



## Subject card

Subject name and code	Object-oriented programming languages III, PG_00064060						
Field of study	Technical Physics						
Date of commencement of studies	October 2025		Academic year of realisation of subject			2027/2028	
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	3		Language of instruction			English	
Semester of study	5		ECTS credits			5.0	
Learning profile	general academic profile		Assessment form			assessment	
Conducting unit	Department of Theoretical Physics and Quantum Computing -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. Jan Franz				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	45.0	0.0	0.0	60
	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	60		5.0		60.0	125
Subject objectives	The aim of this course is to introduce students to object-oriented programming (OOP) in Java with a focus on applications in physics and applied informatics. Students will learn to design, implement, and test scientific software using modern Java tools, libraries, and design patterns. Emphasis is placed on writing robust, maintainable code and developing the skills needed for larger projects in research and technology.						
Learning outcomes	Course outcome		Subject outcome			Method of verification	
	[K6_W05] has knowledge of programming methodology and techniques, and the use of selected IT tools in physics and technology		is able to apply object-oriented programming methodology and techniques, and make effective use of selected computational tools to solve problems in physics and technology.			[SW1] Assessment of factual knowledge	
	[K6_U03] knows programming languages and can use basic software packages		is able to write programs in an object-oriented language, use project management tools, apply testing frameworks, and make use of selected scientific libraries to support problem-solving in physics and technology.			[SU1] Assessment of task fulfilment	
	[K6_W01] understands the importance of physics and its applications in connection to civilization		is able to model simple physical systems using object-oriented programming and reflect on how computational skills support the broader use of physics in science and technology.			[SW2] Assessment of knowledge contained in presentation	
	[K6_K01] understands the need to learn and improve professional and personal competencies, inspires and organizes other people's learning process		is able to independently extend their knowledge of object-oriented programming, critically apply object-oriented tools and design patterns to scientific problems, and collaborate in ways that support and inspire the learning of others.			[SK5] Assessment of ability to solve problems that arise in practice	

Subject contents	Course content – lecture
	<b>1. The Java Ecosystem &amp; Project Setup</b>
	Java Virtual Machine (JVM), Java Development Kit (JDK), Integrated Development Environments (IDEs); project management with Maven and Gradle.
	<b>2. Classes, Objects &amp; Testing</b>
	Classes, fields, methods, constructors; introduction to unit testing with JUnit.
	<b>3. Primitive Types, Wrappers, Arrays &amp; Efficient Java Matrix Library (EJML)</b>
	Primitive types vs objects; arrays; wrapper classes; first look at EJML.
	<b>4. Inheritance and Interfaces</b>
	Inheritance, overriding, abstract classes, interfaces.
	<b>5. Exceptions and Robust Code</b>
	Checked vs unchecked exceptions; error handling strategies.
	<b>6. Collections Framework</b>
	List, Set, Map; iterators; when to use collections.
	<b>7. Design Patterns I</b>
	Factory, Singleton, Observer (with light Unified Modeling Language (UML) illustrations).
	<b>8. Generics &amp; Collections in Practice</b>
	Generic classes and methods; collection implementations.
	<b>9. Refactoring &amp; Testing Practices</b>
	Cohesion, coupling, SOLID (Single responsibility, Openclosed, Liskov substitution, Interface segregation, Dependency inversion) principles; test-driven development (TDD).
	<b>10. Lambda Expressions (Basics)</b>
	Functional interfaces, lambda syntax.
	<b>11. Streams and Applications of Lambdas</b>
	Stream Application Programming Interface (API): map, filter, reduce; parallel streams.
	<b>12. Scientific Libraries in Java</b>
	EJML in more depth; Apache Commons Math; JavaScript Object Notation (JSON) and Extensible Markup Language (XML) parsing.

### **13. Design Patterns II & Project Organization**

Strategy, Composite; modular project structure with Maven/Gradle.

### **14. Student Project Presentations**

Recap of object-oriented programming (OOP) in Java and integration of tools.

### **15. Summary & Outlook**

Future directions in programming (Java trends, concurrency, functional style, artificial intelligence (AI assisted coding)).

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Course content – laboratory

#### **1. The Java Ecosystem & Project Setup**

Create first Maven project; run a simple physics-related program.

#### **2. Classes, Objects & Testing**

Implement a Particle class and basic unit tests.

#### **3. Primitive Types, Wrappers, Arrays & Efficient Java Matrix Library (EJML)**

Vector operations with arrays and EJML.

#### **4. Inheritance and Interfaces**

Class hierarchy for different particle types.

#### **5. Exceptions and Robust Code**

Robust file input/output (I/O) and simple simulation error handling.

#### **6. Collections Framework**

Store and analyze particle trajectories with collections.

#### **7. Design Patterns I**

Implement a particle factory and observer for logging.

#### **8. Generics & Collections in Practice**

Generic containers for results; use sorted sets/maps.

#### **9. Refactoring & Testing Practices**

Refactor earlier code and extend test coverage.

	<b>10. Lambda Expressions (Basics)</b>		
	Apply lambdas to simple numerical transformations.		
	<b>11. Streams and Applications of Lambdas</b>		
	Analyze simulation results with streams.		
	<b>12. Scientific Libraries in Java</b>		
	Solve linear systems and parse input from files.		
	<b>13. Design Patterns II &amp; Project Organization</b>		
	Apply Strategy pattern to select simulation models.		
	<b>14. Student Project Presentations</b>		
	Final project demos with short presentations.		
	<b>15. Summary &amp; Outlook</b>		
	Discussion of how course skills transfer to research projects.		
Prerequisites and co-requisites	Object-oriented programming languages 1 and 2		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	final exam	50.0%	25.0%
	lab credit	50.0%	75.0%
Recommended reading	Basic literature	1. Joshua Bloch, Effective Java, 3rd Edition, Addison-Wesley, 2017 2. Raoul-Gabriel Urma, Mario Fusco, Alan Mycroft, Modern Java in Action, Manning Publications, 2018	
	Supplementary literature	1. Cay S. Horstmann, Core Java Volume 1 Fundamentals. 11 <sup>Th</sup> edition, Prentice Hall, 2018 2. Cay S. Horstmann, Core Java Volume 2 Advanced Features. 11 <sup>Th</sup> edition, Prentice Hall, 2018 3. Herbert Schildt, Java: The Complete Reference. 11 <sup>Th</sup> edition, McGraw-Hill, 2019	
	eResources addresses		
Example issues/ example questions/ tasks being completed	1.) You are given a single class Simulation that directly handles file input, data storage, calculations, and result output. Identify at least two problems with this design. Suggest a refactoring strategy using separate classes or packages. 2.) Programming Task: Radioactive Decay Simulation Implement a Particle class with attributes (id, half-life, state). Store particles in a collection and simulate decay step by step using random numbers. Handle invalid input with exceptions. Include at least one JUnit test. Print the number of undecayed particles after each step.		
Practical activites within the subject	Not applicable		

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