Module handbook

M.Sc. Human Technology in Sports and Medicine [M.Sc. TSM]

Valid for first-year students: Winter term 2022/23 onward

Deutsche
Sporthochschule Köln
German Sport University Cologne

Learning outcomes

Deutsche Sporthochschule Köln
German Sport University Cologne

The central aim of the *M.Sc. Human Technology in Sports and* Medicine is to provide students with the essential skills required to assess, develop and improve sport equipment as well as medical technologies. The understanding of the interaction of the human neuro-musculo-skelettal system with sports and medical technology and with other external physical variables is the fundamental aspect in the programme. Students will gain skills in problem-solving and innovative thinking along with extensive knowledge in developing sports and medicine products as well as special skills in developing methods and tools for the improvement of training and performance assessment.
The programme *Human Technology in Sports and Medicine* combines in-depth knowledge in disciplines like: sports and medical technologies, life sciences, sport sciences and engineering. We believe in a modern and research driven teaching approach, in which we provide the students with the skills and the know-how to build their individual professional profile.

Our strength:
In Cologne we have a saying: *"Jede Jeck is anders".* We, as a study programme, also believe every student is different, has different needs and wishes for his or her professional career. Using a highly research-based teaching and learning approach, the programme *Human Technology in Sports and Medicine* provides students with knowledge, structure and opportunities to reach their individual professional goals.
In the initiation phase (semester 1) students will cooperate with students from many different disciplines and gain fundamental knowledge. They will deepen their knowledge, strengthen their cooperation and apply skills and expertise in smaller group projects in the exploration phase (semesters 2 & 3), where they also start to work on actual state of the art research projects in academia or industry. Students will be able to choose from a variety of research opportunities and already start to create their very individual carrier profile. In the implementation phase (semesters 3 & 4) students will sharpen and round up their profile in bigger projects and their master thesis. The internship should be a key element of the programme, allowing students to profit from the ever-growing network of collaborations with partners from sports industry, orthopaedic industry, academia and private research institutions.

Our commitment:
We want to prepare, guide and accompany students on their – self-selected – carrier path. We aim for supporting our students at its best with opportunities and tools by providing our know-how, motivation and networks.

Perspectives:
Considering the size of rapidly growing global sports and medicine market, graduates will be able to work as leading sports and medical technology specialists in multi- and trans-disciplinary teams in the global industry, research organizations and universities. The *M.Sc. Human Technology in Sports and Medicine* degree allows for consecutive postgraduate studies earning a doctor's degree.

The following learning outcomes are at the core of the entire program:

<u>Professional competencies</u>

It is intended that students will be able to

- recall requirements and background information for an independent development, construction and evaluation of sport related apparatus and technologies, orthopaedic aids and other medical technologies with respect to the functionality and limitations of the human body
- critically evaluate sources of information and identify new sources of problem related information
- generate new hypotheses based on scientific literature and their knowledge
- identify a research gap or the demand for an innovative product or procedure
- explain and reflect on the scientific method as an ongoing circle

- differentiate between and reflect on testing protocols and for biomechanical and physiological diagnostics
- recognize and compare design features and construction forms which are used in sports devices and athletic aids, in orthopaedic aids, joint replacement and implants
- explain in-depth biomechanical principals of sports motion
- reflect on the coupling of the orthopaedic devices with the human body and the interaction of assistive devices and neuromuscular drives (human-technology-interaction)
- differentiate between specific requirements for working in an industrial or academic environment
- identify own key interest and key competencies

Personal competencies

It is intended that students will be able to

- evaluate sports and medical equipment, apparatus or playing grounds and apparel from an ergonomic, a biomechanical and a mechanobiological standpoint
- transfer biomechanical, mechanobiological and ergonomic concepts to current research questions
- independently identify gaps in the scientific knowledge on specific sport motions and develop own research questions
- use state of the measurement devices and tools safely and correctly
- provide data analysis
- plan, organize, and carry out scientific studies and present the results
- transfer knowledge and key competencies acquired to “real” industry or academic problems
- evaluate and examine the material and construction of devices in sports and medicine from a material, constructional and user point of few
- assess quality of sports motion based on quantitative or qualitative data
- critically judge effectiveness of orthopedic technologies
- explain, judge, defend or modify their findings, perspective and opinion on certain tasks

Social competencies

It is intended that students will be able to

- ask targeted questions to improve their individual competencies
- appear with confidence in discussions on topics related to biomechanics, sports technology and medical technology
- identify their own and a group’s strengths and weaknesses
- work in groups and identify how they can contribute to the success of a group’s task
- collaborate with other colleagues or members of a research group and integrate into a new (laboratory) environment
- deal with problems in the process of carrying out a project and solve occurring problems
- communicate a clear outline of a project and present own projects to an informed audience
- defend their own research or opinion on a scientifically solid basis
- highlight their own key competencies to colleagues and superiors

Autonomy

It is intended that students will be able to

- independently inform themselves about state of the art research and/or useful approaches related to a specific topic or problem
- reflect on the success of their learning processes

- independently chose and reflect on methods and study design
- independently prioritize and select problems, their relevance and solution approaches
- work independently and self-confidently in a laboratory environment related to biomechanical and physiological testing

- plan and manage a significant part of a research project or innovation process of a product
- identify demands/problems specific for a certain work/company setting and independently provide solution approaches
- reflect on own key interests and key competencies

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Module: **Basics I – Mathematics and Physics**

