



PRESENTACIÓN

Breve descripción:

This course is a continuation of the courses *Transferencia de Calor* (Heat Transfer) and *Mecánica de Fluidos* (Fluid Mechanics), and students will broaden their knowledge of thermal-fluid sciences by studying **thermal radiation, combustion, turbomachinery, compressible flow, and aerodynamics**.

Titulación (Módulo/Materia):

- Ingeniería Mecánica (Bloque Especializado Mecánica/Tecnología Térmica y Fluidos)

Detalles:

- ECTS: 6 ECTS
- Curso, semestre: 4.^º curso, 2^º semestre
- Carácter: Obligatorio
- Idioma: English

Profesores de la asignatura:

- Aramburu Montenegro, Jorge/Profesor contratado doctor

COMPETENCIAS

INGENIERÍA MECÁNICA

CE20 - Conocimientos y capacidades para el cálculo, diseño y ensayo de máquinas.

CE24 - Conocimiento aplicado de los fundamentos de los sistemas y máquinas fluido-mecánicas.

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

PROGRAMA

Unit 0: Introduction to thermal engineering

--What and how? --Physical origins and rate equations. --Relationship to Thermodynamics. --Units and dimensions. --Analysis of heat transfer problems: methodology. --Relevance of heat transfer. --Summary

Unit 1: Thermal radiation

--Fundamental concepts. --Radiation heat fluxes. --Radiation intensity. --Blackbody radiation. --Emission from real surfaces. --Absorption, reflection, and transmission by real surfaces. --Kirchhoff's law. --The gray surface. --Environmental radiation.



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Unit 2: Radiation exchange between surfaces

--The view factor. --Blackbody radiation exchange. --Radiation exchange between opaque, diffuse, and gray surfaces in an enclosure. --Multimode heat transfer. --Implications of the simplifying assumptions. -Radiation exchange with participating media.

Unit 3: Chemical reactions: combustion

--Introduction. --Fuels and combustion. --Theoretical and actual combustion processes. --Enthalpy of formation and enthalpy of combustion. --First-law analysis of reacting systems. --Adiabatic flame temperature.

Unit 4: Turbomachinery

--Introduction. --Turbomachinery generalities. --Turbomachinery variables. --Velocity triangles and Euler's equation. --Dimensional analysis and similarity.

Unit 5: Compressible flow

--Introduction. --Thermodynamics of compressible flows. --Isentropic flow in ducts (i). --Shock waves in compressible flows. --Isentropic flow in ducts (ii).

Unit 6: Aerodynamics

--Introduction. --Drag force. --Lift force. --Flow-induced vibrations. --Effects of compressibility.

ACTIVIDADES FORMATIVAS

The **dedication of 150-180 hours** (6 ECTS) to the course Termotecnia y Fluidos is distributed in the following educational activities:

- Clases presenciales teóricas: 30 h.
- Clases presenciales prácticas: 30 h.
- Trabajos dirigidos: 0 h.
- Tutorías: 3 h.
- Estudio personal: 80 h.
- Evaluación: 7 h.
- Elaboración y defensa del PFG: 0 h.

METODOLOGÍAS DOCENTES

- Clases expositivas
- 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. 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". Additionally, 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 mark is calculated with an assessment that consists of all the items that are explained in section "Evaluación"; some of the items include mid-term exams (*realización de prueba evaluadas*).



EVALUACIÓN

CONVOCATORIA ORDINARIA

- **Intervención en clases, seminarios y clases prácticas:** 5%.
- **Evaluaciones parciales y finales:** 95%.

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

- Exams: **80%**. Exam 1 (20%) - Test E1 (4%), Problem E1 (16%); Exam 2 (20%) - Test E2 (4%), Problem E2 (16%); Exam 3 (20%) - Test E3 (4%), Problem E3 (16%); Exam 4 (20%) - Test E4 (4%), Problem E4 (16%) Exams 1, 2, 3 are taking during the semester.
- Self-evaluation tests: **15%**. Tests S1-S6. These are six tests, one per unit, each accounting for 2.5%, and are taken a week after a unit has been finished. (If there is no time to take Test S6, then each test accounts for 3%).
- Others: **5%**. Self-assessment (5%). In the self-assessment, the students are asked to give themselves a grade in the course.

