SLOVAK UNIVERSITY of TECHNOLOGY IN BRATISLAVA
FACULTY OF MECHANICAL ENGINEERING
INSTITUT OF APPLIED MECHANICS AND MECHATRONICS

B.Sc. SYLLABUS

ENGINEERING MECHANICS II

DYNAMICS

Number of subject: 2-5520
Study discipline: all study program (No. of credit 6) **Year:** second/summer
Lectures: 39 hour (3 hour/week) (13 week term) **Seminars:** 26 hour (2 hour/week)
Warrantor of subject:
Lecturer: Assoc. Prof. M.Sc. PhD Stanislav Žiaran 2008

Key words: vector, mass, rigid body, constrain, motion, dynamic equilibrium, work, energy, impulse, vibration, impact, gyroscope, reaction.

1. **Introduction to Dynamics; Kinematics of Particles.** History and modern application, Basic concepts, Newton's laws, Units, Formulation and solution of dynamics problems. Rectilinear motion of particles, General plane curvilinear motion. Rectangular co-ordinates. Normal and tangential co-ordinates. Space curvilinear motion. Relative motion. Constrained motion of connected particles.
2. **Kinetics of Particles.** Linear momentum of a particle, Equation of motion (Newton's laws of motion), Dynamic equilibrium, Angular momentum of a particle, Equations of motion in terms of rectangular co-ordinates and normal and tangential components, Motion under a central force, Work of a force, Kinetic energy of a particle, Principle of work and energy, Application of the principle of work and energy, Power and efficiency, Potential energy, Conservative force, Conservation of energy, Principle of impulse and momentum.
3. **System of Particles.** Introduction, Application of Newton´s laws, Linear and angular momentum, Motion of the mass centre, Angular momentum, Conservation of momentum, Kinetic energy, Work-energy principle, Principle of impulse and momentum.
4. **Mechanical Vibration.** Introduction, vibration without damping - free vibrations of particle, simple pendulum, free vibration of a rigid body, forced vibrations, Examples of application.
5. **Mechanical Vibration.** Damped vibrations - damped free vibrations, damped forced vibrations, damped vibrations with kinematic excitation; critical speeds of shaft, transmission of the vibration to the foundation, Examples of application.
6. **Impulsive Motion and Variable Systems of Particle**. Impact, Direct central impact, Oblique central impact, Eccentric Impact, Steady stream of particles, Systems gaining or losing mass, Examples of application.
7. **Rigid Bodies, Kinematics, Moment of Inertia.** Translation, Rotation about fixed axis, Equation defining the rotation of a rigid body about fixed axis, General plane motion, Absolute and relative velocity, Instantaneous centre of zero velocity, Absolute and relative acceleration, Analysis of plane motion in terms of

parameters, Rate of change of a vector with respect to a rotating frame – Coriolis acceleration, Motion about a fixed point, General plane motion. Moments of inertia of masses, moment of inertia of a mass, product of inertia, ellipsoid of inertia.

8. **Plane Motion of Rigid Bodies.** Equations of motion, Angular momentum, D´Alambert's principle, Translation motion, Centroidal rotation motion, Noncentroidal rotation, General plane motion, Constrained plane motion, Rolling motion, Principle of work and energy for a rigid body in plane motion, Kinetic energy of a rigid body in plane motion, Principle of impulse and momentum, Impulsive motion.
9. **Kinetics of Rigid Bodies in Three Dimensions:** Three dimensional motion of a particle relative to a rotating frame – Coriolis acceleration, Frame of reference in general motion. Angular momentum, Inertia tensor, Application of the principle of impulse and momentum, Kinetic energy of a rigid body, Motion of a rigid body in three dimensions, Euler´s equations, Motion of a rigid body about a fixed point.
10. **Gyroscope.** Motion of gyroscope, Eulerian angels, Steady precession of a gyroscope, Motion of an axisymetrical body under no force, Application of gyroscope's moment. Examples of application.
11. **Systems of Rigid Bodies.** Kinematic analyse of the plane machines. Analytical methods of kinematic analyse of the plane machines. Conservation of energy, Conservation of angular momentum, Unconstrained and constrained motion, System of interconnected rigid bodies. Method of dismemberment, method of reduction (constant and non constant ratio), Examples of application.
12. **Dynamic Reactions.** Rotation of unbalanced body, principle inertia axes, static unbalance, couple unbalance, dynamic unbalance, balancing of rigid rotors, single-plane (static) balancing, two-plane (dynamic) balancing, calculation of amount of unbalance. Critical speed of a rotor. Examples of application.
13. **Basis of theory of analytical dynamics.** Generalised co-ordinates, principle of virtual work, generalised force, development of Lagrange's equation, Examples of application.

Literature

McGill, D.J.-King, W.W.: Engineering mechanics - DYNAMICS, Boston 1989, Beer, F.P.-Johnston, E.R.: Vector mechanics for engineers DYNAMICS, New York 1988, Meriam, J.L.-Kraige, L.G.: Engineering mechanics DYNAMICS, New York 1992, Thomson W.T.: Theory of vibration with applications. London 1981. Hibbeler, R.C.: Engineering mechanics – DYNAMICS New York 1997, Záhorec, O.-Caban, S.: DYNAMIKA. SjF TU Košice 2002, Záhorec, O.-Michalíček, M.-Žiaran, S.: DYNAMIKA. Zbierka príkladov. Alfa Bratislava 1991.