related to current challenges in dental research.
Comments	Limited number of students Priorities: Master students in Biomedical Engineering Next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280142
Last Updated	July 10, 2023

C49 / 53824-01

Magnetic Resonance Imaging

Module	B. Image Acquisition and Analysis
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Lecture with practical courses weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	Written exam (a mix of multiple choice "Kprim", single possible questions "Apos" and descriptive questions)
Workload	3 ECTS
Lecturer(s)	Oliver Bieri <oliver.bieri@unibas.ch> (Coordinator) Francesco Santini Claudia Weidensteiner
Course contents	The course gives an overview of Magnetic Resonance Imaging (MRI) which is a non-invasive and ionizing radiation free diagnostic imaging technique that has found widespread applications in clinical routine and research. In this course we will first introduce the fundamentals of MR physics including: nuclear spin, magnetic moments, magnetization, radiofrequency pulse excitation and relaxation processes, which will be followed by topics related to MRI hardware and safety. We will discuss basic concepts of pulse sequences, spatial encoding, k-space and image formation. The final portion of the course will introduce specialized applications such as cardiovascular imaging, spectroscopy, diffusion weighted imaging and functional brain MRI, image artifacts as well as advanced image reconstruction techniques. During the exercises we will demonstrate how to operate an MRI unit, and show several different MR techniques in measurements in phantom and in-vivo.
Bibliography (Mandatory / Optional)	From Picture to Proton“ von Cambridge University Press.
Entry Requirements	Limited number of students only, priority will be given to students from of the Master in Biomedical Engineering.
Learning Outcome and Competences	Upon completion of the course students should have understanding of: - the physical principles of nuclear magnetic resonance - MRI unit and its safety aspects - magnetization excitation and relaxation processes - generation of image contrasts - creation of spin and gradient echo including schematics of basic pulse sequences - spatial encoding and k-space - image reconstruction - spectroscopy Furthermore students should be able to demonstrate knowledge of more advanced MRI techniques including: diffusion weighted imaging, functional brain MRI and cardiovascular imaging as well as examples of its applications.
Comments	next offer of this course in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280239
Last Updated	June 16, 2023

C51 / 70407-01

Forensic Imaging

Module	B. Image Acquisition and Analysis
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Lecture weekly
Assessment Regulations	Type: continuous assessment Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	• Attendance of lectures (80% to pass) • Scientific poster preparation (50%) • Poster presentation, to be presented at the corresponding session (during semester) (50%) • Exercises, to be submitted 2 weeks after every assignment (during semester) (80% filled out to pass) • “Lehrveranstaltung begleitend”
Workload	3 ECTS
Lecturer(s)	Claudia Lenz <claudia.lenz@unibas.ch> (Coordinator)
Course contents	Introduction (2 lessons) • General introduction to forensic medicine Basic Research Tools (2 lessons) • Literature research, referencing • Scientific poster preparation • Python for image analyses of exercises X-ray & CT (6 lessons) • X-ray of living subjects in forensic medicine: general introduction, imaging tools, age estimation, fracture dating • Post mortem CT in forensic medicine: indication list, identification, research projects (automatic registration & detection of causes of death) • Exercises and poster presentation MRI (6 lessons) • MRI of living subjects in forensic medicine: general introduction, strangulation, research projects • Post mortem MRI in forensic medicine: potential, pitfalls, research projects • Exercises and poster presentation Forensic Photography (4 lessons) • General introduction to daylight & infrared photography, application in forensic medicine • Exercises and poster presentation Biomechanics (4 lessons) • General introduction, biomechanical models based on CT or MRI • Exercises and poster presentation Poster Evaluation (2 lessons) • Evaluation of posters, discussion with students/groups
Bibliography (Mandatory / Optional)	
Entry Requirements	• Medical Image Processing • Principles in Medical Imaging Further required competences: • Programming basics in Matlab & Python

	• Basic knowledge in literature research & research methodologies
Learning Outcome and Competences	After completing the module, students will be able to… • Have an overview of current applied and future potential methods in forensic imaging • Differentiate forensic and clinical applications • Have an overview of the discussed research tools • Explain and compare application of X-ray & CT in forensic medicine for living and post mortem subjects • Analyze X-ray & CT imaging data • Explain and compare application of MRI in forensic medicine for living and post mortem subjects • Analyze MRI imaging data • Explain and compare application of Infrared (IR) photography • Analyze IR data • Have an overview of the different biomechanical challenges in forensic medicine • Explain and evaluate different biomechanical models based on CT imaging • Analyze imaging data of biomechanical challenges • Evaluate / discuss and create poster on a relevant course topic
Comments	next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280160
Last Updated	June 29, 2023

