COURSE DESCRIPTION CARD - SYLLABUS

Course name
Technical mechanics [S1MiBM2>MeT2]

Course

Field of study
Mechanical Engineering

Year/Semester
2/4

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
30

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

Lecturers

Prerequisites

Basic knowledge of mathematics in the following areas: vector calculus, differential and integral calculus, complex numbers, linear algebra, Fourier series; basic knowledge of engineering mechanics: statics, kinematics and dynamics. Ability to think logically and creatively, use the Internet and library resources. Social competence: understanding of the need for continuous education and acquisition of new knowledge.

Course objective

To deepen the students' knowledge of engineering mechanics, especially concerning the vibration of mechanical systems and introduction to the dynamics of rotating machinery. To consolidate the knowledge of statics, kinematics and dynamics through the implementation of experiments.

Course-related learning outcomes

Knowledge:
The student has a structured knowledge of the main branches of technical mechanics: statics, kinematics and dynamics of a material point and rigid body. He/she has knowledge of mechanical vibrations, their importance in mechanical engineering, knows the sources and causes of their formation and their effects, mathematical description and methods of minimizing vibrations. The student knows the principles of building physical and mathematical models of mechanical systems with one and many degrees of freedom. He/she has a basis for further study of issues related to machine dynamics.

Skills:
He/she can obtain information from literature, the Internet, databases and other sources. The student can integrate obtained information interpret and draw conclusions from it and form and justify opinions. He/she can use the acquired theories to create and analyze physical and mathematical models of machines and their components. He/she can analytically, as well as using approximate methods, calculate amplitudes of vibrations and natural frequencies of mechanical systems. The student can identify dynamic properties in mechanical systems. He/she can apply methods of minimizing vibrations. He is able to take into account the acquired knowledge in the process of design and operation of machines.

Social competences:
The student recognizes the importance of knowledge in solving cognitive and practical problems and of consulting experts when having difficulty solving a problem independently. He/she is ready to perform professional roles responsibly. The student understands the importance of his decisions on technical systems through their impact on the environment and the operator. He/she is aware of the harmful effects of vibrations on humans, buildings, machinery and understands the necessity of minimizing them.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: credit based on the exam in written form graded according to the following scale: below 41% - ndst, from 41% - dst, from 53% - dst+, from 65% - db, from 77% - db+, from 89% - bdb.
Tutorials: credit on the basis of tests and activity in class. Evaluation according to the following scale: below 50% - ndst, from 58% - dst, from 66% - dst+, from 74% - db, from 82% - db+, from 90% - bdb
Laboratory exercies: the prerequisite is the completion of 100% of the exercises and the completion of 100% of the reports from the exercises scored at least 50% of the points, and 100% of the passed tests (the possibility of improving them twice). Final grade based on the sum of points earned for reports and short tests verifying preparation. Evaluation according to the following scale: below 50% - ndst, from 58% - dst, from 66% - dst+, from 74% - db, from 82% - db+, from 90% - bdb

Programme content

Lecture
1. Introduction. Basic definitions of vibrations. Importance of mechanical vibrations in mechanical engineering. Classification of vibrations. Sources of vibrations in machinery and equipment.
2. Modeling of vibrating systems. Creation of a physical model. Determination of reduced parameters: mass, stiffness and damping. Discretization of continuous systems. Damping models.
3. Construction of a mathematical model - balance and Lagrange equations of the second kind. Description of free vibration of a system with one degree of freedom with and without damping. Parameters characterizing damping and their determination. Identification of dynamic parameters on the basis of free vibrations.
4. Description of harmonically forced vibrations of a system with one degree of freedom with and without damping. The phenomenon of resonance and rumble. Dynamic characteristics.
5. Periodic forcing - application of Fourier series. Self-excited vibration. Parametric vibration. Inertial forcing. Short-term forcing. Random forcing.
6. Kinematic forcing. Force and displacement vibration isolation. Selection of vibration isolator. Geiger's formula. Fundamentals of vibration measurements.
7. Description of motion of systems with two and many degrees of freedom. Frequencies and forms of vibration. Vibration elimination - dynamic vibration eliminator, theoretical basis, tuning principle. Flexural and torsional vibration of shafts. Modeling of the shaft and bearing system.
8. Fundamentals of mechanical system identification, dynamic tests. Frequency response function. Numerical solution of dynamic equations of motion.
Tutorials:
1. Introduction
2. Linear, free, undamped vibrations - construction of a physical model and construction of a mathematical model by balance method. Determination of the frequency of free undamped oscillations.
3. Linear, free, damped vibrations - construction of a physical model and construction of a mathematical model with the balance method. Determination of the frequency of free vibration damped.

4. Linear, free, undamped and damped vibrations - modeling of systems using Lagrange equations of the second kind.
5. Harmonically forced, damped and undamped vibrations - modeling of systems by balance method and by Lagrange equations of the second kind.
6. Harmonically forced, damped and undamped vibrations - modeling of systems by the balance method and by Lagrange equations of the second kind - continued. Determination of amplitudes of vibrations.
7. Modeling of a system with two degrees of freedom. Frequencies and forms of vibration. Torsional vibration of shafts - modeling of the system.
8. Selection of vibration isolation. Tuning of the dynamic eliminator.
Laboratory exercies:
1. Introduction.
2. Determination of moments of inertia of machine elements - three-point suspension method.
3. Determination of moments of inertia of machine elements - method of physical pendulum.
4. Precession motion of the gyroscope.
5. Determination of kinematic and static friction coefficients.
6. Determination of mechanical energy in plane motion.
7. Determination of the restitution coefficient.
8. Equilibrium of a planar convergent and planar non-divergent system of forces.

Course topics

none

Teaching methods

Multimedia presentations on theory and examples of practical calculations. Blackboard exercises. Implementation of multivariant laboratory exercises (each student performs his own variant of the exercise).

Bibliography

Basic:
1.Arczewski K. i inni, Drgania układów fizycznych, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2008 [in Polish]
2. Giergiel J. Drgania układów mechanicznych, skrypt 1037, Skrypty uczelnianie AGH, Kraków 1986 [in Polish]
3. Parszewski Z., Drgania i dynamika maszyn, WNT, Warszawa 1982 [in Polish]
4. Bajkowski J. i inni, Zbiór zadań z teorii drgań , PWN, Warszawa 1989 [in Polish]
5. Sałata W., Mechanika ogólna w zarysie, Poznań, Wyd. PP 1998. [in Polish]
6. Leyko J., Mechanika ogólna. T. 1 i 2, Warszawa, PWN 2008. [in Polish]
7. Instructions for laboratory exercies [in Polish]

Additional:
1.Osowski Z. Tłumienie drgań mechanicznych, PWN Warszawa 1986 [in Polish]
2.Giergiel J., Uhl T., Identyfikacja układów mechanicznych PWN, Warszawa 1990 [in Polish]
3.Harris C.M, Crede C.E., Shock and Vibration Handbook, McGRAW-HILL, New York 1976
4.Kelly S.G., Mechanical Vibrations,Theory and Application, The Univ. of Akron, 2011

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	47	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	53	2,00