Course title: Analytical mechanics	**Neptun code: GEMET414-a**

Course coordinator: Dr. Balázs Tóth, PhD, associate professor

type of lesson: ea. / szem. / gyak. / konz. és száma: Weekly lecture + seminar hours: 2+0

method of accountability: (koll. / gyj. / egyéb[1]): colloquium

curriculum location of the subject: (őszi/tavaszi félév): spring/autumn

pre-study conditions *(ha vannak)*: -

The task and purpose of the subject:

The subject deals with the investigation of complex mechanical systems,
within this framework
on the one hand (i) providing a unified mathematical tool for
the appropriate derivation of the differential equations and constraints
describing the motion of the dynamic system,
on the other hand (ii) presenting several numerical methods suitable for
the solution of the related time-dependent system of differential equation.

Course description:

Reference coordinates and frames, the choice of space coordinates:
base vectors and their derivatives in curvilinear coordinate systems,
Christoffel symbols, Riemann-Christoffel curvature tensor.
Kinematics: curvilinear coordinates of the velocity and acceleration,
differential geometry of space curves, Frenet formulas, Frenet base.
Definition of mass. Kinematics of rigid bodies and (system of) mass particles. Non-inertial reference frames, motion relative to rotating reference frames. Linear and angular momentum of rigid body. Kinetic energy of rigid body.
Newton-Euler equations of rigid body. Euler's angles.
Lagrange-Hamilton-type description of dynamics of particle and rigid body systems. Definition of constraint: constraint equations, classification of constraints, generalized coordinates and coordinate rates, degrees of freedom, the configuration space. The principle of virtual work. Lagrange-type first- and second-kind equations of motion with constraints. Hamilton's principle, the principle of least action, the definition of Hamilton-function. Noether's theorem, cyclic coordinates. Canonical equations of motion, the phase space, the canonical transformation. The Hamilton-Jacobi equations.

Required literature:

1. Meirovitch, L.: Methods of Analytical Dynamics, Dover Publications, Mineola, New York, 2003.
2. Lanczos, C.: The Variational Principle of Mechanics, Fourth Edition, Dover Publications, New York, 1970.

Recommended literature:

1. Hand, L.N. and Finch, J.D.: Analytical Mechanics, Cambridge University Press, 1998.
2. Tabarrok, F.P.J. and Rimrott, J.D.: Variational Methods and Complementary Formulations in
Dynamics, Kluwer Academics Publishers, Dordrecht, Boston, London, 1994.