C57 / M-SBME-MSc C57

Physics Approaches in Cancer Imaging and Treatment

Module	B. Image Acquisition and Analysis
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, unlimited repeatable
Assessment Details	• Attendance of lectures (80% to pass) • 1-2 page written description of the chosen challenge • 30-40min seminar talk/discussion • preparation of a 30-40min hands-on exercise • pass/fail assessment
Workload	3 ECTS
Lecturer(s)	Antje Knopf <antje.knopf@fhnw.ch> (Coordinator)
Course contents	Students will gain insights concerning state-of-the-art research and developments concerning physics approaches in cancer imaging and treatment. After a general introduction about the current challenges in Cancer Imaging and Treatment, the students will make a literature search to identify a challenge they want to work on. For their specific challenge, students are expected to provide a 1-2 page description with respective literature, prepare a 30-40min seminar talk/discussion and a 30-40min hands-on exercise for the fellow students. Examples for topics could be: - The development of a specific Imaging biomarkers for cancer - The advancement of 4D imaging to guide the treatment of moving tumours - The automatization of image processing approaches in cancer treatments (e.g. segmentation) - The generation of synthetic medical images to improve cancer care. - The improvement of medical image acquisition for a better diagnosis, treatment or monitoring of cancer (dual energy CT, photon counting CT, ion imaging) - Better treatment approaches for cancer (Flash therapy, arc therapy, treatment in seated position…) - Benefits and limitations of an Adaptive Radiation Therapy (ART) workflow - Deep learning approaches for delineation treatment planning
Bibliography (Mandatory / Optional)	For example Kim, S., & Wong, J.W. (Eds.). (2018). Advanced and Emerging Technologies in Radiation Oncology Physics (1st ed.). CRC Press. https://doi.org/10.1201/9780429508141
Entry Requirements	Required: C02 Programming Basics with MATLAB C15 Medical Imaging and Medical Image Processing* C24 Principles of Medical Imaging C31 Advanced Methods in Medical Image Analysis Nice to have:

	(C22 Optimisation Methods) (C36 Modelling and Simulation)
Learning Outcome and Competences	After completing the module, students will … • have an overview of current physics challenges in cancer imaging and treatment • have an overview of currently applied and future potential methods for cancer imaging and treatment • can name and explain advanced methods for cancer imaging and treatment • can evaluate, present, and discuss a relevant course topic
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	January 23, 2024

C63 / 70408-01

Applied Methods in Forensic Genetics and Forensic Toxicology

Module	B. Image Acquisition and Analysis
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Lecture with practical courses weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	• Presentation on selected topics of 10 minutes on last lecture blocks, groups of 2 (50%) • Written outline of presentation, including literature study (50%)
Workload	3 ECTS
Lecturer(s)	Götz Schlotterbeck Iris Schulz
Course contents	Forensic Toxicology: Theme 1 Analytical methods in Forensic Toxicology (2h) • Analytical tools: LC-MS/MS, GC-MS/MS, Immunoassays… • Advantages and limitations Theme 2 Driving under the influence of alcohol and drugs (4h) • Biological matrices, sample preparation and measurement • Blood alcohol, limits, regulations • Relevant drugs, limit substances Theme 3 Hair analysis (2h) • Dealing with hair samples in the forensic context • Application of hair testing in abstinence control and crime case works Theme 4 New psychoactive substances (NPS) and knockout substances (2h) • Analytical tools to assess various compound classes • Case studies Forensic Genetics: Theme 1 Biological basis and current applied DNA analysis (4h) • Tasks of forensic genetics: trace, relationship and identification analyses • Human genome, structure and polymorphism; autosomal and gonosomal DNA short tandem repeats • DNA analysis methods: Immunological pre-tests, microscopy, staining, and differential lysis (DL), extraction, amplification and capillary electrophoresis, profile interpretation (biostatistics, database), law • RNA markers and mtDNA sequencing and their applications Theme 2 Specific DNA and RNA applications (3h) • Single cell isolation: Laser-Capture Microdissection (LCM), DEPArray and microfluidic principles, Flow-Cytometry (DEPArray) • Benefits and limits of classical (DL, LCM) and state-of-the-art technologies • RNA profiling and body fluid identification Theme 3 Future Methods (3h) • Principle of DNA sequencing • Pyrosequencing and Next Generation Sequencing • Phenotyping, biogeographic and age estimation
Bibliography *(Mandatory / Optional)*	
Entry Requirements	The course is designed for students holding a Bachelor’s degree of various backgrounds like engineering, natural sciences, computer sciences, medicine or health sciences
Learning Outcome and	After completing the module, students will be able to…

