



Subject card

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| Subject name and code                                                                                                                                                                        | Structural dynamics, PG_00041521                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                              |                                         |                                       |                                     |            |     |
| Field of study                                                                                                                                                                               | Civil Engineering                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                              |                                         |                                       |                                     |            |     |
| Date of commencement of studies                                                                                                                                                              | February 2024                                                                                                                                                                                                                                                                                      | Academic year of realisation of subject                                                                                                                                                                      |                                         |                                       | 2024/2025                           |            |     |
| Education level                                                                                                                                                                              | second-cycle studies                                                                                                                                                                                                                                                                               | Subject group                                                                                                                                                                                                |                                         |                                       | Optional subject group              |            |     |
| Mode of study                                                                                                                                                                                | Full-time studies                                                                                                                                                                                                                                                                                  | Mode of delivery                                                                                                                                                                                             |                                         |                                       | at the university                   |            |     |
| Year of study                                                                                                                                                                                | 1                                                                                                                                                                                                                                                                                                  | Language of instruction                                                                                                                                                                                      |                                         |                                       | English                             |            |     |
| Semester of study                                                                                                                                                                            | 2                                                                                                                                                                                                                                                                                                  | ECTS credits                                                                                                                                                                                                 |                                         |                                       | 3.0                                 |            |     |
| Learning profile                                                                                                                                                                             | general academic profile                                                                                                                                                                                                                                                                           | Assessment form                                                                                                                                                                                              |                                         |                                       | assessment                          |            |     |
| Conducting unit                                                                                                                                                                              | Katedra Wytrzymałości Materiałów -> Faculty of Civil and Environmental Engineering                                                                                                                                                                                                                 |                                                                                                                                                                                                              |                                         |                                       |                                     |            |     |
| Name and surname of lecturer (lecturers)                                                                                                                                                     | Subject supervisor                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                              | dr inż. Tomasz Ferenc                   |                                       |                                     |            |     |
|                                                                                                                                                                                              | Teachers                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                              | dr inż. Tomasz Ferenc<br>Shahzad Ashraf |                                       |                                     |            |     |
| Lesson types and methods of instruction                                                                                                                                                      | Lesson type                                                                                                                                                                                                                                                                                        | Lecture                                                                                                                                                                                                      | Tutorial                                | Laboratory                            | Project                             | Seminar    | SUM |
|                                                                                                                                                                                              | Number of study hours                                                                                                                                                                                                                                                                              | 30.0                                                                                                                                                                                                         | 15.0                                    | 0.0                                   | 0.0                                 | 0.0        | 45  |
|                                                                                                                                                                                              | E-learning hours included: 0.0                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                              |                                         |                                       |                                     |            |     |
| Learning activity and number of study hours                                                                                                                                                  | Learning activity                                                                                                                                                                                                                                                                                  | Participation in didactic classes included in study plan                                                                                                                                                     |                                         | Participation in consultation hours   |                                     | Self-study | SUM |
|                                                                                                                                                                                              | Number of study hours                                                                                                                                                                                                                                                                              | 45                                                                                                                                                                                                           |                                         | 5.0                                   |                                     | 25.0       | 75  |
| Subject objectives                                                                                                                                                                           | The aim of the course is to solve the problems of Structural Dynamics using discrete models with one and n degrees of freedom.                                                                                                                                                                     |                                                                                                                                                                                                              |                                         |                                       |                                     |            |     |
| Learning outcomes                                                                                                                                                                            | Course outcome                                                                                                                                                                                                                                                                                     | Subject outcome                                                                                                                                                                                              |                                         |                                       | Method of verification              |            |     |
|                                                                                                                                                                                              | [K7_U03] can perform classic statical and dynamical analysis of rod structures stability (trusses, frames and ties), both statically determined and undetermined as well as surface structures (plates, membranes and shells)                                                                      | Student builds a dynamic model of frame and truss systems. It determines the stiffness and flexibility matrix of the system. It determines the frequency of natural vibration of frame and truss structures. |                                         |                                       | [SU1] Assessment of task fulfilment |            |     |
|                                                                                                                                                                                              | [K7_U09] is able to design railway tracks of complex geometry on sections and stations, both newly designed and renovated; can make a plan and perform diagnostic of railway track and to interpret its results, propose conclusions; can evaluate durability and reliability of railroad elements | Student can plan and conduct experimental dynamic analysis which allow to asses mode shapes and corresponding natural frequencies                                                                            |                                         |                                       | [SU1] Assessment of task fulfilment |            |     |
|                                                                                                                                                                                              | [K7_U08] Is able to evaluate technical conditio of a road, to design its pavement and choose proper construction technology using mechanistic methods and material investigations                                                                                                                  | Student can conduct experiment that allow to obtain properties of studied material                                                                                                                           |                                         |                                       | [SU1] Assessment of task fulfilment |            |     |
|                                                                                                                                                                                              | [K7_U01] can evaluate and list any loads acting on constructions                                                                                                                                                                                                                                   | Student can assess and compute external load that can act on analyzed structure                                                                                                                              |                                         |                                       | [SU1] Assessment of task fulfilment |            |     |
| [K7_W03] has knowledge of Continuum Mechanics, knows rules of static analysis, stability and dynamics of complex rod, shell and volume structures, both in linear and basic nonlinear regime | The student designs simple engineering structures including vibrations forced by initial conditions and harmonic excitations.                                                                                                                                                                      |                                                                                                                                                                                                              |                                         | [SW1] Assessment of factual knowledge |                                     |            |     |

