Sports Engineering & Rehabilitation Devices

6 CFU. Mechanical Eng., Bioengineers, ICT.

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Nicola Petrone - University of Padova – Italy
Aim of the course is to present methods and tools for approaching the study of sport equipments and rehabilitation devices by means of theoretical lectures, applied workshops and practical experiences during Laboratory sessions.

**LECTURES:**
• In person, with blackboard, slides, interactive discussions.

**WORKSHOPS:**
• Musculo-skeletal modeling, motion capture data analysis, product development, given by experts from research and companies.

**LABORATORIES:**
• Sports & Rehabilitation Engineering Lab. “Hands-on” approach to load, motion and physiological data acquisition.

**COURSE GROUP PROJECT: (OPTIONAL)**
• Group experience on a given topic to experience sensor data collection, analysis and presentation on real research topics or company products.
Course CONTENTS (1)

FUNDAMENTALS:

- **Functional anatomy** of the musculoskeletal system.
- **Muscle Mechanics**
- **Quantitative anthropometry**
- **Modelling** equilibrium and motion of segments of the human body.
- Analysis of **gait** and **running**.
METHODS:
- Kinematic, kinetic and physiological analysis of sport and rehabilitation exercises
- Motion capture systems, inertial sensors, force platforms, pressure insoles and mats, electromyography, data analysis.
- Strain gauge multi-component load cells for load acquisition at the human body and equipment interfaces.
- Musculoskeletal simulation codes.
- Design of a research project for the statistical evaluation of sport and rehabilitation devices.
APPLICATIONS:

- **Classification** of sport equipments and rehabilitation devices.
- Safety **standards**, implementation of standard tests methods.
- Functional evaluation of **sport equipment** and **assistive technologies** such as orthoses, prostheses and training or rehabilitation machines.
- Smart **sensors** and **software** applications for sport performance and rehabilitation.
Course Project Topics: Sports

• Structural and Dynamic evaluation
  – Bicycle Fatigue Life prediction
  – Comfort analysis of Bicycle components

• Functional evaluation of Sports Equipments
  – Comparative analysis of Treadmills
  – Field load acquisition on alpine paralympic skis

• Evaluation of Protective Equipments
  – Impact tests on Helmets
  – Development of an Instrumented Human Head surrogate
  – Development of Airbag test methods
  – Development of Knee braces test methods
Course Project Topics: Rehabilitation

• Wheelchair safety and efficiency units
  – Field data collection on Wheelchairs
  – Analysis of Wheelchair propulsion

• Active and passive Assistive Technologies
  – Passive Exoskeletons design
  – Active Exoskeletons evaluation

• Prosthetics
  – Analysis of running prostheses
  – EMG driven hand prosthesis
  – Gait classification for prosthetic knee
  – Active prosthetic foot design
Can you imagine... Sports without Equipments..?

Can you imagine... Sports without Engineers..?
Nicola Petrone

Associate Professor in Machine Design & Sports Rehabilitation Engineering

Teaching:

• Machine Design & Laboratory (3rd BS Mech Eng) (IT)
• **Sport & Rehabilitation Engineering (2nd MS Mech Eng) (EN)**
• Elements of Biomechanics (School of Medicine) (IT)

INTERNATIONAL COMMITTEES

• Member of ISO TC 149-SC1-WG4 mountain bicycles since 1995.
• Convenor WG3 Racing Bicycle CEN TC333-bicycles Since 1999.
• Member ISEA (International Sports Engineering Association) Executive Committee since 2008.
• Chairman ISO TC 173-SC1-WG1 Wheelchairs, 2012-2016
• SBS expert in ISO TC 159 Ergonomics since 2016
Which experiment would you plan first?
Which results would you trust more?
Which tests would the athlete like more?
Which training method would you suggest is better?
Which test would you choose to evaluate functional performance?
Which tests would the athlete like more?
Our Research Fields....

Which method would you suggest to test the barriers and nets?
Which method could be applied indoor?
Which effect would the environmental conditions have on tests?
Our Research Fields.... Our Research Questions....

Complex 
Inaccurate

Real 

Easier 

Reliable

Simulation 
MEANINGFUL?

OUTDOOR

INDOOR

IN VITRO 

IN VIVO

Conventional 
Reliable/applicable

MEASURE

REPRESENTATIVE?

Real 
Complex/Unethical

Research Tests?