Competences	• possess scientific knowledge of the fundamental principles underlying forensic toxicology and forensic genetics. • know state-of-the-art technologies and future trends in forensic toxicological and forensic genetic methods, including their advances and limitations. • apply acquired knowledge to use existing instrumentations and techniques in forensic practices, and contribute to the development of new methodologies. • can clearly, effectively and concisely present their results to peers as well as to the public in written and oral form according to scientific standards
Comments	next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=0
Last Updated	January 26, 2024

C41 / M-SBME-MSc C41

Neurotechnologies

Module	C. Diagnostics and Therapeutic Technologies
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, unlimited repeatable
Assessment Details	- written exam at semester end (70%) - Presentation + discussion of papers from the field (30%)
Workload	3 ECTS
Lecturer(s)	Simone Hemm <simone.hemm@fhnw.ch> (Coordinator) nn Nn
Course contents	Neurophysiology - signal generation and propagation in the brain Electrophysiological mapping - Microelectrode recording, single unit recording - Local field potentials - Electrocorticography - Electroencephalogram/ Event related potentials - Magnetoencephalography - Signal processing, artifact removal, source localization - Optics for mapping Neurostimulation methods - Transcranial magnetic stimulation - Transcranial alternating current stimulation - Transcranial direct current stimulation - Peripheral nerve stimulation (vagus nerve, spinal cord) - Opto-genetics Deep brain stimulation - DBS Surgery - Technology - Atlases, Group analysis - Electric field Modelling - Lab: Stereotactic planning Brain computer interfaces - Neurofeedback / Training - Machine control, Protheses, orthosis, communication - signal processing and classification - Lab: BCI Neuroethics
Bibliography (Mandatory / Optional)	- Lecture slides, selected book chapters, papers suggested for paper reviews
Entry Requirements	Defined entry level - Basic knowledge on signal processing and image processing are a prerequisite to follow this course - basic knowledge in brain anatomy and physiology would be helpful but not mandatory
Learning Outcome and Competences	After completing the module, students will be able to… - understand the signal generation and propagation in the brain - know the different electrophysiological signals used for brain mapping and stimulation - know and understand different brain mapping techniques, neurostimulation methods and brain computer interfaces - know methods used for signal and data processing - know exemplary techniques used to analyse patient data to increase knowledge about mechanism

	of actions of stimulation - apply exemplary systems for diagnose and therapy - knows neuroethical concerns
Comments	The date of the practical exercise will be announced at the beginning of the lecture.
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	January 25, 2024

C42 / 52059-01

Clinical Biomechanics

Module	C. Diagnostics and Therapeutic Technologies
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Lecture weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	written exam Mandatory workshop clinical gait lab (UKBB/USB) (enrollment at the beginning of the semester) and presence control (4-5 dates Fridays from 1 to 3 pm).
Workload	3 ECTS
Lecturer(s)	Heide Elke Viehweger <heideelke.viehweger@unibas.ch> (Coordinator) Annegret Mündermann nn Nn Georg Rauter
Course contents	Human function analysis based on optical tracking data, Motion capture data collection, Interpretation gait data, Kinematics calculations (lower limb joints) Kinetics calculations (lower limb joints) Clinical applications and examples (orthopaedics, neuroorthopaedics, sports, daily life environment)
Bibliography (Mandatory / Optional)	BAKER, R., & HART, H. M. (2013). Measuring walking a handbook of clinical gait analysis. London, Mac Keith Press. http://site.ebrary.com/id/10705870. WINTER, D. A. (2009). Biomechanics and motor control of human movement. Hoboken, New Jersey, John Wiley & Sons
Entry Requirements	Participation to the following modules: - «minimal requirements» Basics in Physiology and Anatomy (C08 OR C60 OR C61) AND Basics in Maths and Mechanics (C04 AND C16) - «recommended requirements»: Extended knowledge in Maths and Mechanics (C05 and C21) - «nice to have»: Basics in Statistics C56
Learning Outcome and Competences	Understanding of data recording and interpretation in clinical movement analysis.
Comments	Optional participation clinical gait analysis (enrollment at the beginning of the semester) next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280158
Last Updated	July 10, 2023