Degree program: **M.Sc. Human Technology in Sports and Medicine (M.Sc. TSM)**

Valid for students who started: **Winter term 2022/23**

German module title		Grundlagen I - Mathematik and Physik
Abbreviation		TSM1
Subject related semester / Duration		1. SRS / 1
Total Workload (hrs) / Total ECTS points		180 h / 6
Courses of the module Title Semester hours per week / Contact time (hrs) / Self-study (hrs) / Degree semester / Type of class / Language of Instruction / Mandatory attendance		a) Mathematics and Physics 2 SHW / 30 h / 60 h / 1. SRS / SE / English / no b) Tutorials on Mathematics and Physics 2 SHW / 30 h / 60 h / 1. SRS / TUT / English / no
Intended Competency-based Learning Outcomes	Professional competencies (knowledge)	It is intended that students will be able to - explain mathematical and physical concepts. - classify mathematical and physical problems and connect the correct solution approach. - apply mathematical procedures and physical equations, relations and laws.
	Personal competencies (skills)	It is intended that students will be able to - solve mathematical and physical problems systematically - decompose complex mathematical and physical problems in sub-components - apply abstract solution algorithms to specific problems - select the right physical and mathematical approaches for given mathematical or physical problems.
	Social competencies	It is intended that students will be able to - ask targeted questions to improve their individual competencies - collaborate to solve assignments and problems - identify where they can provide input for the group - cooperate to overcome weaknesses
	Autonomy	It is intended that students will be able to - identify own strengths and weaknesses - solve problems independently - prioritize where to ask for and to offer support and help
Key Qualifications		- Knowledge and understanding of mathematical and mechanical concepts most relevant for biomechanics. - Application of mathematical and mechanical concepts to solve abstract “real world” problems.
Key content areas		- equations, systems of equations - linear algebra, vector calculus, matrix operations - analysis, functions and curves - mechanics of mass points - uniform and non-uniform movements

	- inertia, force, momentum and impulse, inertial forces, work, power, energy mechanics of systems of mass points - Newton 1 -3, conservation of momentum, center of mass, degrees of freedom, rotation, moment of inertia - Moment of force and angular impulse, conservation of angular momentum - Circular movements, centripetal and centrifugal force, vibrations, resonance, damping, superimposed vibrations
Teaching and learning methods	Teacher-centered, Exercise
Recommended literature	- Foundation Mathematics for Engineers, John Berry & Patrick Wainwright, SpringerLink - Lectures on Physics, Richard Feynman, Addison–Wesley
Module type (compulsory/elective)	Compulsory
Prerequisites/ Admission requirements	cf. Overview Prerequisites
Intermediate assessments	No intermediate assessment.
Assessment / extent / share of the module grade	Written examination / 120 Min / 100%
Module Commissioner	Cf. Overview Module Commissioners

Subject to change

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Module: **Basics II – Biomechanics**

Degree program: **M.Sc. Human Technology in Sports and Medicine (M.Sc. TSM)**

Valid for students who started: **Winter term 2022/23**

German module title		Grundlagen II – Biomechanik
Abbreviation		TSM2
Subject related semester / Duration		1. SRS / 1
Total Workload (hrs) / Total ECTS points		240 h / 8
Courses of the module Title Semester hours per week / Contact time (hrs) / Self-study (hrs) / Degree semester / Type of class / Language of Instruction / Mandatory attendance		a) Biomechanics 2 SHW / 30 h / 30 h / 1. SRS / SE / English / no b) Mechanobiology 2 SHW / 30 h / 30 h / 1. SRS / SE / English / no c) Ergonomics 2 SHW / 30 h / 30 h / 1. SRS / SE / English / no d) Biomechanics and Mechanobiology 2 SHW / 30 h / 30 h / 1. SRS / TUT / English / no
Intended Competency-based Learning Outcomes	Professional competencies (knowledge)	It is intended that students will be able to - explain biomechanical, mechanobiological and ergonomic concepts. - recall requirements and background information for an independent development, construction and evaluation of sport related apparatus and technologies, orthopaedic aids and other medical technologies with respect to the geometry of the human body, the human body's joints, the biological structures and tissues, the kinematics and kinetics of the muscular drives and their motor control capacity.
	Personal competencies (skills)	It is intended that students will be able to - evaluate sports and medical equipment, apparatus or playing grounds and apparel from an ergonomic, a biomechanical and a mechanobiological standpoint - transfer biomechanical, mechanobiological and ergonomic concepts to current research questions
	Social competencies	It is intended that students will be able to - collaborate to solve assignments and problems - identify where they can provide input for the group - cooperate to overcome weaknesses
	Autonomy	It is intended that students will be able to - ask targeted questions to improve their individual competencies - identify own strengths and weaknesses - independently inform themselves about state of the art research related to the course
Key Qualifications		- Knowledge enhancement - Scientific expertise

Key content areas	Biomechanics - Kinematics of human motion - Kinetics of human motion - Muscle biomechanics - Joint mechanics (joint kinematics, joint stiffness, intraarticular loading) - External contact forces in sports, activities of daily life and rehabilitation - Joint moments and forces, joint power - Local biological effects of contact forces Mechanobiology - Structure and composition of tissues - Basic concepts of tissue biomechanics - Mechanical properties of connective tissues: bone, cartilage, ligaments, tendons and muscles - Tissue adaptation to mechanical loading - Introduction into cellular biomechanics Ergonomics - Anthropometry of the human body and its segments - Age-and gender-specific body geometry and anthropometry Inertial characteristic of the human body and the body segments - Definition, applications and determination of percentiles - Forces acting on the body (e.g. stress-strain-model, measuring forces, forces and body posture) - Ergonomics of motion (gripping and moving spaces) - Occupational measurements / laboratory methods - Risk assessment methods - Physical load due to work posture - Applied Ergonomics (comfort / discomfort, product ergonomics, compatibility) Biomechanics and Mechanobiology (Tutorial) - Measurement techniques: direct kinetics, optical kinetics, dynamics, electromyography, imaging methods, mechanical testing
Teaching and learning methods	Teacher-centered, group work, Laboratory exercise
Recommended literature	- Biomechanics: Neuromechanics of human movement. Roger M. Enoka. Third Edition. Human Kinetics; - Biomechanics and motor control of human movement. David A. Winter. (2009) Third Edition. Wiley; - Biomechanics of the Musculo-skeletal System. Second Edition. Benno M. Nigg & Walter Herzog. Wiley - Research Methods in Biomechanics. Robertson, D. Gordon E., Graham E. Caldwell, Joseph Hamill, Gary

	Kamen, and Saunders N. Whittlesey (2014) Second edition. Champaign, IL: Human Kinetics.
Module type (compulsory/elective)	compulsory
Prerequisites/ Admission requirements	cf. Overview Prerequisites
Intermediate assessments	Details will be given for each seminar in the first session at the semester's start.
Assessment / extent / share of the module grade	Written examination / 120 Min / 100%
Module Commissioner	Cf. Overview Module Commissioners

