



Subject card

Subject name and code	Friction and wear of materials, PG_00072583						
Field of study	Materials Engineering						
Date of commencement of studies	October 2023	Academic year of realisation of subject				2026/2027	
Education level	first-cycle studies	Subject group				Optional subject group Subject group related to scientific research in the field of study	
Mode of study	Full-time studies	Mode of delivery				at the university	
Year of study	4	Language of instruction				Polish	
Semester of study	7	ECTS credits				2.0	
Learning profile	general academic profile	Assessment form				assessment	
Conducting unit	Institute of Nanotechnology and Materials Engineering -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Jarosław Rybicki					
	Teachers	prof. dr hab. inż. Jarosław Rybicki					
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	0.0	0.0	30
	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	30	3.0	17.0	50		
Subject objectives	Friction and material wear phenomena are ubiquitous in nature and technology. Friction can be desirable (e.g., it allows us to walk) or undesirable (it causes enormous, unrecoverable energy losses). The same applies to material wear (e.g., it allows us to write with chalk on a blackboard or necessitates replacing worn brake pads). Both phenomena are highly complex, making a unified description difficult. Classical mechanical, quantum mechanical, and chemical (tribochemistry) phenomena play a role. The aim of the course is to familiarize students with various physical mechanisms and their dependence on thermomechanical parameters (such as feed rate, contact pressure, or temperature).						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	[K6_U03] Can critically analyze and evaluate the functioning – particularly in the context of materials engineering –existing technical solutions, particularly equipment, objects, systems, processes.	Various physical phenomena responsible for friction and wear of materials and methods of counteracting the harmful effects of these phenomena, including economic and toxicological aspects, will be presented.			[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information		
	[K6_W08] Has fundamental knowledge of the development trends in the fields of science and scientific disciplines relevant to materials engineering.	Among other things, modern lubricants will be presented, including those suitable for use in space.			[SW1] Assessment of factual knowledge		
	[K6_U06] Can integrate obtained information, interpret it and draw conclusions, as well as formulate and justify opinions.	The relationship between friction and wear phenomena and the atomic and molecular structure of rubbing surfaces will be discussed.			[SU1] Assessment of task fulfilment		
	[K6_W07] Has detailed knowledge of selected problems of materials science.	In this case, the selected issue is friction and wear phenomena.			[SW1] Assessment of factual knowledge		
	[K6_K01] Understands the need to improve professional and personal competencies; is conscious of own limitations and knows when to turn to experts, properly establishes priorities helping to accomplish tasks defined by oneself or others.	As new materials are created, in many cases new effects arise due to the relative motion of rubbing surfaces.			[SK2] Assessment of progress of work		

Subject contents	<p>Course content – lecture The concepts of surface waviness and roughness and their parameters, the concepts of actual and geometric contact; the Abbott curve, Hertzian contact, Rebinder hardness, surface energy and surface tension; the surface layer and its structure; elastic and plastic contact, frictional interlocking (diffusionless and diffusional).</p> <p>Classical laws of dry friction and their scope of applicability; deviations from the classical laws of friction.</p> <p>Dry friction models:</p> <ul style="list-style-type: none"> <li>- mechanical (Coulomb, Ernst-Merchant, Bowden-Tabor, Epifanov)</li> <li>- molecular (Tomlinson, Deryagin),</li> <li>- mechanical-molecular (Kragielski),</li> <li>- energetic (Kuznetsov, Kostecki).</li> </ul> <p>The dependence of the friction coefficient on pressure, feed rate, and temperature for various classes of materials.</p> <p>Tribological wear mechanisms:</p> <ul style="list-style-type: none"> <li>- oxygen and hydrogen;</li> <li>- abrasive;</li> <li>- fatigue;</li> <li>- deformational;</li> <li>- adhesive;</li> <li>- thermal;</li> <li>- fretting;</li> <li>- cavitation;</li> <li>- abrasive.</li> </ul> <p>Surface layer formation.</p> <ul style="list-style-type: none"> <li>- dislocation definition, basic description,</li> <li>- dislocation interaction energy, forces acting on dislocations, dislocation dipole, dislocation loops, dislocation line stress,</li> <li>- interaction of point defects with dislocations,</li> <li>- dislocation propagation,</li> <li>- Frenkel and Peirels models, atomistic modeling,</li> <li>- dislocation motion, docking, surface layer hardening, material embrittlement.</li> </ul> <p>Lubricants and lubrication: fluid, boundary, and mixed friction. Rheological properties of lubricating liquids (viscosity, internal friction).</p>														
Prerequisites and co-requisites	Basic courses in general physics and solid state physics														
Assessment methods and criteria	<table border="1" data-bbox="453 1525 1485 1659"> <thead> <tr> <th data-bbox="453 1525 794 1563">Subject passing criteria</th> <th data-bbox="794 1525 1139 1563">Passing threshold</th> <th data-bbox="1139 1525 1485 1563">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td data-bbox="453 1563 794 1597"></td> <td data-bbox="794 1563 1139 1597">51.0%</td> <td data-bbox="1139 1563 1485 1597">25.0%</td> </tr> <tr> <td data-bbox="453 1597 794 1630"></td> <td data-bbox="794 1597 1139 1630">80.0%</td> <td data-bbox="1139 1597 1485 1630">25.0%</td> </tr> <tr> <td data-bbox="453 1630 794 1659"></td> <td data-bbox="794 1630 1139 1659">51.0%</td> <td data-bbox="1139 1630 1485 1659">50.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade		51.0%	25.0%		80.0%	25.0%		51.0%	50.0%
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Recommended reading	Basic literature	<p><i>Hebda M, Wąchal A: Trybologia. WNT, Warszawa 2010.</i></p> <p><i>Lawrowski Z.: Tribologia - tarcie, zużycie i smarowanie. WN PWN, Warszawa 1993.</i></p> <p>wybrane artykuły z czasopism specjalistycznych</p>													

	Supplementary literature	<p>P.J. Blau, Friction Science and Technology</p> <p>FROM CONCEPTS to APPLICATIONS, World Scientific 2014</p> <p>D. Dowson, C.M. Taylor, T.H.C. Childs, M. Godett and G. Dalmaz (eds), DISSIPATIVE PROCESSES IN TRIBOLOGY, NATO ASI Series, 2020</p>
	eResources addresses	
Example issues/ example questions/ tasks being completed	<p>Discuss mechanical models of dry friction.</p> <p>Discuss molecular and mechanical-molecular models of dry friction.</p> <p>Discuss the dependence of the coefficient of friction on pressure, feed rate, and temperature.</p> <p>Discuss the abrasive, fatigue, and deformational mechanisms of tribological wear.</p> <p>Discuss the adhesive, fretting, cavitation, and abrasion mechanisms of tribological wear.</p> <p>Formulate and justify the Mott-Nabarro law. Explain the meaning of all the values it contains.</p> <p>Characterize the stress field resulting from a rectilinear edge dislocation.</p> <p>Discuss the interaction between parallel rectilinear edge dislocations.</p> <p>Discuss the concept of dislocation loops their types and eigenenergies.</p> <p>Discuss the Frenkel model of dislocations.</p> <p>Discuss the conservative motion of dislocations. How is it related to slip?</p> <p>Discuss the ascending and descending motion of dislocations. Can ascending and simultaneously conservative motion occur, and under what conditions?</p> <p>Discuss the Frank-Read mechanism. Describe the minimum stresses required to activate this mechanism.</p> <p>Discuss the Eshelby and Leibfried models of dislocation crowding on obstacles.</p>	
Practical activities within the subject	Not applicable	

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