C43 / 53823-01

Biomedical Acoustics

Module	C. Diagnostics and Therapeutic Technologies
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Lecture with practical courses weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	30 min oral exam, Audiologie, Hebelstrasse 10
Workload	3 ECTS
Lecturer(s)	Christof Stieger <christof.stieger@unibas.ch> (Coordinator) Yves Brand nn Nn
Course contents	ANATOMY AND PHYSIOLOGY OF THE HUMAN EAR BASIC ACOUSTICS HEARING LOSS AND SUBJECTIVE AUDIOMETRY OBJECTIVE AUDIOMETRY ELECTROACOUSTICS TRANSDUCER DESIGN CONVENTIONAL HEARING AIDS COCHLEAR IMPLANTS SURGICAL OR BIOLOGICAL REHABILITATION UPPER PATHWAYS PSYCHOACOUSTICS / BINAURAL HEARING
Bibliography (Mandatory / Optional)	
Entry Requirements	Trigonometry, complex numbers (C04), basics in anatomy (C60); Limited number of students only, priority will be given to students of the Master in Biomedical Engineering.
Learning Outcome and Competences	
Comments	next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280143
Last Updated	July 10, 2023

C53 / 53825-01

Technologies in Regenerative Surgery

Module	D. Implants and Regenerative Technology
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Lecture weekly
Assessment Regulations	Type: record of achievement Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	Written exam, Multiple Choice Questionnaire, 1h
Workload	3 ECTS
Lecturer(s)	Arnaud Scherberich <arnaud.scherberich@unibas.ch> (Coordinator) Karoliina Pelttari
Course contents	Students will gain fundamental knowledge on regenerative surgery and its related aspects. Regenerative surgery is an interdisciplinary and rapidly emerging field of research and clinical applications aiming to repair, replace, or regenerate tissues or organs, with the goal of restoring loss of function due to congenital defects, diseases, damage/trauma or aging.
Bibliography (Mandatory / Optional)	
Entry Requirements	C11 or Basic concepts in Cell Biology
Learning Outcome and Competences	
Comments	next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280161
Last Updated	July 10, 2023

C54 / M-SBME-MSc C54

Biointerface Engineering

Module	D. Implants and Regenerative Technology
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, unlimited repeatable
Assessment Details	• Written exam, 90 minutes
Workload	3 ECTS
Lecturer(s)	Michael de Wild <michael.dewild@fhnw.ch> (Coordinator) Bert Müller Madduri Srinivas
Course contents	01: Introduction, presentation and overview of the lecture and lecturers (de Wild/Müller/Madduri, 2) 02: Tissue-material interface and interactions (Madduri, 2) 03: Biomaterials, biocompatibility and bio-interfaces. Principles of surface-tissue interactions (Madduri, 2) 04: Concept and testing of bio- and haemocompatibility, ISO 10993, classes of biomaterials. Classification of biomaterials according to the reaction of the biological system. Biologically relevant structures from the nm- to the mm length scale. Spatial-temporal behaviour of the tissue-material interface during osseointegration. Physico-chemical, in-vitro, in-vivo and clinical assessments (de Wild, 2) 05: Surface modification techniques using physical and chemical strategies (Müller, 2) 06: Micro- and nano-structuring techniques (Müller, 2) 07: Chemical, physical, mechanical, thermal, optical, plasma-technical, electrochemical methods to (bio)chemically and topographically modify und functionalize surfaces of biomaterials (de Wild, 2) 08: Experimental systems for analysis surface roughness, chemistry, tribology; porosity, defects, coatings (de Wild, 2) 09: Tailoring biomaterials for regenerative medicine (Madduri, 2) 10: Bio-inspired implants (Müller, 2) 11: Protein-resistance and biochemical functionalization (de Wild, 2) 12: Biofilm: formation, clinical consequences, treatments (de Wild, 2) 13: Clinical emergence, treatments (Müller/Sigron, 2) 14: Summary and Repetition (de Wild/Müller/ Madduri, 2)
Bibliography (Mandatory / Optional)	- Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons: "Biomaterials Science: An Introduction to Materials in Medicine", 2nd edition, Elsevier Academic Press. - H.M. Grandin, M. Textor, G.M. Whitesides, “Intelligent Surfaces in Biotechnology”, Wiley-vch, ISBN: 978-0-470-53650-6. - J. Breme, R. Thull, C.J. Kirkpatrick, “Metallic Biomaterial Interfaces”, Wiley-vch, ISBN 978-3-527-31860-5.
Entry Requirements	Defined entry level • Scientific background in medicine, chemistry, physics or analytical chemistry. • Basic lectures on chemistry and physics are a prerequisite to follow this course.
Learning Outcome and Competences	After completing the module, students will be able to… • explain the spatial-temporal behaviour of the tissue-material interface in detail. • describe biologically relevant structures from the nm- to the mm length scale.

