

## Research seminar “Mechatronic Systems” on “Biomechanics and Assistive Devices”

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### LECTURE 1. Monday Feb. 9, 10am – 12am, L101/201

This lecture will provide first a brief introduction on the biomechanics of human movement, defining the main concepts related to musculoskeletal modelling, motion analysis and dynamic simulation. After this part, theory and examples on how multibody dynamics techniques can be applied to the inverse and forward dynamic analysis of human movement, focusing on normal walking, will be explained. Models, formulations, and numerical and experimental results obtained by the lecturer and collaborators in the frame of a national research project will be presented.

### LECTURE 2. Monday Feb. 9, 4pm – 6pm, L101/201

The human musculoskeletal system has more muscles than degrees of freedom to actuate, which leads to indeterminacy in muscle force calculation. Optimization methods to solve muscle force redundancy will be described, along with the concept of muscle synergies, which is also used to reduce indeterminacy. In the latter case, muscle activations are factorized into a few neural commands (time-dependent variables) and synergy vectors (muscle weighting factors to the neural commands). Finally, current state-of-the art assistive devices for gait pathologies and their main design challenges will be presented. It will be discussed how musculoskeletal modelling and simulation may improve the design and control of these devices.

### TOPIC DISCUSSION. Tuesday Feb. 10, 4pm – 6pm, L101/201

The students will be asked to develop topics that they want to research and discuss those with the lecturer. Possible topics are:

- Inverse dynamic analysis of human walking.
- Forward dynamic analysis and prediction of human walking.
- Multibody dynamics techniques applied to human movement analysis.
- Solution of the muscle force sharing problem in biomechanics.
- Upper limb assistive devices.
- Lower limb assistive devices.
- Clinical application scenarios for rehabilitation robots.
- Exoskeletons and active orthoses for rehabilitation.
- Design and control challenges for assistive and/or rehabilitation robots.

### PRELIMINARY PRESENTATION. Friday Feb. 13, 9am – 11am, L101/201

After the first research, students will present their preliminary results in this session.