

| Module description: Refrigeration and Heat Pumps |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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| Module Code                                      | t.BA.EUSW.KMWP.25HS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| ECTS Credits                                     | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Language of Instruction/Examination              | German                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Organizational Unit                              | IEFE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Module Coordinator                               | Frank Tillenkamp                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Legal Framework                                  | The module description is part of the legal basis in addition to the general academic regulations. It is binding. During the first week of the semester a written and communicated supplement can specify the module description in more detail.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Module Characteristic                            | Type 2a<br><br>4 consecutive lecture lessons per semester week and class                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Module Description                               | Students learn the basics of chillers and heat pumps and are later able to plan and build these systems in an energy and environmentally friendly way. The thermodynamic processes in the refrigerant are considered in detail and possible cycle processes are analysed. The refrigerants that can be used are the subject of the course. The basics of deep and near-surface geothermal energy are taught in order to capture environmental heat from the ground.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Module Content                                   | <ul style="list-style-type: none"> <li>Fundamentals of refrigeration and heat pump technology</li> <li>Simple circuits</li> <li>Refrigerants in the context of the environment</li> <li>Chiller and heat pump components</li> <li>Planning and dimensioning of systems</li> <li>Geothermal sources</li> <li>Integration of near-surface geothermal energy into building technology</li> </ul> <p><b>Practical exercises:</b></p> <ul style="list-style-type: none"> <li>Analysing the operating conditions of R134a and CO2 systems</li> <li>Performance determination in simple and complex circuits</li> <li>Influence of the outdoor climate on the efficiency of the machines</li> <li>Application of a refrigeration circuit simulation tool</li> </ul> <p><b>Sustainable Development Goals</b></p> <ul style="list-style-type: none"> <li>SDG 4 – Quality Education With a focus on SDG 4, students acquire practical skills for analyzing, planning, and evaluating refrigeration systems and heat pumps. Laboratory experiments, simulations, and group projects encourage students to independently apply their knowledge to current issues in energy technology. SDG 7 – Affordable and Clean Energy With a focus on SDG 7, the course covers energy-efficient refrigeration and heat pump systems, as well as the use of ambient heat and geothermal energy. Students learn how to evaluate the energy efficiency of systems and design them for resource-efficient operation. SDG 9 – Industry, Innovation, and Infrastructure With a focus on SDG 9, the course examines innovative refrigerants, efficient system designs, and environmentally sustainable technologies in refrigeration and heat pump engineering. The goal is to equip students with the skills to design reliable, resource-efficient, and sustainable energy systems. SDG 11 – Sustainable Cities and Communities With a focus on SDG 11, this section highlights the contribution of efficient cooling and heat pump systems to sustainable heating and cooling in buildings and neighborhoods. In particular, it addresses the integration of environmental heat, geothermal energy, and heat utilization into building systems.</li> </ul> |
| Prerequisite Knowledge                           | Fundamentals of fluid dynamics, thermodynamics and applied heat transfer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

## Module description: Refrigeration and Heat Pumps

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|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------------|-----------|--------------------------|--------------------|
| Learning Objectives<br>(Competencies) | Students...                                                                                                                                                                                                                                                                                                                                             |            |               |           | Competencies             | Taxonomies         |
|                                       | Students acquire basic knowledge of near-surface geothermal energy and deep geothermal energy                                                                                                                                                                                                                                                           |            |               |           | F                        | K1, K2             |
|                                       | Students acquire knowledge of the basic circuits of the machines and their components.                                                                                                                                                                                                                                                                  |            |               |           | F                        | K1, K2, K3, K4, K5 |
|                                       | They understand the possible applications and limits of refrigerants and their effect in the atmosphere.                                                                                                                                                                                                                                                |            |               |           | M, F                     | K2, K3, K4, K5, K6 |
|                                       | Taking planning requirements into account, they can independently select, design and plan systems.                                                                                                                                                                                                                                                      |            |               |           | M, F                     | K3, K4, K5, K6     |
| Performance Assessment                | End-of-module exam                                                                                                                                                                                                                                                                                                                                      | Assessment | Length (min.) | Weighting | Social Form              | Scenario/Format    |
|                                       | written exam                                                                                                                                                                                                                                                                                                                                            | Grade      | 90            | 70.00%    | acc. to module agreement |                    |
|                                       |                                                                                                                                                                                                                                                                                                                                                         |            |               |           |                          |                    |
|                                       | Performance assessment during the semester                                                                                                                                                                                                                                                                                                              | Assessment | Length (min.) | Weighting | Social Form              | Scenario/Format    |
|                                       | Presentation of Experiments<br><i>Presentation of Experiments</i>                                                                                                                                                                                                                                                                                       | Grade      | 15            | 15.00%    | acc. to module agreement |                    |
|                                       | Presentation of Experiments<br><i>Presentation of Experiments</i>                                                                                                                                                                                                                                                                                       | Grade      | 15            | 15.00%    | acc. to module agreement |                    |
|                                       |                                                                                                                                                                                                                                                                                                                                                         |            |               |           |                          |                    |
| Classroom Attendance Requirement      | None                                                                                                                                                                                                                                                                                                                                                    |            |               |           |                          |                    |
| Learning material                     | <ul style="list-style-type: none"><li>Tillenkamp, F. (2026). Klimakälte heute. Faktor-Verlag. ISBN 978-3-905711-89-9. <a href="https://pubdb.bfe.admin.ch/de/publication/download/9742">https://pubdb.bfe.admin.ch/de/publication/download/9742</a>.</li><li>Reisner, K. (2022). Fachwissen Kältetechnik. VDE-Verlag. ISBN 978-3-8007-5270-6.</li></ul> |            |               |           |                          |                    |
| Comments                              | Two laboratory experiments are carried out in groups, the results of which are presented in plenary. Participation in the experiments and the presentations are included in the assessment.                                                                                                                                                             |            |               |           |                          |                    |