- sketch the mechanism of cell-adhesion.
- argue why the cell-surface interaction is important and how it can be changed.
- describe the consequences of a low contact angle implant surface in-vitro, in-vivo and clinically.
- understand surface modification techniques using physical and chemical strategies.
- describe various chemical, physical, mechanical, thermal, optical, plasma-technical, electrochemical methods to modify surfaces of biomaterials.
- know about the use of surface functionalized materials and the importance of the properties of such materials for biomedical applications.
- explain the term and the idea “protein-resistance”.
- specify several approaches for antibacterial coatings.

Comments

- Lectures
- Power-point presentations as pdf-files
- Parts of textbooks
- Relevant journal articles
- Group work, experiment evaluation and interpretation
- Q&A session, Tutorial questions and example solutions

2 lectures per week à 45 Min, whole semester 14 weeks
(1st and last event 2 lecturers: intro/overview/requirements, resp. summary/important points for exam/Q&A-session)

Course Enrolment https://esp.hls.fhnw.ch

Further Details FHNW Inside-> "Mein Studium"

Last Updated September 07, 2023

C55 / M-SBME-MSc C55

Implant Design and Manufacturing

Module	D. Implants and Regenerative Technology
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Examination, unlimited repeatable
Assessment Details	- Case studies - Project work
Workload	3 ECTS
Lecturer(s)	Daniel Seiler <daniel.seiler@fhnw.ch> (Coordinator)
Course contents	• Medical implants • Designing “hands on” patient specific implants • Medical additive manufacturing • Manufacturing and testing methods for medical implants • In vitro/in vivo testing and test methods according standards
Bibliography (Mandatory / Optional)	- IMDRF/PMD WG/N49 FINAL:2018 - FDA – Draft guidance for industry / Technical Considerations for Additive Manufactured Devices - Milan Brandt (2017) Laser Additive Manufacturing- Materials, Design, Technologies, and Applications
Entry Requirements	none
Learning Outcome and Competences	After completing the module, students … - obtain an insight into different types of implants - obtain an insight into the design, development and testing implants - will be able to select appropriate fabrication technologies and procedures including additive manufacturing - will be able to select and apply testing methods for medical implants based on standards - will be able to decide on the applicability and to design patient specific implants
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	September 07, 2023

C46 / 55664-01

Hands-on Introduction to Medical Robotics Hardware (block course)

Module	Project Work and Practical Skills
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester
Format	Block course Block
Assessment Regulations	Type: continuous assessment Repeatability: as often as necessary Evaluation Scale: Pass / Fail
Assessment Details	Participants, who need credits for their lecture need to inform the lecturer at the begin of the lecture that they require ECTS credits. The according students will have to perform additional practical exercises before or after the lecture to verify that they understood the content of the course. The participants need to be present at least for 80% of the course and need to pass 4 out of 5 small practical exercises. The course is rated as failed or passed.
Workload	2 ECTS
Lecturer(s)	Nicolas Gerig Georg Rauter
Course contents	Nowadays, there is large knowledge available about control from a theoretical point of view. However, getting an entire setup working from hardware integration, safety, control, up to the graphical user interface or virtual environment, is seldom taught. Participants will learn about basic differences in various automatization environments such as dSPACE, Matlab xPC Target, Matlab/Simulink, LabVIEW, and TwinCAT3. Within one week, the participants will learn how to integrate motors, sensors, and safety components in a predesigned electric cabinet for automation and control purposes. They will develop an automation application for a balancing and visual tracking application, integrate different control schemes, and write a graphical user interface to control the application in real-time. In groups up to four, the participants will learn how to integrate different hardware components in a real-time control system (TwinCAT3, Beckhoff). They will learn how to account for software safety for an application involving servo motors. After successful hardware and software safety integration, different control schemes (model based controllers, non-linear controllers, vision-based non-linear controllers, etc.) will be integrated in Matlab/Simulink. After compilation for TwinCAT3, the controllers will work on an industrial embedded real-time PC. During runtime, the participants will be able adapting controllers-online, record data, and see the influence of different filters. Consequently, the participants will program their own graphical user interface (GUI) in the game development engine UNITY. This GUI can be interfaced with the real-time environment through an Automation Device Specification (ADS), i.e. a field bus interface for TwinCAT3. After first experiments with the hard and software, two groups will work together for realizing a two-degrees of freedom ball balancing application, where each group controls one degree of freedom. The feedback loop will be closed through real-time vision-data that needs to be extracted applying feature extraction in real-time. Finally, the performance of the teams' solutions to the challenging application is evaluated in a friendly competition.
Bibliography (Mandatory / Optional)	
Entry Requirements	Basic knowledge in control, automation, computer vision, Matlab/Simulink and Unity programming is of advantage, but not required.
Learning Outcome and Competences	Hardware, and software integration in real-time applications. Basic knowledge in applied control (model-based control, non-linear control, cascade control). Real-time data extraction using computer vision algorithms.