Subject to change

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Module: **Basics III - Data management and Data analysis**

Degree program: **M.Sc. Human Technology in Sports and Medicine (M.Sc. TSM)**

Valid for students who started: **Winter term 2022/23**

German module title		Grundlagen III - Datenmanagement und Datenanalyse
Abbreviation		TSM3
Subject related semester / Duration		1. SRS / 1
Total Workload (hrs) / Total ECTS points		240 h / 8
Courses of the module Title Semester hours per week / Contact time (hrs) / Self-study (hrs) / Degree semester / Type of class / Language of Instruction / Mandatory attendance		a) Data management and Programming 2 SHW / 30 h / 30 h / 1. SRS / SE / English / no b) Applied Data management and Programming 2 SHW / 30 h / 30 h / 1. SRS / SE / English / no c) Statistics Lecture Series 1 SHW / 15 h / 30 h / 1. SRS / LEC / English / no d) Advanced and Applied Statistics 2 SHW / 30 h / 45 h / 1. SRS / SE / English / no
Intended Competency-based Learning Outcomes	Professional competencies (knowledge)	It is intended that students will be able to - recall and identify most relevant methods of data management and data analysis - recall and identify basic numerical solution techniques - recall and identify basic statistical principals - recall and identify modern statistical techniques and models
	Personal competencies (skills)	It is intended that students will be able to - develop program code / scripts for data management, further data analysis - design basic sports related computer applications / scripts - apply tools/models and techniques to practical examples in the field of statistics or data management - apply tools/models to data sets and/or research questions related to sports science and medical technology - use correct terminology to express them self's or their ideas
	Social competencies	It is intended that students will be able to - appear with confidence in discussions on data management and statistics - defend their own research or opinion on a statistically solid basis
	Autonomy	It is intended that students will be able to - independently choose adequate programming methods or statistical approaches for a given problem - identify and inform themselves about useful programming tools or statistical approaches
Key qualifications		- Advanced understanding and application of

	programming methods & tools and statistical approaches - Ability to apply problem-oriented programming and statistical approaches
Key content areas	<u>Programming & Data Management</u> Procedural programming with Matlab (or Octave) Computer Programming - Data types, variables and constants - Operators - Basic control structures - Functions - Vectors & Matrices - Basic linear algebra functions - Reading and writing of data Algorithms - Root Finding - Searching - Interpolation - Basic Optimization Linear Equation Systems - Basic image processing <u>Statistics</u> - Revision of basic statistical principles, techniques and terminology - Theory and application of statistical modeling techniques (linear models, advanced statistical modeling approaches) - Functional data analysis (functional data theory, functional descriptive statistics, principle component analysis, advanced functional data analysis techniques) - Pattern recognition and classification techniques (unsupervised learning algorithms: e.g. cluster analysis techniques, neuronal network techniques; - Supervised learning algorithms (e.g. discriminate analysis, support vector machine techniques
Teaching and learning methods	Teacher-centered, project-oriented-learning partly based on real scientific research questions, group work
Recommended literature	- Field, Andy P. (2013) Discovering Statistics Using IBM SPSS Statistics: And Sex and Drugs and Rock “n” Roll. 4th edition. Los Angeles: Sage.
Module type (compulsory/elective)	compulsory
Prerequisites/ Admission requirements	cf. <u>Overview Prerequisites</u>
Intermediate assessments	Homework, details will be given for each seminar in the first session at the semester’s start.
Assessment / extent / share of the module grade	Written examination (partly computer-based) / 120 Min / 100%

	Further information will be given during first session at semester's start
Module Commissioner	Cf. Overview Module Commissioners

Subject to change

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Module: **Basics IV – Material and Construction**

Degree program: **M.Sc. Human Technology in Sports and Medicine (M.Sc. TSM)**

Valid for students who started: **Winter term 2022/23**

German module title		Grundlagen IV - Material und Konstruktion
Abbreviation		TSM4
Subject related semester / Duration		1. SRS / 1
Total Workload (hrs) / Total ECTS points		240 h / 8
Courses of the module Title Semester hours per week / Contact time (hrs) / Self-study (hrs) / Degree semester / Type of class / Language of Instruction / Mandatory attendance		a) Material and Construction 2 SHW / 30 h / 90 h / 1. SRS / SE / English / no b) Material and Construction 2 SHW / 30 h / 90 h / 1. SRS / TUT / English / no
Intended Competency-based Learning Outcomes	Professional competencies (knowledge)	It is intended that students will be able to - explain the fundamentals of the construction apprenticeship - recall, recognize and compare design features and construction forms which are used in sports devices and athletic aids, in orthopaedic aids, joint replacement and implants - classify the most important materials used in sports devices and athletic aids, in orthopaedic aids, joint replacement and implants - compare properties of different materials - explain different failure spots and hazard points as well as corresponding solutions
	Personal competencies (skills)	It is intended that students will be able to - execute inspection and testing of different materials - evaluate and examine the material and construction of devices in sports and medicine from a material, constructional and user point of few
	Social competencies	It is intended that students will be able to - present and defend their results in an oral presentation - present and defend their results in a written form - work in groups
	Autonomy	It is intended that students will be able to - inform themselves using tutorial videos available on YouTube produced by the lecturers - work idenpendently in an interdisciplinary setting
Key Qualifications		- Basic knowledge in material sciences - Fundamentals of construction and design process
Key content areas		Material - lattice types and defects - designation of steel - phase diagrams

