**Dynamics of multi-body systems**

**Credits: 5 Semester 3 (WUT) Compulsory: No**

| **Format** | Lectures 25h | Tutorial/project 15 h | Private study 85 h |
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**Lecturers:** J. Frączek, M. Wojtyra (WUT)

**Objectives:** To learn the advanced mechanical systems dynamics and the methods of analysis of complex mechanical systems. These systems consist of many components creating complex structures for which classical kinematics and dynamics methods are not applicable. The knowledge is useful for complex systems design together with analysis of its motion properties.

**Contents:**

The following subjects will be discussed:

Description of multi-body systems using different coordinates.
Constraint equations: detection and elimination of redundant constraints.
Kinematical analysis, and numerical methods used for multi-body systems analysis (*i.e.* considering the spinal cord type multi-segment manipulator),
Assembling of a multi-body mechanism,
Identification of singular configurations.
Newton-Euler and Lagrange equations of motion for complex multi-body systems,
Method of solving the direct and inverse dynamic problems for complex systems,
Numerical integration of ODE and DAE of motion,
Stiff versus flexible structures,
Exercises in dynamical analysis of various mechanisms using commercial package (ADAMS).

**Practical Work:** analysis of a given mechanical system using ADAMS package

**Abilities:** After completing this course, the students will be able to:

Analyse a complex mechanical system properties, and use professional dedicated software for it. This knowledge is needed when analysing the motion properties and designing the complex mechanisms.
Detect the singular positions in the complex robotics structures and synthesise its motion to avoid them.
Analyse numerically those mechanisms considering the inverse and direct kinematics and dynamics.
Know what numerical schemes must be applied (for numerical integration and differentiation) to get right and stable solutions.

**Assessment:** 30% class work, 70% end-semester exam

**Recommended texts:** - ADAMS technical documentation
- J.E.Shigley, J.J.Uicker, *Theory of Machines and Mechanisms,* McGraw Hill, 1995.

**Further readings:** will be provided by lecturers