	GUI-programming for real-time applications.
Comments	
	This course is offered after each semester in February and September Hegenheimermattweg 167b, 4123 Allschwil
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280144
Last Updated	July 27, 2023

C50 / 53821-01

Hands-on Deep Learning

Module	Project Work and Practical Skills
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Internship weekly
Assessment Regulations	Type: continuous assessment Repeatability: as often as necessary Evaluation Scale: 1-6 0,1
Assessment Details	continuous assessment presentation:
Workload	3 ECTS
Lecturer(s)	Philippe Cattin
Course contents	
Bibliography (Mandatory / Optional)	
Entry Requirements	(C31) Advanced Methods in Medical Image Analysis Limited number of students only, priority will be given to students of the Master in Biomedical Engineering.
Learning Outcome and Competences	
Comments	next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280141
Last Updated	July 19, 2023

C52 / 70406-01

Bioengeneering Lab

Module	Project Work and Practical Skills
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Internship irregular
Assessment Regulations	Type: continuous assessment Repeatability: as often as necessary Evaluation Scale: Pass / Fail
Assessment Details	
Workload	3 ECTS
Lecturer(s)	Oliver Braissant nn Nn Pablo Sinues
Course contents	Hands on training on: • Mass spectrometry • Spectrophotometric assays • Microscopy • Calorimetry Laboratory visits at: • Forensic toxicology • Clinical chemistry laboratories at University Hospitals
Bibliography (Mandatory / Optional)	
Entry Requirements	C12 or respective Bachelor Background
Learning Outcome and Competences	
Comments	next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280162
Last Updated	July 27, 2023

C58 / M-SBME-MSc C58

Characterizing Materials in Medicine: Structure and Mechanics

Module	Project Work and Practical Skills
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Type: Laborpraktikum Mode: MScBME - full semester
Assessment Regulations	Examination, unlimited repeatable
Assessment Details	Course-related performance review: Reports und oral presentations.
Workload	3 ECTS
Lecturer(s)	Michael de Wild Lydia Feller Romy Marek
Course contents	After an introduction event, the following analytical methods and experimental studies are performed in the materials science laboratories of the FHNW in Muttenz in groups: - tensile and fatigue testing, - microstructural analysis and fractography, - impact testing, - SEM/EDX investigations, - XRD-analysis, - Surface functionalization and characterization, - Corrosion measurements, - Non-destructive testing (NDT, US, magnetic system), - thickness analysis.
Bibliography (Mandatory / Optional)	Experimental instructions with detailed description of each experiment.
Entry Requirements	Defined entry level • Module C13 passed • Scientific background in medicine, chemistry, physics or analytical chemistry. • Basic lectures on chemistry and physics are a prerequisite to follow this course. • The number of participants is limited to 12 students.
Learning Outcome and Competences	After completing the module, students will be able to… • operate the characterization system independently • interpret the results of the measurements
Comments	2 practical hours per week, whole semester 14 weeks 1st lecture: intro/overview/requirements/rules. The date of the practical exercise will be announced at the beginning of the lecture.
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	September 07, 2023