	- the iron-carbon phase diagram - time-temperature-transformation diagram - heat treatment of steel - high alloy steel - corrosion - non-ferrous metals - polymers - composite materials <u>Construction</u> - overview of the design process and design methodology - tools for the different steps in the design process - project management and teamwork - general construction apprenticeship - special construction of articulated connections - construction of drives - analysis of forces and stresses - material selection - design of elements (sizes and stresses)
Teaching and learning methods	Flipped classroom, project-oriented-learning, group work
Recommended literature	Information will be given at the start of the term
Module type (compulsory/elective)	Compulsory
Prerequisites/ Admission requirements	cf. <u>Overview Prerequisites</u>
Intermediate assessments	Homework. Details will be given for each seminar in the first session at the semester's start.
Assessment / extent / share of the module grade	Material: written examination / 120 min / 50% Construction: Project Presentation (group) + written report (group) / 30 min (presentation), 22.000 – 26.000 letters incl. spaces (report) / 50% Details will be given by lectures in first session of semester
Module Commissioner	Cf. <u>Overview Module Commissioners</u>

Subject to change

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Module: **Technology I – Orthopaedic Technologies**

Degree program: **M.Sc. Human Technology in Sports and Medicine (M.Sc. TSM)**

Valid for students who started: **Winter term 2022/23**

German module title		Technologie I – Orthopädische Technologien
Abbreviation		TSM5
Subject related semester / Duration		2. SRS / 1
Total Workload (hrs) / Total ECTS points		150 h / 5
Courses of the module Title Semester hours per week / Contact time (hrs) / Self-study (hrs) / Degree semester / Type of class / Language of Instruction / Mandatory attendance		a) Orthopaedic Biomechanics – Functionality of Orthoses and Exoskeletons 2 SHW / 30 h / 45 h / 2. SRS / SE / English / no b) Joint replacement, Implants and Prostheses 2 SHW / 30 h / 45 h / 2. SRS / SE / English / no
Intended Competency-based Learning Outcomes	Professional competencies (knowledge)	It is intended that students will be able to - summarize the most important orthopaedic aids with special consideration of prostheses and orthoses, total joint replacements and implants - reflect on the coupling of the orthopaedic devices with the human body and the interaction of assistive devices and neuromuscular drives - indicate the use of orthopaedic devices in sports and the resumption of sports participation after joint replacement - explain injury mechanisms and the functional concepts of orthopedic devices - identify and apply bio-mechanical principles in the relation of orthopedic devices and in the human-technology-interaction
	Personal competencies (skills)	It is intended that students will be able to - identify features of orthopedic technologies related to its indications - critically judge effectiveness of orthopedic technologies - identify technical vulnerabilities and to discuss potential solutions - critically review scientific literature and combine different sources to gain integrative knowledge - explain, judge, defend or modify their findings, perspective and opinion on certain tasks. - Critically review and question the work of course mates
	Social competencies	It is intended that students will be able to - present scientific content with confidence - ask, criticize or support others in order to optimize the learning output of the whole group

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

	Autonomy	It is intended that students will be able to - Independently acquire new understanding in given problems.
Key Qualifications		- Knowledge enhancement - Scientific expertise - Problem management

Key content areas		<u>Orthopaedic Biomechanics – Functionality of Orthoses and Exoskeletons</u>
		- Load management and load re-distribution
		- Injury mechanisms, principles of load re-distribution by orthoses
		- Application for the ankle joint, knee joint, by insoles, by gait strategies, special footwear
		
		<u>Joint replacement, Implants and Prostheses</u>
		- Revision of joint anatomy
		- Overview of the main implants for hip, knee and ankle joints:
		  - Implant designs and development
		  - Fixation techniques
		  - Used materials and components
		  - Survivorship, patients' outcomes
		  - Indications
		- Sport prostheses (jumping and running) / Adapted physical activity
		- Exoprostheses with microprocessor technology

Teaching and learning methods		Teacher-centered, group work, student short scientific presentation, guest lectures, field trips
Recommended literature		Literature will be provided in the course
Module type (compulsory/elective)		compulsory
Prerequisites/ Admission requirements		cf. <u>Overview Prerequisites</u>
Intermediate assessments		Details will be given for each seminar in the first session at the semester's start.
Assessment / extent / share of the module grade		Written examination / 90 Min / 100%
Module Commissioner		Cf. <u>Overview Module Commissioners</u>

Subject to change

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Module: **Technology II – Sports Biomechanics and Project Management**

Degree program: **M.Sc. Human Technology in Sports and Medicine (M.Sc. TSM)**

Valid for students who started: **Winter term 2022/23**

German module title		Technologie II – Sportbiomechanik und Projektmanagement
Abbreviation		TSM6
Subject related semester / Duration		2. SRS / 1
Total Workload (hrs) / Total ECTS points		150 h / 5
Courses of the module Title Semester hours per week / Contact time (hrs) / Self-study (hrs) / Degree semester / Type of class / Language of Instruction / Mandatory attendance		a) Sports Biomechanics 3 SHW / 45 h / 45 h / 2. SRS / SE / English / no b) Project Management 2 SHW / 30 h / 30 h / 2. SRS / SE / English / no
Intended Competency-based Learning Outcomes	Professional competencies (knowledge)	It is intended that students will be able to - explain in-depth biomechanical principals of sports motion - reflect on current state of the art research on specific sports motions - identify main tasks along the project management lifecycle and explain key terms in project management
	Personal competencies (skills)	It is intended that students will be able to - assess quality of sports motion based on quantitative or qualitative data (e.g. kinematics, kinetics, physiological, muscular activity) for motion or performance analysis - independently identify gaps in the scientific knowledge on specific sport motions and develop own research questions - develop, plan, and evaluate a project by applying project management techniques to ensure an effective and efficient use of resources in projects
	Social competencies	It is intended that students will be able to - work in groups and split workload and use resources effectively to comprehensively understand a specific topic or reach a common (project) goal - explain biomechanical principals of motion to an informed audience (e.g. coaches, researchers) - present them-selves as experts on a specific topic related to sports biomechanics
	Autonomy	It is intended that students will be able to - inform them-selves on sports biomechanical research and know where to find latest state of the art information - manage and plan their own projects or tasks with respect to budget, time, personal and other resources
Key Qualifications		- scientifically approach a sports biomechanical topic in-depth - develop and manage a project based on project management principles

