| Code | II.5. |
|---|---|
| Course Title (English) | Engineering Physics-Mechanics II |
| Course Title (Polish) | Fizyka techniczna – Mechanika techniczna z wytrzymałością materiałów II |
| Credits | 6 ECTS |

*Language of instruction* **English**

*Type of studies* MSc studies

*Unit running the programme* Institute of Mechanics and Machine Design Fundamentals

***Course coordinator** and academic teachers* **Jacek Przybylski, Assoc. Prof**., Jacek Przybylski, Assoc. Prof., (Lec.), Krzysztof Sokół, PhD. (Tut.)

*Form of classes and number of hours*

| Semester | Lec. | Tut. | Lab. | Proj. | Sem. | Credit points |
|---|---|---|---|---|---|---|
| 2 | 30e | 30 | - | - | - | 6 |

*Learning outcomes* The dynamic course objectives are to model and analyse three-dimensional motion of a particle; to model and analyse simple two-dimensional motion of rigid bodies; to interpret results from the mathematical analysis in a physical context and to acquire a basic understanding of the use of Work-Energy and Impulse-Momentum methods in dynamics. This course introduces engineering students to dynamics of particles and rigid bodies. Methods (kinematic relationships, Newton's laws, conservation of energy, momentum, and angular momentum) for analysing the motion of particles and bodies are learned. After the course students must have the ability to determine the kinematic relationships between position, velocity, and acceleration for two-dimensional motion of rigid bodies; to apply Newton's equation in two dimensions to calculate the motion due to applied forces or to calculate the forces resulting from a specified motion; to analyse the two dimensional and three dimensional motion of rigid bodies using conservation laws for energy, momentum, and angular momentum; to apply analytical dynamics concepts to solve the problems of motion of rigid bodies under applied loads and to model and analyse vibration of one-degree-of-freedom system.

*Prerequisites* Engineering Physics – Mechanics I (P12), knowledge of differential and integration calculus, Mathematics I and II

*Course description* LECTURE

**Kinetics of a Particle**. Newton's Law of Motion. Equations of Motion: Rectangular Coordinates. Equations of Motion: Normal and Tangential Coordinates. Work of a Force.

Principle of Work and Energy. Conservative Forces and Potential Energy.
**Moments of Inertia of Masses**. Determination of the Moment of Inertia of a Three-Dimensional Body by Integration. Moments of Inertia of Composite Bodies. Moment of Inertia of a Body with Respect to an Arbitrary Axis through the Origin. Ellipsoid of Inertia. Principal Axes of Inertia.
**Planar Kinetics of Rigid Bodies: Force-Mass-Acceleration Method**. Angular Momentum of a Rigid Body. Equations of Plane Motion. Force-Mass-Acceleration Method: Plane Motion. Differential Equations of Motion.
**Planar Kinetics of Rigid Bodies: Work-Energy and Impulse-Momentum Methods.** Part A: Work-Energy Method. Work and Power of a Couple. Kinetic Energy of a Rigid Body. Work-Energy Principle and Conservation of Mechanical Energy. Part B: Impulse-Momentum Method. Impulse-Momentum Principles. Rigid-Body Impact.
**Rigid-Body Dynamics in Three Dimensions**. Kinematics. Impulse-Momentum Method. Euler's Equations of Motion. Work-Energy Method. Force-Mass-Acceleration Method. Rotation of a Rigid Body about a Fixed Axis. Dynamic Reactions.
**Vibrations**. Undamped Free Vibrations of Particles. Undamped Forced Vibrations of Particles. Damped Free Vibrations of Particles.
**Elements of Analytical Mechanics**. Constraints. Virtual Work. Generalised Coordinates. Lagrange's Equations of Motion.

TUTORIALS: see lecture content

LABORATORY

**Plane truss**. Implementation of the finite element software packages to the solution of mechanical problems. Description of the truss element. Discretization and mesh generation of a plane truss. Discussion of results obtained on the basis of FEM and analytical methods.
**Damped free and forced vibration of a particle with different initial conditions**. Modelling of the phenomenon with the use of PHASER system. Transient and steady state response. Phase portrait.

PROJECT
Not applicable

SEMINAR
Not applicable

*Form of assessment* Exam

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| *Basic reference materials* | 1. Set of lecture notes and problems for individual solution (based on literature presented below). Handouts for tutorial classes.<br>2. Ferdinand Beer, Jr., E. Russell Johnston, Elliot Eisenberg, Phillip Cornwell, David Mazurek: "Vector Mechanics for Engineers", Mc Graw-Hill Science/Engineering/Math, New York, 2009<br>3. S.P.Nitsure: "Engineering Mechanics", Technical Publications, Pune, 2006<br>4. Russell C. Hibbeler: "Engineering Mechanics: Co mbined Statics & Dynamics", Mastering Engineering Series, Prentice Hall, 2009<br>5. Louis Brand: "Vectorial Mechanics", Wharton Pres s, 2007<br>6. J.L. Meriam, L.G. Kraige: "Engineering Mechanics " John Wiley&Sons, New York, 1987, Vol 1 - Statics, Vol 2 - Dynamics<br>7. R. Resnick, D. Halliday, K.S. Krane: "Physics", Vol 1, John Wiley&Sons, New York, Fourth Edition, 1992<br>8. Modern Physics: Classical Mechanics Video Lectures, Stanford Online Video Course: http://freevideolectures.com/Course/2293/Modern-Physics-Classical-Mechanics<br>9. Massachusetts Institute of Technology, Professor Walter Lewin's lectures http://ocw.mit.edu/OcwWeb/Physics/8-01Physics-IFall1999/VideoLectures/index.htm |
| *Other reference materials* | For Polish-speaking students:<br>1. B.Skalmierski: Mechanika, Wydawnictwo Politechniki Częstochowskiej 1998-2001 (t. 1-3)<br>2. I.W.Mieszczerski: Zbiór zada ń z mechaniki. PWN Warszawa 1969<br>3. 4. J.Leyko: Mechanika ogólna, PWN Warszawa 2006 (t. 1 i 2)<br>4. 5. J.Leyko, J. Szmelter: Zbiór zada ń z mechaniki ogólnej, PWN Warszawa 1976 (t. 1 i 2)<br>5. J.Misiak: Zadania z mechaniki ogólnej. Cz. I, I I, III WNT Warszawa 2000<br>6. J.Nizioł: Metodyka rozwiązywania zadań z mechaniki, WNT Warszawa 2002<br>7. M.Niezgodziński, T.Niezgodziński: Zbiór zada ń z mechaniki ogólnej, PWN Warszawa 2003<br>8. T.Niezgodziński: Mechanika ogólna, PWN Warszawa 2006 |

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| e-mail of the course coordinator and academic teachers | jacek.pr@imipkm.pcz.czest.pl, sokol@imipkm.pcz.czest.pl |
| Average student workload (teaching hours + individ. ) | 4 hours of teaching hours + 3 hours of individual work per week |
| Remarks: | |
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