C59 / 70405-01

Hands-on Clinical Biomechanics and Ergonomics Engineering

Module	Project Work and Practical Skills
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Internship irregular
Assessment Regulations	Type: continuous assessment Repeatability: as often as necessary Evaluation Scale: Pass / Fail
Assessment Details	
Workload	3 ECTS
Lecturer(s)	Marlene Mauch (USB) Annegret Mündermann Corina Nüesch
Course contents	Mini project human movement invluding study design, data collection with different lab equipment, data processing, data analysis, final report Focus on synchronized real-time data analysis methods from the gait rehabilitation robot the FLOAT, IMUs, motion tracking, etc. applied to different small research questions. EMG-based control of an arm exoskeleton (Eduexo) using Arduino
Bibliography (Mandatory / Optional)	
Entry Requirements	Basics in Anatomy, Physiology and Bioengineering (C60, C61, C11, C12) Basics in Maths, Mechanics and Programming (C04, C16, C17, C02) and Basics in Materials Science (C01)
Learning Outcome and Competences	
Comments	next offer in HS 2024
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280166
Last Updated	July 27, 2023

C62 / 70412-01

Hands on MRI and CT

Module	Project Work and Practical Skills
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Internship irregular
Assessment Regulations	Type: continuous assessment Repeatability: as often as necessary Evaluation Scale: Pass / Fail
Assessment Details	• Attendance of practical sessions minimum 80% • Scientific reports, to be submitted 2 weeks after practical session (80% filled out to pass) • Exercises, to be submitted 2 weeks after every assignment (during semester) (80% filled out to pass) • Presentation, to be presented at the end of the semester • Final grading: pass/fail
Workload	3 ECTS
Lecturer(s)	Oliver Bieri Claudia Lenz
Course contents	Session CT I (4 lessons): • General introduction; • Safety instructions; • Instruction for writing reports; • Image acquisition of object I, try different reconstruction kernels; • Convert images to dicom, measure object dimension, discuss contrast & resolution; • Find out which object it is. Session MRI I (4 lessons): • General introduction; • Safety instructions; • Instruction for writing reports; • Image acquisition of object I, try different sequences; • Convert images to dicom, measure object dimension, discuss contrast & resolution; • Find out which object it is. Session CT II (4 lessons): • Image acquisition of object II; • Try 3D segmentation; • Find out which object it is. Session MRI II (4 lessons): • Image acquisition of object II; • Try 3D segmentation; • Find out which object it is. Session CT III (4 lessons): • Image acquisition of object III; • Try tissue segmentation; • Find out which object it is. Session MRI III (4 lessons): • Image acquisition of object III; • Try tissue segmentation; • Find out which object it is.

Session Student Presentations (4 lessons):
- Presentation and feedback;
- Comparison of CT & MRI.

Bibliography (Mandatory / Optional)

Entry Requirements

Only students attending the lectures C51 Forensic Imaging & C49 Magnetic Resonance Imaging during the same semester will be allowed to register. In maximum, 6 students can attend (first come, first serve).

Learning Outcome and Competences

After completing the module, students will be able to…
- Perform CT scans on objects/phantoms
- Perform MRI scans on objects/phantoms
- Know MR/CT safety reasons and rules
- Explain the advantages and disadvantages of MRI/CT
- Understand and explain image sequences and protocols
- Know and discuss how to improve image sequences and protocols
- Analyze CT images
- Analyze MRI images
- Evaluate and compare MRI and CT images
- Illustrate and discuss results in scientific reports
- Present and critically discuss results

Comments

next offer in HS 2024

Course Enrolment

Reg.: course registration, dereg: cancel course registration

Further Details

https://vorlesungsverzeichnis.unibas.ch/en/home?id=280163

Last Updated

July 27, 2023

C64 / tbd

Data Sciences Project

Module	Project Work and Practical Skills
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Type: Laborpraktikum Mode: MScBME - full semester
Assessment Regulations	
Assessment Details	
Workload	6 ECTS
Lecturer(s)	
Course contents	
Bibliography (Mandatory / Optional)	
Entry Requirements	
Learning Outcome and Competences	
Comments	
Course Enrolment	
Further Details	
Last Updated	July 10, 2023

C65 / 70360-01

3D Human Movement Studies – A Biomechanical, Physiological and Technical Perspective