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Key content areas	Sports Biomechanics (SB) - In-depth biomechanics of various sport disciplines such as: Paralympic sports, human gait (walking, running, sprinting), jumping, throwing, lifting, cycling, swimming, racket sports, contact sports, winter sports - In-depth literature research on specific research questions in the field of sports biomechanics Project Management (MA) - Project conceptualization (definition of project scope, project objectives) - Project planning (workload, scheduling, resource management, risk management) - Project monitoring and evaluation - Agile project management
Teaching and learning methods	Teacher-centered, group work, scientific presentation, research-oriented
Recommended literature	- The Biomechanics of Sports techniques, Hay (1993) - Biomechanics in Sport: Performance Enhancement and Injury Prevention, Zatsiorsky (2000) - Biomechanics of Sport and Exercise, McGinnis (2013) - Journal of Sports Biomechanics - Project Management: A Systems Approach to Planning, Scheduling, and Controlling (10th ed.). Kerzner, H. (2009). John Wiley & Sons. - Project Management: Achieving Competitive Advantage (4th ed.). Pinto, J. K. (2016). Pearson Educational Limited.
Module type (compulsory/elective)	compulsory
Prerequisites/ Admission requirements	cf. Overview Prerequisites
Intermediate assessments	Details will be given for each seminar in the first session at the semester's start.
Assessment / extent / share of the module grade	Sports Biomechanics: Presentation (group) / 3-5 min + discussion / 60% Project Management: Term paper / 6.000 – 10.000 letters incl. spaces / 40% Details will be given by lectures in first session of semester
Module Commissioner	Cf. Overview Module Commissioners

Subject to change

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Module: **Technology III – Sports Equipment and Instrumentation**

Degree program: **M.Sc. Human Technology in Sports and Medicine (M.Sc. TSM)**

Valid for students who started: **Winter term 2022/23**

German module title		Technologie III - Sportequipment und Instrumentation
Abbreviation		TSM7
Subject related semester / Duration		2. SRS / 1
Total Workload (hrs) / Total ECTS points		270 h / 9
Courses of the module Title Semester hours per week / Contact time (hrs) / Self-study (hrs) / Degree semester / Type of class / Language of Instruction / Mandatory attendance		a) Instrumentation Technology 2 SHW / 30 h / 60 h / 2. SRS / SE / English / no b) Sports and Rehabilitation Equipment 2 SHW / 30 h / 60 h / 2. SRS / SE / English / no c) Footwear and Playing Surfaces 2 SHW / 30 h / 60 h / 2. SRS / SE / English / no
Intended Competency-based Learning Outcomes	Professional competencies (knowledge)	It is intended that students will be able to - critically evaluate the value of sources of information - identify new sources of problem related information - recall and consider aspects of safety when using instrumentation or testing devices
	Personal competencies (skills)	It is intended that students will be able to - combine sources of information to generate new understanding - judge the sources and methods to gain new knowledge and understanding - create own basic measurement instrumentation related to a specific research question
	Social competencies	It is intended that students will be able to - present, explain, justify and defend their approaches - explain their difficulties in gaining understanding
	Autonomy	It is intended that students will be able to - independently search for sources of information - independently prioritize and select problems, their relevance and solution approaches - reflect on the success of their learning processes
Key Qualifications		- Knowledge enhancement - Technical expertise - Problem management
Key content areas		Instrumentation Technology - Electrical properties - Magnetic Properties - Optical Properties

	- Thermal Properties - Electrical safety guidelines - Own applications (e.g. Arduino) <u>Sports and Rehabilitation Equipment</u> - Structure and properties - Design and material behavior - physical properties of materials and construction elements (electrical, magnetic, optical, thermal) - sport-specific apparel, biomechanical requirements - testing and inspection - Compression wear - Mechanical testing and mechanical properties, practical equipment tests - Analysis of risk and hazard <u>Footwear and Playing Surfaces</u> - Structure and properties - Design and material behavior - Raw materials - Sport-specific technologies, biomechanical requirements - Mechanical testing methods and properties, practical equipment-based testing - Risk analysis - Testing and inspection - Production and development
Teaching and learning methods	Teacher-centered, project-based learning, research-oriented learning, student presentation, group work
Recommended literature	- Routledge Handbook of Sports Technology and Engineering Edited By Franz Konstantin Fuss, Aleksandar Subic, Martin Strangwood, Rabindra Mehta, Taylor and Francis
Module type (compulsory/elective)	compulsory
Prerequisites/ Admission requirements	cf. <u>Overview Prerequisites</u>
Intermediate assessments	Student presentations, details will be given for each seminar in the first session at the semester's start.
Assessment / extent / share of the module grade	One presentation in each course / each 10 min / 3 x 13,33% = 40% Term paper in one course of choice / 12.000 – 20.000 letters incl. spaces / 60% Details will be given by lectures in first session of semester
Module Commissioner	Cf. <u>Overview Module Commissioners</u>

Subject to change

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Module: **Technology IV – Modeling and Simulation**

Degree program: **M.Sc. Human Technology in Sports and Medicine (M.Sc. TSM)**

Valid for students who started: **Winter term 2022/23**

German module title		Technologie IV - Modellierung und Simulation
Abbreviation		TSM8
Subject related semester / Duration		2. SRS / 1
Total Workload (hrs) / Total ECTS points		180 h / 6
Courses of the module Title Semester hours per week / Contact time (hrs) / Self-study (hrs) / Degree semester / Type of class / Language of Instruction / Mandatory attendance		a) Multi Body Modeling 2 SHW / 30 h / 60 h / 2. SRS / SE / English / no b) Finite Element Modeling 2 SHW / 30 h / 60 h / 2. SRS / SE / English / no
Intended Competency-based Learning Outcomes	Professional competencies (knowledge)	It is intended that students will be able to - Recall and explain basics of modelling - Recall and explain the mathematical / physical foundations of different modelling techniques
	Personal competencies (skills)	It is intended that students will be able to - adapt existing models to a specific research question - model basic dynamic multi-body systems and use them for calculations
	Social competencies	It is intended that students will be able to - appear with confidence in discussions on topics related to modeling and simulation - share models with other students and work in teams
	Autonomy	It is intended that students will be able to - independently chose adequate modeling and simulation approaches - identify and inform themselves about latest or useful modeling and simulation approaches
Key Qualifications		- Project specific modeling - Methodological Expertise

