Universidad de Navarra

Energy Technologies (Ing.Gr.)
Guía docente 2026-27

PRESENTACIÓN

Breve descripción:

This course is a continuation of the course *Transferencia de Calor* (Heat Transfer), where students learnt about the conduction and convection modes of heat transfer. In this course, we focus on the study of **heat exchangers**, important devices that perform the heat transfer process between two fluids, and on the study of **boiling and condensation**, which is important in heat exchangers with two-phase flows. Additionally, **refrigeration cycles** are analyzed, with an emphasis on the study of a heat pump-air conditioner of Mitsubishi electric.

Titulación (Módulo/Materia):

- Ingeniería en Tecnologías Industriales (Bloque especializado en Tecnologías Industriales/Tecnología Energética)
- Ingeniería Mecánica (Bloque especializado Mecánica/Tecnología Térmica y de Fluidos)
- Ingeniería Eléctrica (Bloque Especializado de electricidad/Energía)

Detalles:

- **ECTS**: 4 ECTS
- **Curso, semestre**: 4.º curso, 1.º semestre
- **Carácter**: Obligatorio
- **Idioma**: English

Profesores de la asignatura:

- Aramburu Montenegro, Jorge / Profesor Titular
- Villarón Baz, Juan Ignacio / Colaborador docente

RESULTADOS DE APRENDIZAJE (Competencias)

INGENIERÍA EN TECNOLOGÍAS INDUSTRIALES

CG9 - Capacitar al egresado en un conjunto de competencias sociales, interpersonales, emocionales y de trabajo en un entorno multidisciplinar e internacional.

CG13 - Valorar la importancia de la gestión de la experiencia, el conocimiento y la tecnología como factores clave para la mejora de la competitividad en el entorno actual.

CE20 - Conocimientos aplicados de ingeniería térmica.

INGENIERÍA MECÁNICA

CE21 - Conocimientos aplicados de ingeniería térmica.

CG10 - Capacidad de trabajar en un entorno multilingüe y multidisciplinar.

INGENIERÍA ELÉCTRICA

CG10 - Capacidad de trabajar en un entorno multilingüe y multidisciplinar.

PROGRAMA

Unit 1: Heat exchangers

--Introduction. --Types of heat exchangers. --Design criteria and the fouling factor. --The overall heat transfer coefficient. --The log mean temperature difference method. --The effectiveness–NTU method. --Methodology to calculate a heat exchanger.

Unit 2: Boiling and condensation

--Dimensionless parameters in boiling and condensation. --Boiling modes. --Pool boiling. --Pool boiling correlations. --Forced convection boiling. --Condensation: physical mechanisms. --Laminar film condensation on a vertical plate. --Turbulent film condensation. --Condensation in horizontal tubes. --Film condensation on radial systems. --Dropwise condensation.

Unit 3: Refrigeration cycles

--Refrigeration and heat pumps. --The reversed Carnot cycle. --The ideal vapor-compression cycle. --Actual vapor-compression cycle. --Selecting the right refrigerant. --Heat pump systems. --Innovative vapor-compression cycles. --Gas refrigeration cycles. --Absorption refrigeration cycles. --Thermoelectric power generation and refrigeration systems.

ACTIVIDADES FORMATIVAS

The **dedication of 100-120 hours** (4 ECTS) to the course Energy Technologies is distributed in the following educational activities:

- Clases expositivas (AF1): 13 h teóricas + 27 h prácticas.
- Trabajos individuales y/o en equipo (trabajos) (AF4): 10 h.
- Tutorías y atención de dudas (AF6): 2 h.
- Estudio personal (AF5): 50 h.
- Evaluaciones (AF9): 5 h.

