# Syllabus

## *Course Description*

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| **Course Title** | Applied Energetics |
| **Course Code** | 45545 |
| **Course Title Additional** | |
| **Scientific-Disciplinary Sector** | IIND-07/A |
| **Language** | English |
| **Degree Course** | Master in Energy Engineering |
| **Other Degree Courses (Loaned)** | |
| **Lecturers** | Dr. Ing. Fabian Ernst Ochs,<br>FabianErnst.Ochs@unibz.it<br>https://www.unibz.it/en/faculties/engineering/academic-staff/person/32732<br>dr. Stefano Piazzi,<br>Stefano.Piazzi@unibz.it<br>https://www.unibz.it/en/faculties/engineering/academic-staff/person/38511 |
| **Teaching Assistant** | |
| **Semester** | First semester |
| **Course Year/s** | 1 |
| **CP** | 6 |
| **Teaching Hours** | 36 |
| **Lab Hours** | 24 |
| **Individual Study Hours** | 90 |
| **Planned Office Hours** | 18 |
| **Contents Summary** | The Applied Energetics course is a core teaching in the context of the Master in Energy Engineering and, specifically, it deals with an overview on nuclear energy systems and the fundamentals of energy systems analysis.<br><br>After completing the course, students should be able to:<br>• Understand the main energy resources and global energy |

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| | scenarios<br>• Understand the principles, technologies, and role of nuclear power systems within modern energy systems.<br>• Apply thermodynamic, heat transfer, and mass transfer principles to analyze engineering problems and thermal devices.<br>• Evaluate and analyze energy systems using technical (exergy), economic, and environmental (LCA) assessment methods.<br>• Develop a comprehensive engineering perspective on the design, performance, and sustainability of energy systems. |
| **Course Topics** | One part of the course, taught by Dr. Piazzi, is intended to give the students an overview of the different energy systems with a focus nuclear energy and different analysis techniques. The following topics will be covered:<br>• Overview of energy resources and the global energy mix.<br>• Analysis of energy scenarios and energy markets.<br>• Detailed study of nuclear energy systems.<br>• Assessment of energy systems from: 1) Economic perspective (energy economics indicators), 2) Environmental perspective (Life Cycle Assessment – LCA), 3) Technical perspective (exergy analysis).<br><br>The other part of the course, taught by Prof. Ochs, will cover the following topics:<br>• Basic thermodynamics concepts, First and, Second Law, material properties<br>• Heat transfer<br>• Mass transfer<br>• Components of energy systems (heat exchanger, cooling tower, heat pumps) |
| **Keywords** | Energy resources; Nuclear energy systems; Thermodynamics; Heat transfer; Mass transfer; Energy systems analysis |
| **Recommended Prerequisites** | Basic courses of thermodynamics |
| **Propaedeutic Courses** | |
| **Teaching Format** | The course consists of lectures in which the topics are presented by the professor. There are also classes (exercises) that will give practical examples of the application of theoretical topics. Course topics will be presented on the blackboard and using electronic slides. Teaching material and additional materials will be provided by the Professor during the semester. |

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| **Mandatory Attendance** | Not mandatory. |
| **Specific Educational Objectives and Learning Outcomes** | Intended Learning Outcomes (ILO)<br><br>Knowledge and understanding<br><br>Students should acquire the knowledge and the understanding of:<br>1. Applied thermodynamics and heat and mass transfer, with/without phase change. Knowledge of key factors for different thermal devices and systems, in particular, heat exchangers.<br>2. Energy resource and energy systems<br>3. Nuclear power plants<br>4. Energy systems analysis<br><br>Applying Knowledge and understanding<br><br>5. The ability to analyze the technical approach to thermodynamic problems of different appliances. The exercise part provides instruction on the calculation methods for thermodynamic problems as well as the calculation of various explicit examples on the white board and with computers.<br>6. The ability to analyze energy systems from different perspectives.<br><br>Making judgements<br><br>7. Autonomous judgement will be enhanced by means of the knowledge of basic concepts and analytical approaches applied to thermodynamic systems.<br><br>Communication skills<br><br>8. the ability to correctly and properly present the concepts acquired in the course both in written and oral form<br>9. the ability to use the proper technical terms to describe the topics covered during the course<br><br>Ability to learn<br><br>10. Capability of autonomous study of heat and mass transfer phenomena and mechanisms applied in thermal devices and |

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| | systems. |
| **Specific Educational Objectives and Learning Outcomes (additional info.)** | |
| **Assessment** | The students are asked to produce a group project work on the design and modeling of an energy system selected by each group; this part of the assessment evaluates the ability of the student to apply the topics of the course in actual contexts, the comprehension of the theoretical concepts and the ability to make judgments.<br><br>- Summative assessment:<br>100% project work presentation: presentation and discussion (30 minutes); ILOs assessed: 1,3,4,5,6,7,8,9. |
| **Evaluation Criteria** | Students regularly enrolled in the 1st year of the Master in Energy Engineering are eligible for the attendance of the lessons and the exam. Other exceptional cases have to be discussed with the Professor.<br><br>The project work will be presented in front of the class at the end of the course and will be evaluated according to different criteria:<br>• Difficulty of the chosen solution<br>• Relevance of Topic<br>• Description of Problem and Approach<br>• Details of the analysis<br>• Presentation of Results<br>• Sensitivity Analysis<br>• Communication skills and master of the technical language |
| **Required Readings** | Slides of the course. |
| **Supplementary Readings** | Müller, I., Müller, W. 2009, Fundamentals of Thermodynamics and Applications: With with Historical Annotations and Many Citations from Avogadro to Zermelo, Springer Verlag<br><br>VDI Wärmeatlas, Springer Verlag |

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| | Nellis, G., Klein, S., Heat Transfer, 2008 Cambridge University Press<br><br>Baehr, H.D., Kabelac, St. 2005, Thermodynamik, Springer Verlag<br><br>P.K. Nag, 2005, Engineering Thermodynamics, Tata McGraw-Hill Education<br><br>De Sanctis, E., Monti, S., Ripani, M., Energy from Nuclear Fission: An Introduction, Springer, 2016<br><br>Ronald Allen Knief, Nuclear Engineering: Theory and Technology of Commercial Nuclear Power, American Nuclear Society, 2008<br><br>Shigeaki Okajima, Teruhiko Kugo, Takamasa Mori, Nuclear Reactor Physics, Springer, 2024 |
| **Further Information** | Connections with other courses and Professional applications of the covered topics:<br>The knowledge acquired in this course is fundamental for energy engineers providing them with the basic knowledge of applied engineering thermodynamics and an understating of energy resources and nuclear energy systems.<br>The competences can be deployed in private engineering companies, in public agencies, in utilities' companies, as well as in the industry. |
| **Sustainable Development Goals (SDGs)** | Affordable and clean energy, Climate action, Sustainable cities and communities, Industry, innovation and infrastructure |