Key content areas		Multi Body Modeling
		- Basics of technical mechanics (e.g. Link-Segment model, Free Body Diagram)
		- Model Categories
		  - Mathematical and physical models
		  - Structural and statistical models
		- Steps of the modeling method
		  - From description to the application of the model (simulation)
		- Advantages and disadvantages of modeling methods

	- Forward dynamics
	- Inverse dynamics
	- Multi-body dynamics
	  - Definition of coordinate systems
	  - Calculating 3D joint angles
	  - Using rotation matrices
	  - Calculation of joint moments
	
	<u>Finite Element Modeling (FEM)</u>
	- Ordinary and partial differential equations
	- Simple mathematical models and solution methods
	- Comparing analytical and numerical solutions
	- Advanced models: applications in sports
	- Introduction to Finite Elements:
	  - Key steps of a finite element analysis
	  - Theoretical aspects (e.g. errors, solvers, …)
	  - Simple spring assemblies using Matlab
	  - Finite Element Software (e.g. Febio)
	  - Stress analysis of simple geometries
	  - Setup of biomechanical FE models

Teaching and learning methods	Teacher-centered, project-based learning approaches, group work
Recommended literature	- Biomechanics and motor control of human movement. David A. Winter. (2009) Third Edition. Wiley; - Applied Numerical Methods with Matlab, Steven Chapra, Mc Graw Hill - Applied Finite Element Analysis, Larry Segerlind, 2nd Edition Taschenbuch, Wiley
Module type (compulsory/elective)	compulsory
Prerequisites/ Admission requirements	cf. <u>Overview Prerequisites</u>
Intermediate assessments	Homework, details will be given for each seminar in the first session at the semester's start.
Assessment / extent / share of the module grade	Written examination / 120 min / 100%
Module Commissioner	Cf. <u>Overview Module Commissioners</u>

Subject to change

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Module: **Technology V –Diagnostics in Sports, Medicine and Rehabilitation**

Degree program: **M.Sc. Human Technology in Sports and Medicine (M.Sc. TSM)**

Valid for students who started: **Winter term 2022/23**

German module title		Technologie V – Diagnostik in Sport, Medizin und Rehabilitation
Abbreviation		TSM9
Subject related semester / Duration		2. SRS / 1
Total Workload (hrs) / Total ECTS points		150 h / 5
Courses of the module Title Semester hours per week / Contact time (hrs) / Self-study (hrs) / Degree semester / Type of class / Language of Instruction / Mandatory attendance		a) Biomechanical and Physiological Diagnostics 2 SHW / 30 h / 45 h / 2. SRS / SE / English / no b) Biomedical Diagnostics 2 SHW / 30 h / 45 h / 2. SRS / TUT / English / no
Intended Competency-based Learning Outcomes	Professional competencies (knowledge)	It is intended that students will be able to - differentiate between the most important methods for athletic testing and biomechanical and physiological diagnostics - reflect on given testing protocols and methods
	Personal competencies (skills)	It is intended that students will be able to - use state of the measurement devices and tools safely and correctly - design and carry out own testing protocols for a specific research question - interpret testing results
	Social competencies	It is intended that students will be able to - work in groups - integrate into a laboratory environment - identify their own and a group's strengths and weaknesses - identify how they can contribute to the success of a group's task
	Autonomy	It is intended that students will be able to - work independently and self-confidently in a laboratory environment related to biomechanical and physiological testing
Key Qualifications		- Practical work in a laboratory environment - Expertise in data acquisition - Performance analysis and biomechanical testing
Key content areas		Physical measurement technologies - distance, time, velocity, acceleration, temperature, air-pressure, atmospheric humidity, concentration of oxygen, carbon dioxide and nitrogen, force, pressure - 2D and 3D motion capture - Electronic measurement technologies

	- voltage, current, resistance - electric fields - isolation, conductivity - Material properties - stiffness, hysteresis - Physiological measurement technologies - electrical potentials: EMG, ECG, EEG - medical imaging methods: pQCT, Micro-CT , Ultrasound - muscle strength measurements: isometric, isokinetic and dynamic - blood count, blood gas, hormones, enzymes - Spiroergometry (gas exchange analysis) - Data analysis and processing - Post processing of 2D and 3D motion raw data - Handling C3D-files - Filtering
Teaching and learning methods	Teacher-centered, project-based learning approaches, laboratory exercises
Recommended literature	- Research Methods in Biomechanics. Robertson, D. Gordon E., Graham E. Caldwell, Joseph Hamill, Gary Kamen, and Saunders N. Whittlesey (2014) Second edition. Champaign, IL: Human Kinetics. - Biomechanics and motor control of human movement. David A. Winter. Third Edition. Wiley;
Module type (compulsory/elective)	compulsory
Prerequisites/ Admission requirements	cf. Overview Prerequisites
Intermediate assessments	Details will be given for each seminar in the first session at the semester's start.
Assessment / extent / share of the module grade	Oral examination / 20 min / 100%
Module Commissioner	Cf. Overview Module Commissioners

Subject to change

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Module: **Philosophy of Science**

Degree program: **M.Sc. Human Technology in Sports and Medicine (M.Sc. TSM)**

Valid for students who started: **Winter term 2022/23**

German module title		Wissenschaftstheorie
Abbreviation		TSM10
Subject related semester / Duration		3. SRS / 1
Total Workload (hrs) / Total ECTS points		180 h / 6
Courses of the module Title Semester hours per week / Contact time (hrs) / Self-study (hrs) / Degree semester / Type of class / Language of Instruction / Mandatory attendance		a) Ethics, Technology and Research in Humans 2 SHW / 30 h / 60 h / 3. SRS / SE / English / no b) Research Methods 2 SHW / 30 h / 60 h / 3. SRS / SE / English / no
Intended Competency-based Learning Outcomes	Professional competencies (knowledge)	It is intended that students will be able to - Understand, apply, combine elements of scientific methods to gain new knowledge and insight. - discuss ethical problems of relevance to research and application
	Personal competencies (skills)	It is intended that students will be able to - critically review, judge and eventually defend complex scientific concepts. - take a critical stance towards their own standpoint and their roles as future researchers and experts
	Social competencies	It is intended that students will be able to - exchange and accept different ideas and views of scientific approaches as well as ethical evaluations - justify, defend or change own opinions
	Autonomy	It is intended that students will be able to - Learn how to independently design scientific research approaches - Critically reflect existing and new approaches to design scientific studies. - critically reflect upon the role of scientists and experts in public discussions
Key Qualifications		- Critical reflection upon the process and methods of research and its application
Key content areas		Ethics, Technology and Research in Humans - central concepts and norms involving research with human study subjects - key ethical aspects of sound scientific practice - principles of utilitarian and deontological ethics as present in research ethics, medical ethics and bioethics - outlines of selected current debates in medical

