



Bachelor in Physics

(Academic Year 2026-27)

Thermodynamics		Code	800499	Year	2nd	Sem.	1st
Module	General Core	Topic	Classical Physics		Character	Obligatory	

	Total	Theory	Exercises
ECTS Credits	7.5	4.5	3
Semester hours	69	39	30

Learning Objectives (according to the Degree's Verification Document)	
To get knowledge of: - Thermodynamic Laws and their consequences. - First Law as the general principle of energy conservation with an equation of state, the internal energy - Entropy and how its properties affect the thermodynamic behavior of systems. - Thermodynamic potentials as a complete information of a thermodynamic system. - Relationship between thermodynamic formalism and experiments.	
Brief description of contents	
Zeroth Law. Concept of temperature. First Law: internal energy and heat. Second Law: entropy. Thermodynamic potentials, stability and equilibrium. Open systems, phase changes, critical points. Third Law.	
Prerequisites	
Calculus. Fundamental Physics.	

Coordinator	María Amparo Izquierdo Gil			Dept.	EMFTEL
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Theory/Problems – Schedule and Teaching Staff								
Group	Lecture Room	Day	Time	Professor	Period/Dates	Hours	T/E	Dept.
B	10	Mo,Tu Fr	9:00 – 10:30 9:00 – 11:00	Mohamed Khayet Souhaimi	Full term	69	T/E	EMFTEL

T: Theory, E: Exercises

Office hours				
Group	Professor	Schedule	E-mail	Location
B	Mohamed Khayet Souhaimi	1er. semestre Tu: 12:15-14:00 We: 12:15-13:30 +3h online 2º semestre W: 11:00-14:00 +3h online	khayetm@fis.ucm.es	01.106.0

Syllabus
1.- Introduction and fundamental concepts. Microscopic and macroscopic descriptions. Thermodynamic systems. Thermodynamic variables. Equilibrium. Changes in equilibrium states and processes. 2.- Temperature and the Zeroth Law of Thermodynamics. Thermal equilibrium. Zeroth Law of Thermodynamics. Empirical temperature. Temperature scales. 3.- Phenomenological description of most common thermodynamics systems. Thermodynamic equilibrium. Hydrostatic systems. Description of other simple systems. 4.- The concept of work in Thermodynamics. Work in a hydrostatic system and in other simple systems. General equation of work. 5.- The First Law of Thermodynamics. Adiabatic work. Internal energy function. Heat flow. First Law of Thermodynamics. Heat concept. Heat capacity. Illustrative applications of the first Law of Thermodynamics. 6.- The Second Law of thermodynamics. Classical statements of the second Law of Thermodynamics. Entropy. Entropy and irreversibility. Principle of increase of entropy. 7.- Thermodynamic formalism of closed systems. Fundamental equation of Thermodynamics. Entropy and internal energy representations. Equilibrium and stability in a homogeneous closed system. 8.- Alternative representations. Thermodynamic potentials. Helmholtz and Gibbs functions. Maxwell' s relations. Equilibrium and stability in the alternative representations. 9.- Practical equations in Thermodynamics Practical equations for the entropy, the internal energy and the thermodynamic potentials. 10.- Open systems Second Law of Thermodynamics for open systems. Chemical potential. Fundamental equation and chemical potentials. Equilibrium conditions. Gibbs phase rule. 11.- Phase transitions Classification of phase transitions. First-order phase transitions. Clausius-Clapeyron equation. Other phase transitions. Critical points. 12.- Third Law of Thermodynamics Statements and consequences of the Third Law of Thermodynamics.
Bibliography
Basic: • D. Kondepudi, I. Prigogine, <i>Modern Thermodynamics</i> (Wiley) • M. W. Zemansky, R. H. Dittman, <i>Heat and Thermodynamics</i> (McGraw-Hill) • C.J. Adkins, <i>Equilibrium thermodynamics</i> (McGraw-Hill) Complementary: • W. Greiner, L. Neise y H. Stöcker. <i>Thermodynamics and Statistical Physics</i> (Springer Verlag) • M. Kardar. <i>Statistical Physics of Particles</i> (Cambridge University Press) • Münster, <i>Classical Thermodynamics</i> (Wiley-Interscience)

Online Resources
Virtual campus http://phet.colorado.edu/es/simulations/category/physics/heat-and-thermodynamics http://www.sc.ehu.es/sbweb/fisica/estadistica/estadistica.htm http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html http://entropysite.oxy.edu/

Methodology
The following formative activities will be developed: * Theory lessons where the main concepts of the subject will be explained. * Practical lessons involving resolution of exercises and supervised activities. Students will be provided with a collection of exercises prior to their resolution in class. Professor will receive students in the specified schedule of tutorials in order to solve doubts and expand concepts.

Evaluation Criteria		
Exams	Weight:	70 %
Final mark for the Exams section: N_{Exam}, between 0 and 10. There will be a practical final exam, consisting of solving problems and exercises, in which class notes and freely chosen books of theory can be used.		
Other Activities	Weight:	30 %
The continuous evaluation activities will consist of problems and/or exercises delivered throughout the course individually and/or in group, and/or small individual tests carried out during the course. The final mark for this section will be $N_{\text{OtherActiv}}$ and will range from 0 to 10.		
Final Mark		
Final mark: $C_{\text{Final}} = \max (0.7N_{\text{Exam}} + 0.3N_{\text{OtherActiv}} , N_{\text{Exam}})$ Minimum final exam mark to apply weighting: $N_{\text{Exam}} \geq 4$. If $N_{\text{Exam}} < 4$: the final mark of the course will be $C_{\text{Final}} = N_{\text{Exam}}$ The final mark criteria, as well as the grading for other activities, will be maintained in the exam of the extraordinary call.		