Important: during Exam 4, students can retake Test E1, Problem E1, Test E2, Problem E2, Test E3, and/or Problem E3 if they have failed any of them. However, the maximum mark in each part will be 5/10 (for example: if all the questions in a test are correct the 10/10 mark will be reduced to 5/10). Please remember that a student could pass the subject if they have failed one or more parts. If a student decides to retake a part previously failed, the student has to inform the lecturer one week before Exam 4.

In order to pass the course,

- the overall mark must be greater than or equal to 5/10, AND
- students must have taken all the parts of all the exams, even though they fail one or more of them.

CONVOCATORIA EXTRAORDINARIA

- **Intervención en clases, seminarios y clases prácticas:** 5%.
- **Evaluaciones parciales y finales:** 95%.

Students will have to retake at least all the parts that were not previously passed (for example: Test E1, Problem E1, and Problem E3). A part is passed when the mark is greater than or equal to 5. For example, Test E1 is passed with 6/10 and Problem E1 is failed with 4 /10, therefore Problem E1 must be retaken, but Test E1 will be retaken only if the student wants to increase their mark. If someone decides to retake a part that was previously passed, the student has to inform the lecturer one week before the retake exam.

In the assessment, two marks will be calculated and the maximum will be the final mark. Mark A: with the same grade distribution as in the regular exam. Grade B: assuming Tests E1, E2, E3 and E4 account for 5% each and Problems E1, E2, E3 and E4 account for 20% each.

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

HORARIOS DE ATENCIÓN

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- Despacho IG-104. Edificio Igara. Planta -1



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- Horario de tutoría: Students are more than welcome to approach the lecturer to ask any course-related question. Appointments will be made via email at jaramburu@tecnun.es. In general, no email will be answered on weekends and doubts will not be solved by email.

BIBLIOGRAFÍA

Bibliografía básica:

- 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, Hoboken (NJ), 2007. [Chapter 1 for **Unit 0.**] [Localízalo en la biblioteca](#)
- 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, Hoboken (NJ), 2007. [Chapter 12 for **Unit 1** and Chapter 13 for **Unit 2.**] [Localízalo en la biblioteca](#)
- Y.A. Çengel and M.A. Boles, *Thermodynamics: An Engineering Approach*, 5th Edition, McGraw-Hill, Mexico, 2006. [Chapter 15 for **Unit 3.**] [Localízalo en la biblioteca](#)
- A. Rivas Nieto, *Máquinas Hidráulicas*, TECNUN Universidad de Navarra, Servicio de Publicaciones, 2008. [For **Unit 4.**]
- F. Santos Sabrés, *Máquinas Hidráulicas*, TECNUN Universidad de Navarra, Servicio de Publicaciones, 1999. [For **Unit 4.**]
- P. Gerhart, R. Gross y J. Hochstein, *Fundamentos de Mecánica de Fluidos*, 2^a Edición, Adison-Wesley Iberoamericana, Argentina, 1995. [Chapter 10 for **Unit 5** and Chapter 8 for **Unit 6.**] [Localízalo en la biblioteca](#)

Bibliografía complementaria:

- B. R. Munson, T. H. Okiishi, W. W. Huebsch, A. P. Rothmayer. *Fundamentals of Fluid Mechanics* (7th Edition), John Wiley & Sons, 2013. [Chapter 12 for **Unit 4**, Chapter 9 for **Unit 5**, and Chapter 7 for **Unit 6.**]
- Frank M. White, *Fluid Mechanics* (4th Edition), McGraw-Hill, 1998. [Chapter 11 for **Unit 4**, Chapter 9 for **Unit 5**, and Chapter 7 for **Unit 6.**] [Localízalo en la biblioteca](#)