	ethics, bioethics and research ethics Research Methods - The scientific process as an ongoing process - Observation, experiment, hypothesis, research question, prediction, scientific theory - Observational and experimental study designs - Reasoning, explaining, prognosticate - "Evidence based medicine" - Artificial intelligence
Teaching and learning methods	Teacher-centered teaching, problem-based learning approaches, group work, case-based discussions
Recommended literature	- Scientific Method in Practice, Hgh G Gauch Jr, Cambridge University press; - Feynman Lectures: Feynman's Messenger Lectures (caltech.edu);
Module type (compulsory/elective)	compulsory
Prerequisites/ Admission requirements	cf. Overview Prerequisites
Intermediate assessments	Details will be given for each seminar in the first session at the semester's start.
Assessment / extent / share of the module grade	Research Methods: Oral examination / 15 min / 50% Ethics, Technology and research in Humans: Term paper / 10.000 – 15.000 letters incl. spaces / 50% Details will be given by lectures in first session of semester
Module Commissioner	Cf. Overview Module Commissioners

Subject to change

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Module: **Project I - Sports Technology Project**

Degree program: **M.Sc. Human Technology in Sports and Medicine (M.Sc. TSM)**

Valid for students who started: **Winter term 2022/23**

German module title		Projekt I – Sporttechnologieprojekt
Abbreviation		TSM11.1
Subject related semester / Duration		3. SRS / 1
Total Workload (hrs) / Total ECTS points		360 h / 12
Courses of the module Title Semester hours per week / Contact time (hrs) / Self-study (hrs) / Degree semester / Type of class / Language of Instruction / Mandatory attendance		a) Applied Research Methods 2 SHW / 30 h / 90 h / 3. SRS / SE / English / no b) Sports Technology 6 SHW / 90 h / 150 h / 3. SRS / TUT / English / no
Intended Competency-based Learning Outcomes	Professional competencies (knowledge)	It is intended that students will be able to - generate new hypotheses based on scientific literature and their knowledge. - identify a research gap or the demand for an innovative product or procedure
	Personal competencies (skills)	It is intended that students will be able to - derive own research questions - use the equipment needed for their project, scientifically correct, safely and reliably - adapt known methodologies to their own research or product idea - write down and present their findings in a scientific adequate way - plan, organize, and manage scientific studies
	Social competencies	It is intended that students will be able to - interact with other researchers or colleagues related to the project - communicate a clear outline of their project - present their own project to an informed audience - deal with problems in the process of carrying out a project and solve occurring problems
	Autonomy	It is intended that students will be able to - plan and manage a significant part of a research project or innovation process of a product - identify own weaknesses in knowledge and independently seek for help or find adequate resources to inform them selves
Key Qualifications		- Plan, design and manage a significant part of a research project or innovation process of a product - Present project results on point and scientifically appropriate
Key content areas		Applied Research Methods - Specific literature review - Identification of research question and primary

	parameters for analysis - Project specific post processing and data analysis - Project specific presentation with focus on relevant important content - Scientific writing Sports Technology - Development of new or modification of an existing equipment or assistive technology related to sports technology - Investigate technological equipment and/or assistive devices related to Paralympic sports - Analysis of new sports technological equipment or devices - Empirical studies with a clear focus on aspects related to the study program - Realization of project/product idea (e.g. design and construction of a product, planning and conducting a research study) - Evaluation and presentation of the product/research findings (e.g. prototype testing/proof of concept/case report/study report)
Teaching and learning methods	research-based learning approach, project-based learning approaches
Recommended literature	
Module type (compulsory/elective)	elective
Prerequisites/ Admission requirements	cf. Overview Prerequisites
Intermediate assessments	Progress presentations, details will be given for each seminar in the first session at the semester's start.
Assessment / extent / share of the module grade	Short paper (single) + Project presentation (single) / Short paper: 4 pages, ISBS abstract guidelines; Project presentation: 15 min / 50% + 50% Details will be given by lectures in first session of semester
Module Commissioner	Cf. Overview Module Commissioners

Subject to change

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Module: **Project II - Medical Technology Project**

Degree program: **M.Sc. Human Technology in Sports and Medicine (M.Sc. TSM)**

Valid for students who started: **Winter term 2022/23**

German module title		Projekt II – Medizintechnologieprojekt
Abbreviation		TSM11.2
Subject related semester / Duration		3. SRS / 1
Total Workload (hrs) / Total ECTS points		360 h / 12
Courses of the module Title Semester hours per week / Contact time (hrs) / Self-study (hrs) / Degree semester / Type of class / Language of Instruction / Mandatory attendance		a) Applied Research Methods 2 SHW / 30 h / 90 h / 3. SRS / SE / English / no b) Medical Technology 6 SHW / 90 h / 150 h / 3. SRS / TUT / English / no
Intended Competency-based Learning Outcomes	Professional competencies (knowledge)	It is intended that students will be able to - generate new hypotheses based on scientific literature and their knowledge. - identify a research gap or the demand for an innovative product or procedure
	Personal competencies (skills)	It is intended that students will be able to - derive own research questions - use the equipment needed for their project, scientifically correct, safely and reliably - adapt known methodologies to their own research or product idea - write down and present their findings in a scientific adequate way - plan, organize, and manage scientific studies
	Social competencies	It is intended that students will be able to - interact with other researchers or colleagues related to the project - communicate a clear outline of their project - present their own project to an informed audience - deal with problems in the process of carrying out a project and solve occurring problems
	Autonomy	It is intended that students will be able to - plan and manage a significant part of a research project or innovation process of a product - identify own weaknesses in knowledge and independently seek for help or find adequate resources to inform themselves
Key Qualifications		- Plan, design and manage a significant part of a research project or innovation process of a product - Present project results on point and scientifically appropriate
Key content areas		Applied Research Methods - Specific literature review - Identification of research question and primary

