Syllabus

Course Description

Course Title	Advanced Materials for Energy Engineering
Course Code	45503
Course Title Additional	
Scientific-Disciplinary Sector	IMAT-01/A
Language	English
Degree Course	Master in Energy Engineering
Other Degree Courses (Loaned)	
Lecturers	Prof. Paolo Scardi, Paolo.Scardi@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/33742
Teaching Assistant	
Semester	First semester
Course Year/s	2
CP	6
Teaching Hours	30
Lab Hours	30
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	The course is intended to give the student a broad scope preparation in selecting and using materials for applications in energy engineering. In more detail, besides theory and general knowledge, learning Ashby approach to materials selection is an objective. Students are trained in laboratory practices, with hands-on activities related to the topics discussed in the classroom teaching; therefore, further objectives are learning basics principles and how to use instruments, including: testing materials durability (e.g., microhardness, mechanical fatigue), modifying materials (e.g., by shot-peening), characterizing materials properties (e.g., residual

	stress by XRD and Hole Drilling methods); electrical and electrochemical testing of solar cells, batteries, fuel cells, hydrogen production, wind energy generation, thermoelectric materials and devices.
Course Topics	Elements of materials science: classification and basic properties. Selection of materials based on their use and cost – Ashby diagrams and approach to materials selection based on specific applications. Production of energy. High-temperature materials (heat engines, e.g. turbines). Materials for direct generation (e.g. solar cells, fuel cells, wind power, thermoelectricity). Storage (batteries, supercapacitors, hydrogen carrier) and transport of energy (conductors, superconductors, insulators). Energy saving: influence of the choice of materials (thermal insulation). Aging, damage and failure of materials in exercise (e.g. creep, mechanical fatigue, cavitation, wear and corrosion). Expertise in renewable and sustainable materials for energy engineering. Materials selection for high temperature applications; for electrochemical devices; all topics of the European Green Deal, solar, hydrogen, waste heat recovery.
Keywords	Material science; Materials for energy generation; Materials for energy storage and transport; Sustainable materials for energy engineering
Recommended Prerequisites	Students should be familiar with basic elements of general chemistry, physics and solid mechanics. Before attending the course, students should review their background on materials science, e.g. by reading some textbook (see basic bibliography) or any other equivalent source
Propaedeutic Courses	Electrochemical Energy Storage and Conversion – course 45534 – extends some of the topics of the present course with emphasis on the Devices; it is therefore an ideal continuation, recommended to students attending Advanced Materials for Energy Engineering
Teaching Format	Frontal lectures, exercises and related laboratory practice
Mandatory Attendance	Not mandatory
Specific Educational Objectives and Learning	1) Knowledge and understanding • Learning materials by properties and application-based

Outcomes	selection, with special attentions to applications in energy engineering 2) Applying knowledge and understanding • Using concepts discussed and learned in the classroom lectures for the laboratory practice • Solving simple exercises and computations dealing with materials performance in selected energy-related applications 3) Making judgements • Being able to select materials for specific applications • Using Ashby diagrams for materials selection 4) Communication skills • Bing able to produce a report on laboratory activity • Making and presenting a PowerPoint presentation on a specific topic of the course and/or a laboratory activity 5) Learning skills • Being able to autonomously extend the knowledge acquired during the study course by reading and understanding scientific and technical documentation. • Carrying out assigned jobs in the laboratory practice, independently and as part of a small team.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	The assessment of the course consists of two parts: • Formative Assessment (assessed ILOs: 2,3,5): preparation of a report on the laboratory activity. This can be done individually or as part of a team (groups of no more than 4 students) (50%): assessed with the correction and evaluation of the report; • Summative Assessment (assessed ILOs: 1,2,3,4): presentation of the laboratory activity and an assigned topic among the main ones presented in the study course (50%): assessed through a PowerPoint presentation, followed by questions. Discussion and evaluation of the reports and experience in the laboratory activity Both parts must be positive to pass the exam. The final grade is the weighted average between the two parts. A positive evaluation of the report is a pre-requisite to access the oral exam (PowerPoint presentation). Assessment language: English

Evaluation Criteria	A positive evaluation of the report on the laboratory activity is a pre-requisite to sit for the oral exam, which is given as a PowerPoint presentation followed by discussion (questions/answers to specific topics regarding the presentation and main themes of the lectures given during the study course). The final grade is the weighted average of the report (50%) and the oral exam (50%). Both parts must be positive. • Criteria for the evaluation of the report: appropriate execution of the laboratory activity and correct description of results; methods and technologies used in the laboratory experience. • Criteria for the evaluation of the oral exam: quality of and correctness of the presentation. Ability to answer questions.
Required Readings	There is no single textbook that covers the entire course. The course material is collected from various textbooks and research paper; lecture notes will be made available in advance (before each corresponding lecture). The course resources will be made available via UniTn's Moodle platform or shared folders on GDrive. Useful textbooks include the following ones. For general reference: • M. F. Ashby, Materials Selection in Mechanical Design, Butterworth-Heinemann, 2010. • W. D. Callister, D. G. Rethwisch, Fundamentals of Materials Science and Engineering: An Integrated Approach, Wiley, 2012. Additional sources will be announced during the course.
Supplementary Readings	Further sources – deeper insight: • D. W. Bruce, D. O'Hare, R. I. Walton, Energy Materials, Wiley, 2011. Additional sources will be announced during the course
Further Information	Connections with other courses: Electrochemical Energy Storage and Conversion – course 45534 – Further Information extends some of the topics of the present

	course with emphasis on the Devices; it is therefore an ideal continuation, recommended to students attending Advanced Materials for Energy Engineering. Professional applications of the covered topics: Expertise in renewable and sustainable materials for energy engineering. Materials selection for high temperature applications; for electrochemical devices; all topics of the European Green Deal, solar, hydrogen, waste heat recovery.
Sustainable Development Goals (SDGs)	Affordable and clean energy, Climate action, Responsible consumption and production, Industry, innovation and infrastructure