module title: **Kinematics, Vibrations & Stability of Mechanical Systems**		
field of study: **Mechanical Engineering**	type of study: **full-time**	course code: **S6_2-8**
course: **Modelling & Simulation in Mechanics**	degree: **Master (MSc)**	year: **I** semester: **II**
type of classes: **lecture, laboratory**	hours per week: **2L, 3Lab**	No of ECTS credits: **5**

MODULE DESCRIPTION

TARGETS

T1. Provide the basic knowledge on modeling and simulation of machines and mechanisms.
T2. Provide practical skills in the use of CATIA.
T3. Provide the basic knowledge on mechanical vibrations of damped and undamped systems with limited number of independent variables and continuous systems.
T4. Provide the basic knowledge on criterions of stability
T5. Ability to determine critical load, free vibrations frequency and free vibrations modes of slender systems

PREREQUISITES & ADDITIONAL REQUIREMENTS

R1. Fundamentals of mechanics and mathematics.
R2. Capability of individual work and collaboration in a group.
R3. Data analysis and presentation of results.

LEARNING OUTCOMES

LO1. Theoretical and practical knowledge in use of CATIA software.
LO2. Creates 3D model by means of CATIA software.
LO3. Designs mechanisms of different levels.
LO4. Analysis and synthesis of mechanisms and machines with kinematic joints with different level of degrees of freedom.
LO5. Writes reports on the basis of performed simulations.
LO6. Theoretical knowledge in mechanical vibrations.
LO7. Ability to determine free vibrations frequency of damped and undamped mechanical systems.
LO8. Ability to determine free vibrations modes of damped and undamped mechanical systems.
LO9. Theoretical knowledge in criterions of stability.
LO10. Ability to determine critical force of slender system on the basis of static and kinetic criterion of stability.

TEACHERS

module coordinator: dr Sebastian Uzny, assoc. prof. - uzny@imipkm.pcz.pl
academic teachers:
- dr Sebastian Uzny, assoc. prof. - uzny@imipkm.pcz.pl
- dr Krzysztof Sokół - sokol@imipkm.pcz.pl

MODULE CONTENT

LECTURE	hours
L 1-3 – Operations in *Part* Design.	**3**
L 4-6 – Operations in *Assembly Design*.	**2**
L 7-13 – Introduction to *DMU Kinematics.*	**7**
L 14-15 – Introduction to *Drafting.*	**2**
L16 – Basic concepts of vibrations problem	**1**
L17 – Equations of motion of individual mechanical system with single number of independent variables	**1**
L18,**19** –Single degree of freedom system (free vibrations, forced vibrations, passage through resonance)	**2**
L20,21 – Dumped vibrations of the single oscillator (free vibrations, forced vibrations)	**2**
L22,23 – Vibrations of two-degree of freedom system (two pendulums connected with spring)	**2**
L24 – Vibrations of double pendulum	**1**
L25,26 – Vibrations of beam as a continuous system (Hamilton principle, boundary conditions, free vibration frequencies of beam)	**2**
L27 – Modes of free vibrations – beam systems	**1**
L28,29 – Influence of compressive force on vibrations of columns (kinetic criterion of stability)	**2**
L30 – Vibrations of non-conservative system (Beck's column)	**1**

LABORATORY	hours
Lab 1-6 – Part Design - modeling problems.	**6**
Lab 7-10 – Basic modeling of mechanisms – assemblies.	**4**
L 11-14 – Simulation and motion analysis – block on the inclined plane.	**4**
Lab 15-18 – Simulation and motion analysis – Geneva drive.	**4**
Lab 19-22 – Simulation and motion analysis – clash detection.	**4**
Lab 23-26 – Simulation and motion analysis – planetary drive.	**4**
Lab 27-30 – Technical documentation in CATIA – *Drafting* module.	**4**
Lab 31-33 – dumped and undamped vibrations of a single degree of freedom system (different initial conditions)	**3**
Lab 34-36 – determination of free vibrations frequency of beam (different boundary conditions)	**3**
Lab 37-39 – determination of modes of free vibrations of beam (different boundary conditions)	**3**
Lab 40-42 – characteristic curves in the plane: external load - natural frequency	**3**
Lab 43-45 – regions of divergence and flutter instability of generalized Beck's column	**3**

TEACHING TOOLS

1 - lecture with the use of multimedia presentations
2 - computer laboratory, engineering software – CATIA, MathCad, Mathematica
3 - samples of laboratory exercises

SOURCE LITERATURE

1. Nader Zamani CATIA V5 FEA Tutorials,2008
2. Jaecheol Koh CATIA V5 Design Fundamentals: A Step by Step Guide, 2010
3. CATIA – technical documentation.
4. L. Meirovitch: Fundamentals of Vibrations, McGraw-Hill Higher Education, 2001
5. Rao V. Dukkipati, J. Srinivas: Textbook of Mechanical Vibrations, Prentice-Hall of India Private Ltd, New Delhi, 2004