Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

CORSO DI LAUREA MAGISTRALE IN TECNOLOGIE SMART PER O SPORT E LA SALUTE
MASTER IN SMARTE TECHNOLOGIEN FÜR SPORT UND GESUNDHEIT

Contenuto degli insegnamenti
Inhalt der Lehrveranstaltungen

Coorti dal 2025-2026
Kohorten ab 2025-2026

Primo anno / Erstes Jahr
Foundations of physical activity and health (I year, I term, 6 CFU) • The definitions of physical activity, health-related physical activity, physical exercise, sport, leisure time physical activity, fitness, physical education; • The international guidelines for physical activity and sedentary behaviour; • Physical literacy and health literacy; • Goal setting and motivation to practice (the SMART approach); • Fitness testing, monitoring and surveillance; • Subjective and instrumental measures of physical activity: pros and cons; • The foundations of physical activity prescription to general population and to specific groups (e.g. people with special needs and/or pathologies); • Practical experience with testing and monitoring
Artificial Intelligence and Machine learning (I year, I term, 9 CFU) • Agent technologies • Search space exploration; • Automated planning: • Data analysis; • Model selection; • Supervised and unsupervised learning; • Reinforcement learning for health and sports; • Foundations of deep learning; • Computer vision in health applications.

Sensors and electronic systems for sports and health (I year, I/II term, 12 CFU)

1. **Module 1: Sensors for biosignals (I year, I term, 6 CFU)**
   - Main figures of merit, technologies, current market trends of sensors and actuators especially in the field of sports and health
   - Electrochemical sensors (gas, bio-analytes)
   - Electrophysiological bioimpedance sensors (ECG, respiratory rate, skin conductance, EEG, EMG, EOG)
   - Mechanical sensors (acceleration, orientation, strain, pressure)
   - Thermal, magnetic, and radiation sensors
   - Optical sensing technologies and spectroscopy
2. **Module 2: Electronic systems for sports and health (I year, II term, 6 CFU)**
   - Sensor readout topologies
   - Low-power management implementations
   - On-body and intra-body real-time data communication strategies
   - Actuation devices, with particular focus to sports and health applications
   - Integration technologies for bio-interfaced systems, with particular focus to sports and health applications.
   - SPICE simulations and new computational paradigms for edge and low-power computing (e.g., neuromorphic devices).

Robotic systems for sports and health (I year, I/II term, 12 CFU)

1. **Module 1: Cognitive Robotics (I year, I term, 6 CFU)**
   - Cognitive robotic architectures
   - Cognitive vision
   - Cognitive robot navigation
   - Cognitive robot manipulation
   - Decision making
   - Knowledge representation and reasoning
   - Robotic platforms and simulators
2. **Module 2: Socially aware robot assistants (I year, II term, 6 CFU)**
   - Social cognition and the theory of mind
   - Affective computing in human and robots
   - Verbal and non-verbal human-robot communication
   - Human-aware safe robot navigation and motion planning
   - Context-based action, plan and intention recognition and shared decision making
   - Personalization through robot learning and adaptation

Introduction to bioengineering (I year, I/II term, 12 CFU)

1. **Module 1: Bioengineering (I year, I term, 6 CFU)**
   - Fundamentals of biosystems and their environment
   - Biological tissues: characterization and properties
   - Biomaterials: overview, modelling, engineering, and characterization
   - Biological signals: sources, classification
   - Strategies for biosignal acquisition and biofeedback actuation (wearables, implants, smart pills, smart textiles)
   - Biosignal instrumentation: classification, regulation, and security
2. **Module 2: Biosignal processing (I year, II term, 6 CFU)**
   - Brain and body signals
   - Processing of peripheral physiological signals (ECG, respiratory rate, skin conductance)
   - Processing of EMG signals
   - Processing of eye and body tracking signals
   - Processing of brain signals (electroencephalography, MEG, ECoG)
   - Brain and body computer interfaces

Humans and Systems (I year, II term, 12 CFU)

1. **Module 1: Human-System interaction (I year, II term, 6 CFU)**
   - Usability engineering: the human factor
   - User experience: the human actor
   - User-centered design
   - User requirements
   - Formative and summative user evaluation
   - Tangible and embodied interfaces
   - Mobile and ubiquitous interfaces
2. **Module 2: Sports- and Health Behaviour and System Recommendation (I year, II term, 6 CFU)**
   - Compliance, trust and adoption
   - Technology acceptance model
   - Integrated behavioural model
   - Human decision-making and gamification
   - Recommender systems.
   - Pervasive and mobile technology

Secondo anno / Zweites Jahr

Embedded and Software systems (II year, I term, 6 CFU)

- Real-time and embedded system principles - hardware, system software, application software
- Embedded system design process - systems engineering processes
- Embedded systems architecture
- Hardware software co-design
- Embedded processors and micro-controllers
- Real-time operating systems and scheduling

Security and privacy in connected sports and health systems (II year, I term, 6 CFU)

- Security and cryptography concepts and principles
- User authentication, authentication protocols and key establishment
- Operating systems security and access control
- Software security, malicious software, firewalls
- Web and browser security
- Intrusion detection and network-based attacks

Specialization topics (II year, I/II term, 12 CFU)
To choose

1 Human biomechanics for physical assistive robots (II year, I term, 6 CFU)

- Fundamentals of mechanics and biomechanics
- Fundamentals of multibody modelling (for biomechanics)
- Human-body kinematics: modelling and simulation
- Modelling ligaments and muscles - integration in multi-body models
- Static and dynamic analysis of the human body and motion
- Applications:
  - Human-body assistive devices: analysis / synthesis of prosthetic limbs/joints, exoskeletons
  - Human-body simulation and tracking/analysis: sports and rehabilitation

2 Wearable electronics (II year, I term, 6 CFU)

- Introduction to wearable electronics for sports and health
- Autonomous energy supply for wearables
- Multimodal sensing approaches
- Biofeedback systems (real-time feedback user experience)
- Packaging technologies for wearables and implants (e.g., textiles, smart skins, pills)
- Wearable system integration

3 Materials and Technologies for biomimetic electronics (II year, II term, 6 CFU)

- Biocompatibility and biomaterials
- Bio-interfaces: definition, characterization (e.g., chemical, physical, optical, mechanical), bio-surface modification and treatment
- Overview of electronic materials and technologies employed in biomimetic electronics
- Bio-inspired nanostructures and devices: introduction and applications
- (Bio)stimuli-responsive structures and materials
- Basics of (bio)sensing principles

4 Bionic limbs (II year, II term, 6 CFU)

- Severe injuries of the upper and lower extremities
- Functional restoration in upper and lower limb amputees with bionic limbs
- Selective nerve transfers in upper and lower limb amputees
- Phantom pain in limb amputees
- Human–machine interfaces in prosthetics
- Rehabilitation in upper and lower limb prosthetics