METODOLOGÍAS DOCENTES

- Clases expositivas
- Clases en sala de informática
- Clases en laboratorio
- Trabajo individual o en grupo, resolución de problemas e informes de laboratorio
- Entrevista personal con el profesor de una asignatura
- Realización de pruebas evaluadas

Lectures (*clases expositivas*) include both theoretical sessions and sessions where problems /exercises are solved. All the PowerPoint presentations that the lecturer uses during the lectures and the proposed problems for each unit are in Adi. In addition to attending the lectures, students analyze a heat-pump air conditioner of Mitsubishi theoretically in the computer rooms (*clases en sala de informática*) and experimentally in the lab (*clases en laboratorio*). From the study of Mitsubishi's equipment, student must write a report (*trabajo individual o en grupo, resolución de problemas e informes de laboratorio*). Students should work on their own according to their ability to learn concepts and the skills needed to successfully fulfill the competences listed in section "Competencias". Furthermore, tutorials (*entrevista personal con el profesor de una asignatura*) are available to all students, meaning that students are welcome to approach the lecturer to ask any course-related questions. The grade is calculated with an assessement that consists of all the items that are explained in section "Evaluación"; some of the items include tests and a midterm exam (*realización de pruebas evaluadas*).

EVALUACIÓN

CONVOCATORIA ORDINARIA

- **Evaluaciones parciales y finales (SE1)**: 70%.
- **Evaluación de trabajos individuales y/o en equipo (SE4)**: 20%.

- **Evaluación de actividades prácticas (SE2)**: 10%.

The maximum grade a student can get is 10/10. The grade is distributed as follows:

- Continuous assessmet: **5%**. Four online tests done via Adi.
- Midterm exam: **50%**. Two questions (5%) and a problem (20%) about Unit 1. Two questions (5%) and a problem (20%) about Unit 2.
- Exam: **20%**. Two-to-six questions (10%) and a problem (10%) about Unit 3.
- Report about the practical: **20%**.
- Assignment: **5%**.

To pass the course,

- **the overall grade must be greater than or equal to 5/10, AND**
- **the grade in the midterm exam must be greater than or equal to 3/10, AND**
- **the grade in the exam must be greater than or equal to 3/10.**

CONVOCATORIA EXTRAORDINARIA

- **Evaluaciones parciales y finales (SE1)**: 70%.
- **Evaluación de trabajos individuales y/o en equipo (SE4)**: 20%.
- **Evaluación de actividades prácticas (SE2)**: 10%.

If the subject is failed, then the parts that were not passed must be retaken (the midterm exam if the grade was below 5/10 and the exam if the grade was below 5/10). The **same criteria** used in the regular assessment will be followed (overall grade greater than or equal to 5/10 **AND** midterm exam's grade greater than or equal to 3/10 **AND** exam grade greater than or equal to 3/10). Two marks will be calculated: one considering the report about the practical session, the assignment, and the online tests, and the other without considering them. The grade distribution in the second grade would be: 71.4% midterm exam, and 28.6% exam.

ATTENTION: Please note that any attempt at fraud, copying, plagiarism, or other irregular behavior constitutes a serious offense as outlined in Title IV, "Academic Disciplinary Rules for Students," within the University of Navarra's Code of Conduct.

For further information on Assessment, please see the Assessment document in Adi.

HORARIOS DE ATENCIÓN

Dr Jorge Aramburu Montenegro (jaramburu@unav.es)

- Despacho IG-104. Edificio Igara. Planta -1.
- Horario de tutoría: Students are more than welcome to approach the lecturer to ask any course-related question. Appointments must be arranged by email at jaramburu@unav.es. As a general rule, emails will not be answered on weekends, and questions will not be addressed by email. Furthermore, questions regarding the midterm exams or final exams will not be answered on the day before the exam.

BIBLIOGRAFÍA

Basic bibliography:

- F. P. Incropera, D. P. De Witt, T. L. Bergman, and A. S. Lavine, *Fundamentals of Heat and Mass Transfer*, 6th edition, John Wiley & Sons, United States of America, 2007. Localízalo en la biblioteca
- Y. A. Çengel and M. A. Boles, *Thermodynamics: An Engineering Approach*, 5th edition, McGraw-Hill, 2006. Localízalo en la biblioteca