Module	Project Work and Practical Skills
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Block course irregular
Assessment Regulations	Type: continuous assessment Repeatability: as often as necessary Evaluation Scale: Pass / Fail
Assessment Details	
Workload	3 ECTS
Lecturer(s)	
Course contents	Overview of different methods for the analysis of 3-dimensional humen movement Applications of these methods in clinical and sport environment Methodologies: Marker-based, IMU-based and markerless motion analysis; dynamomatry; EMG; the Float; stress experiment; pressure distribution; Ultrasound; spirometry; robot manipulation; exoskeleton; musculoskeletal modeling Applications muscle-tendon properties; gravitation research; postural control and training wiht virtual reality; performance screening, anterior crucieat ligament; stress experiment ankle joint; sport shoe research; movement economics via spiroergonomics; muscle physiology and ultrasound; models of motor control and adaptation; movement science and robotics (manipulation, exoskeletons); musculoskeletal modeling and data analysis; neurorehabilitation and the Float; instrumented functional tests for orthopaedic conditions; gait analysis in the orthopaedic outpatient clinic; muscular deficit in orthopaedic disorders; mechanosensitivity of articular cartilage; stress tests in biomechanical assessments and research
Bibliography (Mandatory / Optional)	
Entry Requirements	C60, C61, C11, C04, C12, C16, C17, C01, C02 Limited number of students from each department. Priority will be given to students in the - Master's program in Biomedical Engineering with Specialization C: Diagnostic and Therapeutic Technologies and the - Master's program in Sports Science in Prevention and Health Promotion. However, registration is open to all. Students will be notified of their acceptance or rejection after the registration deadline.
Learning Outcome and Competences	Understanding the different methods and technologies, their applications and limitations.
Comments	Please bring your own food, food can be consumed during lunch time at the respective institution. Travel costs can be reimbursed for students of the University of Basel via Eucor (https://www.unibas.ch/de/Studium/Mobilitaet/Mobilitaet-Region/Eucor.html). For this purpose, the following documents must be sent to info.eucor@unibas.ch no later than three months after the end of the course(s) attended: - Tickets - Copy of a valid student ID or the current confirmation of matriculation - Signed confirmation of attendance of the course (received via course coordinator) - Bank account details and home address A maximum of 200 CHF for Fribourg and 500 CHF for Karlsruhe (for all EUCOR) courses can be refunded per semester. Students are responsible for informing themselves about the current conditions for reimbursement at

	Eucor. No costs will be covered by the university or the department."
Course Enrolment	Reg.: course registration, dereg: cancel course registration
Further Details	https://vorlesungsverzeichnis.unibas.ch/en/home?id=280241
Last Updated	July 10, 2023

C95 / M-SBME-MSc C95

Semester Thesis / Internship at FHNW HLS

Module	Project Work and Practical Skills
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	Projektarbeit (Project Work)
Assessment Details	
Workload	12 ECTS
Lecturer(s)	
Course contents	
Bibliography (Mandatory / Optional)	
Entry Requirements	
Learning Outcome and Competences	
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	September 07, 2023

C96 / tbd

Semester Thesis / Internship at University Basel

Module	Project Work and Practical Skills
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Autumn semester (start: Autumn semester 24)
Format	Type: Vorlesung Mode: MScBME - full semester
Assessment Regulations	
Assessment Details	
Workload	12 ECTS
Lecturer(s)	
Course contents	
Bibliography (Mandatory / Optional)	
Entry Requirements	
Learning Outcome and Competences	
Comments	
Course Enrolment	
Further Details	
Last Updated	July 10, 2023

C98 / M-SBME-MSc C98

Master Thesis at FHNW HLS

Module	Master Thesis
Institute / Site	FHNW HLS Muttenz
Language	English
Semester	Spring semester (start: study year 24/25)
Format	Type: Master-Thesis Mode: MScBME - full semester
Assessment Regulations	Projektarbeit (Project Work)
Assessment Details	
Workload	30 ECTS
Lecturer(s)	
Course contents	
Bibliography (Mandatory / Optional)	
Entry Requirements	
Learning Outcome and Competences	
Comments	
Course Enrolment	https://esp.hls.fhnw.ch
Further Details	FHNW Inside-> "Mein Studium"
Last Updated	September 07, 2023

C99 / tbd

Master Thesis at University Basel

Module	Master Thesis
Institute / Site	University of Basel, Department of Biomedical Engineering
Language	English
Semester	Spring semester (start: study year 24/25)
Format	Type: Master-Thesis Mode: MScBME - full semester
Assessment Regulations	
Assessment Details	
Workload	30 ECTS
Lecturer(s)	
Course contents	
Bibliography (Mandatory / Optional)	
Entry Requirements	
Learning Outcome and Competences	
Comments	
Course Enrolment	
Further Details	
Last Updated	July 10, 2023