	parameters for analysis - Project specific post processing and data analysis - Project specific presentation with focus on relevant important content - Scientific writing Medical Technology - Development of new or modification of an existing medicine equipment or assistive technology - Analysis of new medical/clinical/assistive equipment or devices - Clinical studies with a clear focus on aspects related to the study program - Realization of project/product idea (e.g. design and construction of a product, planning and conducting a research study) - Evaluation and presentation of the product/research findings (e.g. prototype testing/proof of concept/case report/study report)
Teaching and learning methods	research-based learning approach, project-based learning approaches
Recommended literature	
Module type (compulsory/elective)	elective
Prerequisites/ Admission requirements	cf. Overview Prerequisites
Intermediate assessments	Progress presentations, details will be given for each seminar in the first session at the semester's start.
Assessment / extent / share of the module grade	Short paper (single) + Project presentation (single) / Short paper: 4 pages, ISBS abstract guidelines; Project presentation: 15 min / 50% + 50% Details will be given by lectures in first session of semester
Module Commissioner	Cf. Overview Module Commissioners

Subject to change

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Module: **Internship**

Degree program: **M.Sc. Human Technology in Sports and Medicine (M.Sc. TSM)**

Valid for students who started: **Winter term 2022/23**

German module title		Praktikum
Abbreviation		TSM12
Subject related semester / Duration		3. SRS / 1
Total Workload (hrs) / Total ECTS points		360 h / 12
Courses of the module Title Semester hours per week / Contact time (hrs) / Self-study (hrs) / Degree semester / Type of class / Language of Instruction / Mandatory attendance		Internship -SHW / min. 360 h / n.a. / 3. SRS / n.a / n.a. / yes
Intended Competency-based Learning Outcomes	Professional competencies (knowledge)	It is intended that students will be able to - identify own key interest and key competencies - differentiate specific requirements for working in an industrial or academic environment
	Personal competencies (skills)	It is intended that students will be able to - transfer knowledge and key competencies acquired during the MSc TSM program to "real" industry or academic problems - use data capturing equipment safely and reliably - provide data analysis
	Social competencies	It is intended that students will be able to - integrate into a new environment and team - highlight their own key competencies to colleagues and superiors
	Autonomy	It is intended that students will be able to - reflect on own key interests and key competencies - identify demands/problems specific for a certain work/company setting and independently provide solution approaches - compare their own expectations of workplaces with real life situations. Possibly adapt their own expectations and views.
Key Qualifications		- Problem identification - Problem management - Identify own key interest and key competencies - Practical work experience
Key content areas		- Project planning - Project management - Practical experience - "real world problems" - Data capturing - Data analysis

Module Description

Teaching and learning methods	Practical work
Recommended literature	
Module type (compulsory/elective)	compulsory
Prerequisites/ Admission requirements	cf. Overview Prerequisites
Intermediate assessments	
Assessment / extent / share of the module grade	Certificate
Module Commissioner	Cf. Overview Module Commissioners

Subject to change

Module Description

Deutsche Sporthochschule Köln
German Sport University Cologne

Module: **Master Thesis**

Degree program: **M.Sc. Human Technology in Sports and Medicine (M.Sc. TSM)**

Valid for students who started: **Winter term 2022/23**

German module title		Masterarbeit
Abbreviation		TSM13
Subject related semester / Duration		4. SRS / 1
Total Workload (hrs) / Total ECTS points		900 h / 30
Courses of the module Title Semester hours per week / Contact time (hrs) / Self-study (hrs) / Degree semester / Type of class / Language of Instruction / Mandatory attendance		a) Reading, Writing and Publishing in empirical Sciences 2 SHW / 30 h / 60 h / 4. SRS / SE / English / no b) Master Thesis - SHW / -h / 810 h / 4. SRS/ - / English / n.a.
Intended Competency-based Learning Outcomes	Professional competencies (knowledge)	It is intended that students will be able to - differentiate between and judge the quality of different scientific literature resources - carry out the process of scientific publishing - reflect on the role and importance of scientific publishing within the scientific method as an ongoing circle - reflect on the concept and importance of peer reviewing
	Personal competencies (skills)	It is intended that students will be able to - design and carry out all relevant steps of a scientific study - determine the relevance of results - write and review a scientific manuscript - reflect their own scientific writing from a meta-perspective of a reviewer
	Social competencies	It is intended that students will be able to - collaborate with other colleagues or members of a research group - present and discuss methods and results of a research project
	Autonomy	It is intended that students will be able to - reflect on own progress - independently chose and reflect on methods and study design - independently write their master thesis - independently work on peer reviewed publications - identify and inform themselves about useful approaches and relevant information related to their research topic
Key Qualifications		- Study design and project management - Data capturing and data analysis - Scientific writing
Key content areas		Reading, Writing and Publishing in empirical Sciences - Kinds of scientific publications - Structure of and first steps to write a scientific publication - Scientific metrics (e.g. impact factor, h-index, citations,

	journal rankings) - Conflict of interest, BIAS - Process of peer-reviewed publication (submission, review, answering reviewer comments) - Working with co-authors Master Thesis - Identification of relevant research question - Establish adequate study design and methods - Empirical data collection - Data analysis - Adequate presentation of result (e.g. tables, figures) - Discussion and interpretation of results - Scientific writing
Teaching and learning methods	Research-based learning approaches, Problem-based learning approaches, Teacher-centered
Recommended literature	
Module type (compulsory/elective)	compulsory
Prerequisites/ Admission requirements	cf. Overview Prerequisites
Intermediate assessments	
Assessment / extent / share of the module grade	Master Thesis / thesis guidelines / 100%
Module Commissioner	Cf. Overview Module Commissioners

Subject to change