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|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------------------|
| Subject contents                | <p>Introduction. Basic definitions. Modelling of dynamic systems</p> <p>Basic dynamics laws. Forces in dynamic systems. Equation of motion. Introduction to MATLAB</p> <p>Free undamped (natural) vibrations of 1-DOF systems</p> <p>Free damped vibrations of 1-DOF systems</p> <p>Forced vibrations of 1-DOF systems: harmonic loading</p> <p>Forced vibrations of 1-DOF systems: periodic and impulse loading</p> <p>Forced vibrations of 1-DOF systems: arbitrary loading</p> <p>Design of 1-DOF system under dynamic loading</p> <p>Free undamped (natural) vibrations of N-DOF systems</p> <p>Free damped vibration of N-DOF systems.</p> <p>Forced vibrations of N-DOF systems</p> <p>Vibration measurement technology. Vibrations reduction systems in engineering structures</p> <p>Experimental dynamic analysis</p> <p>Introduction. Basic definitions. Modelling of dynamic systems</p> |                   |                               |
| Prerequisites and co-requisites | <p>Determination of internal forces in statically determinate structures (beams, frames, trusses, mixed frame-truss schemes) Determination of internal forces in statically indeterminate structures (beams, frames, trusses, mixed frame-truss schemes using the force method or the displacement (stiffness) method) Determination of displacements using principle of virtual work Determination of geometric properties of area (centroid, moment of inertia) Determination of stresses and strains (in bending) Matrix analysis of structures (stiffness matrix, flexibility matrix) Programming in MATLAB/FreeMat</p>                                                                                                                                                                                                                                                                         |                   |                               |
| Assessment methods and criteria | Subject passing criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Passing threshold | Percentage of the final grade |
|                                 | Test                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 60.0%             | 100.0%                        |

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|----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Recommended reading                                            | Basic literature                                                                                                                                                                                                                                                                               | <p>Chopra A.K.: Dynamics of structures. Upper Saddle River, New Jersey: Prentice Hall 2001</p> <p>Rucka M., Wilde K.: Dynamika Budowli z przykładami w środowisku Matlab. Wydawnictwo Politechniki Gdańskiej, Gdańsk 2008</p> <p>Branicki C., Wizmur M.: Metody macierzowe w mechanice budowli i dynamika budowli. Wydawnictwo Politechniki Gdańskiej. Gdańsk 1980</p> <p>Chmielewski T., Zembaty Z.: Podstawy dynamiki budowli. Arkady, 1998</p> <p>Lewandowski R.: Dynamika konstrukcji budowlanych. Wydawnictwo Politechniki Poznańskiej 2006</p> |
|                                                                | Supplementary literature                                                                                                                                                                                                                                                                       | <p>Clough R.W., Penzien J.: Dynamics of structures. McGraw-Hill Inc. 1993</p> <p>Śliwiński A.: Ultradźwięki i ich zastosowania. Wydawnictwa Naukowo-Techniczne Warszawa 2001</p> <p>Kucharski T.: Systemy pomiarów drgań mechanicznych. Wydawnictwa Naukowo-Techniczne Warszawa 200</p>                                                                                                                                                                                                                                                              |
|                                                                | eResources addresses                                                                                                                                                                                                                                                                           | Adresy na platformie eNauczenie:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Example issues/<br>example questions/<br>tasks being completed | <p>Determine the natural frequency of a frame system with one dynamic degree of freedom.</p> <p>Determine the damping ratio based on the measured displacement of free vibrations.</p> <p>Determine the frequencies and mode shapes of the frame system with n-dynamic degrees of freedom.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Work placement                                                 | Not applicable                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

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